सत्यमेव जयते

भारत सरकार
GOVERNMENT OF INDIA

परमाणु ऊर्जा विभाग
DEPARTMENT OF ATOMIC ENERGY

निर्माण, सेवा एवं संपदा प्रबंध निदेशालय
DIRECTORATE OF CONSTRUCTION, SERVICES AND ESTATE MANAGEMENT



सिविल कार्यों के लिए विनिर्देश

SPECIFICATIONS FOR CIVIL WORKS

2023

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& ESTATE MANAGEMENT

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भारत सरकार / Governmemt of India
परमाणु ऊर्जा विभाग / Department of Atomic Energy
निर्माण सेवा एवं संपदा प्रबंध निदेशालय / Directorate of Construction Services & Estate Management

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FOREWORD

The DCSEM specifications for civil works being published by DCSEM from time to time are very comprehensive and useful in execution of works. These specifications not only give the standards for building materials but also serve as guidelines to engineers and contractors for specification of materials, execution of works and mode of measurements.

The DCSEM Specifications were first compiled in 2008. Subsequently, these specifications have been revised in the year 2015.

Many new items, construction technologies and materials, which are used in various DCSEM works and projects have been incorporated in this specifications of Civil works.

I wish to place on record the effective coordination on the part of Sh. Rajiv Nayan, Head (PCD) and technical inputs and the efforts by Sh. P. K. Panda (SO/G), Sh. A. G. Rajendra Babu (TO/F), Sh. R. P. Pareek (SO/F), Sh. M. Nagrajan (SO/E), Sh. M. N. Hulge (SA/D) and all other officers of this directorate in preparing and finalizing of these Specifications for Civil works-2023.

My special thanks to Chief Engineer (C2), Chief Engineer (C1/CQD) and Chief Engineer (ESG) for their valuable suggestions.

I am sure that these Specifications will be useful to all concerned in the building industry in general and DCSEM in particular.

09/06/2023

(K. Mahapatra)
Director

Place:- Mumbai
Date:- 09.06.2023

PREFACE

1. DCSEM Specifications for Civil works 2023 are the revised edition of existing DCSEM Specifications for Civil Works-2015.

2. DCSEM Specifications for Civil Works, 2023 will replace existing DCSEM Specifications for Civil Works, 2015. The specifications of many items have been updated and improved by making them more comprehensive. Many new items using new materials and latest technology have also been added.

3. Chapter wise salient features are as follows:

   3.1 **List of Indian Standard Codes:** Modified by deleting IS codes discontinued and by adding relevant IS codes.
   3.2 **Mandatory Test:** Reviewed and items such as AAC block, Paver block, natural stone, ready mix mortar etc added.
   3.3 **Earth Work & Allied Works:** Specifications for filling in plinth with fly ash have been incorporated.
   3.4 **Concrete & Allied Works:** Specification are modified according to latest revision of IS codes.
   3.5 **Masonry Works:** Specifications for Autoclaved Aerated Concrete Masonry Work have been incorporated.
   3.6 **Flooring Works:** Specifications tile adhesive and chequered cement tile flooring have been incorporated.
   3.7 **Joinery Works:** Specifications for uPVC casement/sliding windows & doors, Wire Mesh, paneling material have been incorporated.
   3.8 **Roofing:** Specifications for suspended polyester fiber HD panel false ceiling system have been incorporated.
   3.9 **Waterproofing Works:** Specifications for chemical based water proofing system and underground tank external HDPE water proofing have been incorporated.
   3.10 **Road Works:** Specifications for Granular sub base (GSB), Wet Mix Macadam (WMM) & Dense Bitumen Macadam (DBM) have been incorporated.
   3.11 Specifications for structural auditing of buildings have been incorporated.
   3.12 Recommended / preferred manufacturer list for materials is modified by deleting names of discontinued makes and by incorporating of new makes.

4. Due care has been taken to prepare DCSEM Specifications for Civil works 2023 as correctly as possible. It is, however, possible that some errors might have crept in inadvertently. In case any error or omission is noticed, it may be brought to the notice of the **Head (PCD), DCSEM, V. S. Bhawan, Anushaktinagar, Mumbai-400094.**

   Suggestions for improvement are always welcome.

Rajiv 09/06/2023

Place:- Mumbai
Date:- 09.06.2023

(Rajiv Nayan)
Head (PCD)

DEPARTMENT OF ATOMIC ENERGY
DIRECTORATE OF CONSTRUCTION, SERVICES & ESTATE MANAGEMENT
SPECIFICATIONS FOR CIVIL WORKS: 2023

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Specifications for Civil Works (General Notes)

i. The detailed specifications given hereinafter are for the items of works described in the schedule ofquantities and shall be guidance for proper execution of work to the required standards.

ii. It may also be noted that the specifications are of generalised nature and these shall be read in conjunction with the description of item in schedule of quantities and drawings. The work also includes all minor details of construction which are obviously and fairly intended and which may not have been referred to in these documents but are essential for the entire completion in accordance with standard Engineering practice.

iii. Unless specifically otherwise mentioned, all the applicable codes and standards published by the Bureau of Indian Standards and all other standards which may be published by them before the date of receipt of tenders, shall govern in all respects of design, workmanship, quality and properties of materials and methods of testing, method of measurements etc. Wherever any reference to any Indian Standard Specifications occurs in the documents relating to this contract, the same shall be inclusiveof all amendments issued thereto or revisions thereof, if any, up to the date of receipt of tenders.

iv. In case there is no I.S. specification for the particular work, such work shall be carried out in accordance with the general guidelines of manufacturer/specialised agency subject to full satisfaction and approval of the Engineer-in-Charge.

v. The work shall be carried out in a manner complying in all respects with the requirements of relevant bye-laws of the Municipal Committee/Municipal Corporation/Development Authority/Improvement Trust under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-Charge and, unless otherwise mentioned, nothing extra shall be paid on this account.

vi. Samples of various materials, fittings etc. proposed to be incorporated in the work shall be submittedby the contractor for approval of the EIC before order for bulk supply is placed.

vii. The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials in any place. No excavated earth or building materials shall be stacked on areas where other buildings, roads, services, compound walls etc. are to be constructed.

viii. The contractor shall maintain in perfect condition all works executed till the completion of the entire work awarded to him. Where phased delivery is contemplated, this provision shall apply to each phase.

ix. The contractor shall give a performance test of the entire installation(s) as per standard specifications before the work is finally accepted and nothing extra whatsoever shall be payable to the contractor for the test.

x. The contractor shall clear the site thoroughly of all scaffolding materials and rubbish etc. left out of his work and dress the site around the building to the satisfaction of the Engineer-in-Charge before the work is considered as complete.

xi. Post construction inspection and testing: After completion of the work and during maintenance period liability of the contractor, the work shall also be subjected to 'Post construction inspection and testing'. In case the materials or articles incorporated in the work are found to be inferior, though the samplecollected for the same might have been passed at the time of execution, it shall be the responsibility of the contractor to replace the same at his own cost, failing which the Department may rectify the same at the risk and cost of the contractor or Department may accept the work as sub-standard, and cost be adjusted from the outstanding security deposit, as per the terms and conditions of the contract for the work.

xii. The Chief Engineer, DCSEM, shall be the sole deciding authority as to the meaning, interpretationsand implications for various provisions of the specifications and his decision in writing shall be final and binding on all concerned.

xiii. In case any difference or discrepancy between the specifications and the description in the schedule of quantities, the schedule of quantities shall take precedence. In case of any difference or discrepancy between specifications and drawing, the specifications shall take precedence.

II - LIST OF INDIAN STANDARDS

Following are the Indian Standards, relevant to building works

(All Latest Versions of I.S. code with relevant Parts & Sections shall be referred)

I. S. CODE NO.	SUBJECT
1. CARRIAGE OF MATERIALS	
4082	Recommendations on stacking & storage of construction materials and components at site.
2. EARTH WORK	
632	Specification for Gamma-BHC (Lindane) Emulsifiable Concentrate.
1200 (Part-1)	Methods of measurement of building and Civil Engineering Works (Part-1: Earth Work)
4081	Safety code for Blasting and related drilling operations.
6313 (Part 2)	Code of practice for Anti Termite Measures in Buildings (Part-2 : Pre-constructional chemical treatment Measures)
6313 (Part 3)	Code of practice for Anti Termite Measures in Buildings (Part-3: Treatment for existing buildings)
6940	Methods of Test of Pesticides and their formulation.
8944	Specification for Chlorpyrifos Emulsifiable Concentrate.
8963	Technical Specification- Chlorpyrifos
3. MORTAR	
196	Atmospheric conditions for testing
269	Ordinary Portland cement, 33 Grade
383	Coarse and fine aggregate for concrete -Specification
455	Portland slag cement - Specification
650	Standard sand for testing of cement - Specification
1344	Specifications for calcined clay pozzolana
1489	Portland Pozzolana cement -Specification (Part-1: Fly ash based), (Part-2: Calcined Clay Based)
1542	Sand for Plaster - Specification
1727	Methods of tests for pozzolanic materials
2116	Specification for -Sand for Masonry mortars
2250	Code of practice for preparation and use of masonry mortars
2386	Methods of Test for Aggregates for Concrete
2386 Pt.I	Particle size and shape)
2386 Pt. II	Estimation of deleterious materials and organic impurities
2386 Pt.III	Specific gravity, density, voids, absorption and bulking
3025	Methods of sampling & test (Physical & Chemical) for water and waste water
3812 (Part-1 & 2)	Pulverized Fuel ash (Part-1: For use as pozzolana in cement, cement mortar and concrete.) (Part-2: For use as admixture in cement mortar and concrete)
4031 (Part-1 to 15)	Methods of physical tests for hydraulic cement
4032	Method of chemical analysis of hydraulic cement
8041	Rapid hardening Portland cement - Specifications
8042	White Portland cement - Specification
8043	Hydrophobic Portland cement - Specifications
8112	Ordinary Portland cement- 43 grade- Specification

I. S. CODE NO.	SUBJECT
12269	Ordinary Portland cement -53 grade-Specifications
4. CONCRETE WORK	
383	Coarse and fine aggregate for concrete -Specification
456	Code of practice for plain and reinforced concrete
516	Hardened Concrete-Methods of Test
1199	Method of sampling and analysis of concrete
1200 (Part-2)	Methods of measurement of building and Civil Engineering Works (Part-II: concrete work.)
1322	Bitumen felts for water proofing and damp proofing
2386	Methods of test for aggregate for concrete
2505	Concrete vibrators- Immersion type-General requirements
2506	General requirements of screed board type vibrators
2645	Integral water proofing compounds for Cement Mortor and Concrete -Specification
7861 (Part-1)	Hot weather concreting.
7861 (Part-2)	Cold weather concreting.
9103	Admixture for concrete.
5. R.C.C. WORK	
432-(Part-1)	Mild steel & medium tensile steel bars and hard drawn steel wire for concrete reinforcement.- Mild steel & medium tensile steel bars
432 (Part-2)	Mild steel & medium tensile steel bars and hard drawn steel wire for concrete reinforcement - Hard drawn steel wire
456	Code of practice for plain and reinforced concrete
457	Code of practice for general const. of plain & reinforced concrete for dams & other massive structure.
516	Hardened Concrete-Methods of Test
1161	Steel tubes for structural purposes
1199	Methods of sampling and analysis of concrete.
1200 (Part-2)	Methods of measurement of building and Civil Engineering Works (Part-II: concrete work.)
1200 (Part-5)	Methods of measurement of building and Civil Engineering Works (Part-V: form work).
1343	Pre-stressed Concrete - Code of practice
1566	Hard drawn steel wire fabric for concrete reinforcements
1599	Method for Bend Test
1608	Metallic materials - Tensile testing at ambient temperature
1785 (Part-I& II)	Specifications for plain hard drawn steel wire for pre-stressed concrete
1786	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
1893 (Part-1)	Criteria for Earthquake resistant design of Structures (General provisions and Building)
1893 (Part-4)	Criteria for Earthquake resistant design of Structures (Industrial structures including stack like structures)
2090	Specifications for high tensile steel bars used in prestressed concrete.
2204	Code of practice for construction of reinforced concrete shell roof.
2210	Criteria for the design of shell structure and folded plates
2314	Steel Sheet Piling Sections.
2502	Code of practice for bending and fixing of bars for concrete reinforcement.
2750	Specifications for steel scaffoldings
2751	Code of practice for welding of mild steel plain & deformed bars used for reinforced concrete construction.
2911-(Part-1)	Code of practice for design & Construction of pile foundations (Section -1 to 3)

I. S. CODE NO.	SUBJECT
2911(Part-1-Section-4)	Design & construction of Pile Foundations - Bored precast concrete piles.
2911 (Part-3)	Under reamed pile foundations
2911 (Part-4)	Load test on Piles
3201	Criteria for design and construction of precast concrete trusses and purlins
3370. (Part I to IV)	Code of practice for concrete structures for storage of liquids.
3414	Code of practice for design and installation of joints in buildings.
3558	Code of practice for use of immersion vibrators for consolidating concrete
3696 (Part 1 & 2)	Safety code for scaffolds & ladders
3935	Code of practice for composite construction.
4014(Part1 & 2)	COP for steel tubular scaffolding (I: Defination/Material; II: Safety Resolutions) (Reaffirmed 1999)
4326	Earthquake resistant design and construction of Buildings - Code of Practice
4926	Code of practice for Ready Mix Concrete
4990	Plywood for concrete shuttering work - Specifications
5121	Safety code for piling and other deep foundation
9716	Guide for lateral dynamic load test on piles
10262	Guidelines for Concrete Mix Design Proportioning
13920	Code of Practice-Ductile detailing of Reinforced concrete structures subject to seismic forces.
14362	Pile boring equipments-General requirements.
6. EQUIPMENTS	
460(Pt-I,II& III)	Specification for test sieves.
1791	Specification for batch type concrete mixer.
2430	Methods for sampling of Aggregates for concrete.
2505	General requirement for concrete vibrators, immersion type
2506	General requirements for screed board concrete vibrators
2514	Specification for concrete vibrating tables.
2722	Specification for portable swing weigh batchers for concrete (single and double bucket type).
2750	Specification for steel scaffolding.
7. MASONRY WORK:	
1077	Common burnt clay building bricks
1200 (Pt-.III)	Methods of measurement of building and Civil Engineering Works (Part-3: Brick work)
2116	Sand for masonry mortars.
2185	Concrete Masonry Units - Specifications
2212	Code of practice for brick work
2222	Burnt clay perforated building bricks.
2849	Specification for non load bearing gypsum partition blocks(solid and hollow types)
3495 (Part 1 to 4)	Method for test for burnt clay building brick
4139	Specification for calcium silicate bricks
5454	Method for sampling of clay building bricks.
6041	Code of Practice for construction of autoclaved cellular concrete block masonry
6441	Methods of test for autoclaved cellular concrete products
12894	Pulverized fuel ash- lime bricks specification
13757	Specification of burnt clay fly ash bricks

I. S. CODE NO.	SUBJECT
8. STONE WORK:	
1121(Part-1to 4)	Methods for determination of compressive, transverse, tensile & shear strengthsof natural building stones
1122	Methods for determination of specific gravity and porosity of natural building stones
1123	Methods for identification examination of natural building stones
1124	Methods of test for water absorption of natural building stones
1125	Determination of weathering of natural building stones - Method of Test
1126	Determination of durability of natural building stones - Method of Test
1129	Dressing of natural building stones
1200 (Part-4)	Methods of measurement of building and Civil Engineering Works (Part-4: Stone Masonry)
1597. (Part-1)	Code of practice for construction of Rubble stone masonry
1597 (Part-.2)	Code of practice for construction of Ashlar masonry
1805	Glossary of Terms relating to stone Quarrying and dressing.
4101 (Part-1)	Code of practice for external facings and veneers Part-1: Stone facing.)
9. MARBLE WORK:	
1122	Methods for determination of specific gravity and porosity of natural building stones
1124	Methods of test for water absorption of natural building stones
1130	Marble (blocks, slabs and tiles)
3316	Structural granite
14223(Part-1)	Polishing building stones-Granite.
10. WOOD WORK:	
204	Tower bolts (Part I-: ferrous metals; Part II -: Non ferrous metals).
205	Non-ferrous metal butt hinges
206	Tee and strap hinges - Specification
207	Gate and shutter hooks and eyes.
208	Door handles - Specification
281	Mild steel sliding door bolts for use with padlocks - Specification
287	Permissible moisture contents of timber used for Different purposes - Recommendations.
303	Plywood for general purpose
362	Parliament hinges
363	Hasps and staples
364	Fanlight catch
401	Preservation of timber Code of practice
419	Putty for use on window frame
451	Technical supply condition for wood screws
452	Door springs, rat-tail type
453	Double acting spring hinges.
707	Glossary of term applicable to timber technology and utilization.
710	Specifications for marine ply.
723	Steel counter sunk head wire nails.
729	Drawer locks, cupboard locks, and box locks
848	Specification for Synthetic resin adhesive for plywood (phenolic and aminoplastic)
851	Synthetic resin adhesive for construction work (Non-structural) in wood
852	Specifications for animal glue for general wood working purposes.
875 (Part-1)	Dead loads - Unit weight of building materials & stored materials
883	Design of structural timber in Building.

I. S. CODE NO.	SUBJECT
1003(Part-1I)	Timber panelled and glazed shutters (Door shutters)
1003 (Part-2)	Timber panelled and glazed shutters(windows and ventilator shutters)
1019	Rim latches
1141	Code of practice for seasoning of timber
1200	Method of measurement of Building and Civil Engineering works
1200 (Part-14)	Methods of measurement of building and Civil Engineering Works, (Part-14: Glazing.
1200 (Part-21)	Methods of measurement of building and Civil Engineering Works (Part-21: Wood work and joinery.
1328	Veneered decorative plywood
1341	Steel Butt hinges
1378	Oxidized copper finishes.
1568	Wire cloth for general purposes.
1658	Fiber hard board - Specifications
1659	Block boards
1708	Method of testing of clear specimen of timber
1734	Methods of tests for plywood
1823	Floor door stoppers.
1837	Fanlight pivots
1868	Anodic coating on Aluminium & its alloy
2046	Decorative thermosetting synthetic resins bonded laminated sheet.
2095 (Part 1)	Gypsum plaster board - Part 1 - Plain Gypsum Plaster Board.
2095 (Part 2)	Gypsum plaster board - Part 2 - Coated/ Laminated Gypsum Plaster Board.
2096	Specification for A.C. flat sheet.
2191(Part1)	Wooden flush door shutter (cellular and hollow core type)- Plywood face panels
2191 (Part2)	Particle board face panels and hard board face panels.
2202-(Part1)	Wooden flush door shutters (solid core type)- Plywood face panels
2202 (Part2)	Particle board face panels for wooden flush door shutters.
2209(Part1)	Mortise locks (vertical type)
2380	Method of test for wood particle board and boards from lignocellulosic materials
2547	Specification for gypsum plaster
2681	Non ferrous metal sliding door bolts(aldrop) for use with pad locks
2753	Method for estimation of preservatives in treated timber and its treating solutions.
2835	Flat transparent sheet glass
3087	Particle boards of wood and other lignocellulosic materials (medium density) for general purposes - Specification
3097	Veneered particle boards - Specification
3400 (Part I)	Method of test for vulcanized rubbers Part 1: Tensile Stress - Strain Properties
3400-(Part2)	-Hardness
3400-(Part4)	-Accelerated aging
3564	Door closers (Hydraulically regulated)
3618	Phosphate treatment of iron and steel for protection against corrosion.
3818	Continuous (Piano) hinges
3828	Ventilator chains
3847	Mortise Night Latches
4020 (1 to 16)	Methods of tests for wooden flush Doors .
4021	Timber door, window and ventilator frames
4835	Polyvinyl acetate dispersion base adhesive for wood
4948	Welded steel wire fabric for general use.
4992	Door Handles for mortise locks (vertical type).

I. S. CODE NO.	SUBJECT
5187	Flush bolts
5509	Specification for Fire Retardant Plywood
5523	Method of testing anodic coating on aluminium & its alloys.
5930	Mortise latch (vertical types)
6318	Plastic window stays & fasteners
6607	Rebated mortise locks (vertical type)
6760	Slotted countersunk head wood screws.
7196	Hold fasts
7197	Double action floor springs (without oil check) for heavy doors
7534	Sliding locking bolt for use with padlocks.
7638	Wood/lignocellulosic based panel products-Method for sampling
8756	Mortise ball catches for use in wooden almirah
11215	Moisture content of timber and timber products-Method of determination.
12406	Medium density fibre board for general purpose - Specification
12817	Stainless steel Butt hinges
12823	Specification for wood products-Pre-laminated particle boards
14856	Glass fibre reinforced plastic (GRP) panel type door shutters for internal use - Specifications
14900	Specification for transparent float glass.
11. STEEL WORK:	
63	Whiting for paints and putty - Specifications
198	Varnish, gold size.
228	Methods of chemical analysis of Structural steel
277	Specification for galvanised steel sheets (plain and corrugated)
278	Galvanised steel barbed wire for fencing - Specification
800	General Conatruction in Steel - Code of practice
806	Code of practice for use of steel tube in general building construction
808	Dimension for hot rolled steel beam, column, channel and angle section
813	Scheme of symbols for welding.
814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
816	Code of practice for use of metal ARC welding for general construction in mild steel
817	Code of practice for training and testing of metal arc welders.
818	COP for safety & healthy requirements in electric & gas welding & cutting operation.
822	Code of practice for inspection of welds..
1038	Steel doors, windows and ventilators
1081	COP for fixing & glazing of metal (steel & aluminium) doors, windows & ventilators
1148	Steel rivet bars (Medium and High Strength) for structural purposes
1161	Steel tubes for structural purposes
1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates.
1200 (Part 8)	Methods of measurement of building and Civil Engineering Works Part-8: steel work and iron works
1363 (Part 1 to 3)	Hexagon head bolts, screws and nuts of product grade C
1599	Metallic Materials - Bend Test
1608	Mechanical testing of materials - tensile testing
1730	Steel plates, sheets, strips and flats for structural and general engineering purposes- Dimensions

I. S. CODE NO.	SUBJECT
1821	Dimensions for clearance holes for metric bolts.
1852	Rolling and cutting tolerance for hot rolled steel products.
2062	Hot rolled medium and high tensile structural steel
4351	Steel door frames.
4736	Hot-dip zinc coatings on steel tubes.
4923	Hollow steel sections for structural use-specification
6248	Metal rolling shutters and rolling grills.
6911	Stainless Steel plates,Sheet and Strip- Specification.
7452	Hot rolled steel sections for doors, windows & ventilators.
12. FLOORING:	
210	Grey iron casting
653	Linoleum sheets and tiles - Specifications
809	Rubber flooring materials for general purpose
1122	Methods for determination of specific gravity and porosity of natural building stones)
1124	Method of test for water absorption of natural building stones
1130	Marble (blocks, slabs and tiles).
1197	Code of practice for laying of rubber floors.
1198	Code of practice for laying, fixing and maintenance of linoleum floors
1200 (Part11)	Methods of measurement of building and Civil Engineering Works Part-11 paving and floor finishes.
1237	Cement concrete flooring tiles - Specifications
1443	Code of practice for laying and finishing of cement concrete flooring tiles
1661	Code of practice for application of cement and cement lime plaster finishes
2114	Code of practice for laying in situ terrazzo floor finish
2571	Code of practice for laying in situ cement concrete flooring
3461	Specification for PVC Asbestos Floor Tiles
3462	Flexible P.V.C. Flooring.
3670	Code of practice for construction of timber floor
4457	Ceramic Glazed vitreous acid resisting tiles- specifications
4631	Code of practice for laying of epoxy resin floor toppings
5318	Code of practice for laying of flexible P.V.C. sheet & tiles flooring
5389	Code of practice for laying of hardwood parquet and wood block floors.
9197	Specifications for epoxy resin, hardeners and epoxy resin compositions for floor topping
13630 (Part1to15)	Ceramic tiles- Methods of test, sampling and basis for acceptance.
13712	Specification for ceramic tiles; definition, classification, characteristic and marking.
15477	Adhesive for use with ceramic tiles and mosaics
15622	Pressed ceramic tiles - Specifications
15658	Concrete paving Blocks - Specification
13. ROOFING	
73	Paving Bitumen
277	Galvanised steel sheets (plain and corrugated)
458	Concrete pipes (with and without reinforcement)
459	Corrugated and semi-corrugated asbestos cement sheets
651	Glazed stone ware pipes and fittings
702	Industrial Bitumen

I. S. CODE NO.	SUBJECT
1199	Method of Sampling & Analysis of concrete
1200 (Part9)	Methods of measurement of building and Civil Engineering Works Part-9 roof covering (including cladding)
1200 (Part10)	Methods of measurement of building and Civil Engineering Works Part-10 ceiling and lining
1254	Corrugated aluminium sheets
1322	Bitumen felts for water proofing and damp-proofing.
1346	Code of practice for waterproofing of roof with bitumen felts
1609	Code of practice for laying damp proof treatment using bitumen felts
1626 (Part 1-3)	Asbestos cement building pipes, gutters and fittings (Spigot and socket types)
1834	Specification for hot applied sealing compounds for joints in concrete.
1838	Preformed filler for expansion joints in concrete- non-extruding and resilient type Bitumen impregnated fiber).
2115	Code of practice for flat roof finish: mud phuska.
2633	Method of testing uniformity of coating on zinc coated articles.
3007-(Part1)	Code of practice for laying of corrugated asbestos cement sheets.
3007-(Part2)	Code of practice for laying of semi corrugated asbestos cement sheet.
3348	Fiber insulation boards. (
3384	Specification for bitumen primer for water proofing and damp proofing.
3607	Magnesite for chemical Industry. (Reaffirmed - 2003)
4671	Expanded polystyrene for thermal insulation purposes.
7193	Glass fiber base Bitumen felts
8183	Bonded mineral wool.
14753	Polymethyl Metacrylate (PMMA) (Acrylic) sheets
14862	Fibre cement flat sheets- specifications.
14871	Specifications for products in fibre reinforced Cement-Long corrugated or Asymmetrcal section sheets and fittings for roofing and cladding.
14. FINISHING	
75	Linseed oil, raw and refined.
77	Linseed oil, boiled, for paints.
104	Specification for ready mixed paint, brushing, zinc chrome, priming.
109	Specification for ready mixed paint, brushing priming plaster to Indian Standard colour, white and off white.
133	Enamel, interior (a) under coating (b) finishing colour as required
137	Ready mixed paint, brushing, matt or egg-shell flat, finishing, interior, to Indian Standard Colour, as required.
158	Ready mixed paint, brushing, bituminous, black lead free acid alkali, water and heat resisting for general purposes.
168	Ready mixed paint, air drying for general purpose.
217	Cut back bitumen
218	Creosote oil for use as wood preservatives
337	Varnish, finishing interior.
341	Black Japan, types A, B, and C
347	Varnish, shellac for general purpose.
348	French polish.
419	Putty for use of window frames. (Reaffirmed - 2001)
427	Distemper, dry, colour as required.
428	Washable distemper - Specification
524	Varnish, finishing, exterior, synthetic air drying.
525	Varnish, finishing, exterior and general purposes

I. S. CODE NO.	SUBJECT
533	Gum spirit of turpentine (oil of turpentine)
712	Specification for building limes.
1200 (Part12)	Methods of measurement of building and Civil Engineering Works Part-12 plastering and pointing
1200 (Part13)	Methods of measurement of building and Civil Engineering Works Part-13 white washing, colour washing, distempering and other finishes
1200 (Partt.15)	Methods of measurement of building and Civil Engineering Works Part-15 painting, polishing & varnishing.
2095 (Part1-3)	Gypsum plaster boards
2096	Asbestos cement flat sheets.
2339	Aluminium paint for general purposes - In dual Container
2547(Part2)	Gypsum building plaster-premixed light weight plasters.
2932	Enamel synthetic, exterior (a) Under coating (b) Finishing.
2933	Enamel, Exterior (a) Under coating (b) Finishing
5410	Cement paint - Specification
6278	Code of practice for white washing & colour washing.
13607	Ready Mixed Paint, Finishing, General Purposes, Synthetic
15489	Paint, Plastic Emulsion - Specification
15. ALUMINIUM:	
733	Wrought Aluminium and Aluminium alloys, bars, rods and sections (For General Engineering purpose)-Specification.
737	Wrought Aluminium and Aluminium alloys sheet and strip for General Engineering purpose)-Specification.
1285	Wrought Aluminium and Aluminium alloys, Extruded round tube and Hollow section and sections(For General Engineering purposes))-Specification.
1868	Anodic coating on Aluminium and its alloys- Specification.
1948	Specification for Aluminium Doors, windows and ventilators.
2553 (Part 1)	Safety Glass- General Purpose **(For toughened and laminated glass)**
3908	Specification for Aluminium equal leg angles.
3909	Specification for Aluminium unequal leg angles.
5523	Method of testing anodic coating on aluminium and its alloy.
6012	Measurement of coating thickness by Eddy Current Method
6315	Floor Springs (Hydraulically Regulated) for heavy doors-Specifications
6477	Dimensions For wrought aluminium and aluminium alloys extruded sections
14900	Transparent Float glass-Specification.
16. WATER PROOFING:	
1322	Specifications for bitumen felts for water proofing and damp proofing
2645	Specifications for Integral cement water proofing compounds.
3370-(Part1)	Code of practice for concrete structures for the storage of Liquid-General requirements
3370-(Part2)	Code of practice for concrete structures for the storage of Liquid-Reinforced concrete structures.
3384	Specifications for bitumen primer for water proofing and damp proofing.
7193	Glass fibre base bitumen felts.
12200	Provision of water stops at transfers construction joints in masonry and concrete dams-code of practice.
12432(Part3)	Application for spray applied insulation- Code of practice: Polyurethane/ polyisocyarurate.

I. S. CODE NO.	SUBJECT
17. DEMOLITION AND DISMANTLING:	
1200(Part18)	Methods of measurement of building and Civil Engineering Works Part-18 : Demolition and dismantling.
4130	Demolition of buildings - Code of Safety
18. ROAD WORKS:	
73	Paving Bitumen
164	Ready mixed paint for road marking
217	Cut Back bitumen
334	Glossary of terms relating to bitumen and tar.
702	Specification for industrial bitumen.
1195	Specification for I bitumen mastic for flooring
1201 to 1220	Methods for Testing Tar and bituminous materials
1834	Specification for hot applied sealing compound for joints in concrete.
2720(Part5)	Method of test for soil: determination of liquid limit and plastic limit.
2720(Part7)	Method of test for soil: determination of water content - dry density relation using light compaction.
2720(Part27)	Method of test for soil: determination of dry density of soils in place, by sand replacement method.
5317	Pitch mastic asphalt for bridge decking & Roads-Specifications
5640	Method of test for determining aggregate impact value of soft coarse aggregates.
6241	Method of test for determination of stripping value of road aggregates.
13801	Chequered cement concrete tiles - Specifications
15658	Concrete paving Blocks Specification
IRC 10	Recommended practice for borrow pits for road embankments constructed by manual operation.
IRC 14	Recommended practice for open graded premix carpet
IRC 16	Standard Specifications and code of practice for prime coat & Tack coat
IRC 19	Standard Specifications and code of practice for water bound macadam
IRC 27	Specifications for bituminous macadam
IRC 29	Specification for bituminous concrete for road pavements
IRC 35	Code of practice for road marking
IRC 37	Guidelines for design of flexible pavments
IRC 36	Recommended practice for construction of earth embankments for road works.
IRC 60	Tentative guidelines for the use of lime fly ash concrete as pavement base of sub base.
IRC 88	Recommended practice for lime fly ash stabilized soil base/sub base in pavement construction.
IRC 94	Specifications for dense bituminous macadam
IRC 95	Specifications for semi dense bituminous macadam
IRC 107	Specification for bitumen mastic wearing courses.
IRC 109	Guidelines for wet mix macadam
IRC SP 78	Specifications for mix seal surfacing (MSS) close graded premix surfacing (CGPS)
19. SAFETY CODES	
818	Safety and healthy requirements in Electric and gas welding and cutting operations.
3696 (Part-I)	Safety code for scaffolds
3696 (Part-II)	Safety code for ladders
3764	Safety code for Excavation works
4081	Safety code for blasting and related drilling operation

I. S. CODE NO.	SUBJECT
4130	Safety code for Demolition of Building
5916	Safety code for construction involving use of hot bituminous materials
6922	Criteria for safety & Design of structures subject to underground blasts.
7293	Safety code for working with construction machinery.

III - MANDATORY TESTS

NOTES:

i. The mandatory tests shall be carried out when the quantity of materials to be used in the work exceeds the minimum quantity specified.

ii. If the quantity of materials to be used in work is less than minimum quantity as specified for mandatory test, the contractor shall submit manufacturer's test certificate, if asked for by EIC.

iii. Optional tests specified or any other tests, shall be carried out in case of specialized works or important structures as per direction of the Engineer-in-Charge.

iv. Testing charges, including incidental charges and cost of sample for testing shall be borne by the contractor for all mandatory & optional tests.

v. In case of non-IS materials, it shall be the responsibility of the contractor to establish the conformity of material with similar IS specification by carrying out necessary tests. Testing charges including incidental charges and cost of sample for testing shall be borne by the contractor for allsuch tests.

vi. The testing of materials shall be carried out in Government Lab/ NABL approved labs only.

THE MANDATORY TESTS SHALL BE AS FOLLOWS

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying outthe test	Frequency of testing
Anti-Termite chemical					
Chemicals, (with Dilution Ratio 1part:19Part water) (Chloropyrifos 20EC&Lindane20 EC)	a) Concentration / content b) Acidity c) Flash point	Lab. Test	IS 8963/8944	50* Litre.	*Once for first lot of chemical brought at site. Thereafter once for every 200 litres or part thereof, of same manufacturer.
* For ATT Chemicals whose dilution ratio is different, Minimum quatity and Frequency shall be suitably modified.					
Reinforced cement concrete work					
Water for construction purposes	pH value, Limits of Acidity, Limits of Alkalinity, Percentage of Solids (Chlorides, Suspended matter, Sulphates Inorganic solids, Organic solids.)	Lab	IS 3025	Water from each source	Before commencement of work & thereafter: Mandatory - Once in one year from each source; Optional: once in 3 months from each source; Municipal supply - optional.
Reinforced cement concrete (including RMC)	a) slump test	Field	IS: 1199	5 CuM.	Same as Per Frequency of Sampling guidelines of IS 456-2000.

Material	Test	Field / laboratorytest	Test procedure	Minimum quantity of material / Work for carrying outthe test	Frequency of testing
	b) cube test	Lab	IS : 516	5 CuM.	Same as Per Frequency of Sampling guidelines of IS 456-2000
Ready mixed cement concrete (At RMC Plant) (IS-4926)	Cube test	Lab (At RMC PlantLab)	IS-516 and as per para 6.3.2 ofIS-4926-2003	50 CuM	One for every 50 CuM of production or every 50 batches, whichever is the greater frequency
Note : For all other small items and where RCC done in a day is less than 5 cum, Cube test may be carried out as required by Engineer-in-Charge.					
Sand / Fine Aggregate	Bulking of Sand	Field	IS 2386 - Part 3	20 CuM	Every 20 CuM or part there of or more frequently as decided by Engineer-in-Charge
	Silt content	Field	IS 2386 - Part 2	20 CuM	Every 20 CuM or part there of or more frequently as decided by Engineer-in-Charge
	Particle size and distribution	Field or Laboratory as decided by the Engineer -in-Charge	IS 2386 - Part 1	40 CuM.	Every 40 CuM offine aggregate / sand required in RCC. Work only
	Deleterious Materials & Organic Impurities	Field	IS 2386 - Part 2	20 CuM	Every 20 CuM or part thereof or more frequently as decided by Engineer-in-Charge
Cement	Fineness(m^2/kg)	Lab.	IS 4031 (Part-2)	Each fresh lot	Every 50 MT or part thereof
	Normal consistency	Lab.	IS 4031 (Part-4)	-Do-	-Do-
	Setting time (minutes) (a)Initial b) Final	Lab.	IS 4031 (Part-5)	-Do-	-Do-

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying outthe test	Frequency of testing
	Soundness a) Le-Chat expansion (mm) b) Auto clave(%)	Lab.	IS 4031 (Part-3)	-Do-	-Do-
	Compressive strength(Mpa) a) 72 ± 1 hr b)168 ± 2hr	Lab.	IS 4031 (Part-6)	-Do-	-Do-
Fly Ash	Total Chloride in Percentage by Mass	Lab	IS 12423	10 CuM	Every 10 CuM orpart thereof
	Loss on Ignition in percentage by mass (Max)	Lab	IS 1727	10 CuM	Frequency as decided by EIC
	Fineness, Specific Surface in (m^2/kg)	Lab/ Field	IS 4031 (Part- 2)	10 CuM	Frequency as decided by EIC
	Compressive Strength at 28 daysin N/mm^2 (Min)	Lab	IS 4031 (Part-6)	10 CuM	Only in cases when fly ash is used as pozzolana in cement.
Stone Aggregate / Coarse Aggregate	a) Percentage of soft or deleterious materials	General visual inspection/ Lab test where required by the EIC	IS 2386 - Part 2	One test for each source	One test for each source
	b) Particle size distribution	Field / Lab	IS 2386 - Part 1	10 CuM	Every 40 CuM Or part thereof and Once in three months for each source of coarse aggregates (RCCworks)
	c) Specific Gravity	Field / Lab	IS 2386 - part 3	10 CuM	Once in three months for each source of coarse aggregates (RCCworks)
	d) Estimation of Organic Impurities	Field / Lab	IS 2386 - Part 2	10 CuM	-do-
	e) Bulk Density	Field / Lab	IS 2386 - Part 3	10 CuM	-do-
	f) Aggregate crushing strength	Field / Lab	IS 2386 - part 4	10 CuM	-do-
	g) Aggregate impact value	Field / Lab	IS 2386 - part 4	10 CuM	-do-

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
Timber	Moisture	Field (by moisture meter) Laboratory test as required by Engineer-in-Ch.		1 CuM	Every one CuM or part thereof
Flush Door	End immersion test, Knife test, Glue Adhesion test	Laboratory	IS: 4020	26 shutters	As per sampling and testing as instructed by the Engineer-in-Charge.
Aluminium sections	i)Thickness of anodic coating/ Powder coating ii)Weight	Field/Lab	IS: 5523/ IS: 13871	Field: 50kg. Lab:200kg.	Field: Each section of lot as directed by Engineer-in Charge. Lab: Three specimenof each section from every lot at PDI
Bricks	Testing of bricks / brick tiles for dimensions, Compressive strength, Water absorption, Efflorescence.	Laboratory	IS 3495 Part I to IV	2000 Nos	No of bricks to be selected from brick lot (For each of the characteristic) 5 : 2001 to 10000 10 : 10001 to 35000. 15 : 35001 to 50000 5 : for every addl. 50000 or part thereof provided Make/Brand remains same. If < 2000, As per decision of the EIC
Steel for RCC	Physical tests Tensile strength Retest Rebend test Nominal mass Bend test Elongation test Proof stress	Lab / field	IS 1608 IS 1786 IS 1786 IS 1786 IS 1599 IS 1786 IS 1786	Each lot from each source from each diameter of bar	Below 100 Tonnes Dia < 10 mm one sample for each 25 tonnes or part thereof If dia is >10 mm but less than 16 mm: One sample each 35 tonnes or part thereof. If dia >16 mm one sample for each 45 tonnes

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying outthe test	Frequency of testing
	Chemical Tests: 1.Carbon Constituent 2.Sulphur 3.Phosphorus 4.Phosphorus & Sulphur	Lab	IS:228		Once for every fresh lot of one or more trucks as directed by the Engineer-in-Charge.
Soil core test	OMC Proctor density		As per IS12175	-	Two for every 50 SqM
Ceramic tiles/ Vitrified tiles	Dimensions, Water Absorption, Modulus of Rupture, Surface Hardness,		As per IS13630	5000 Nos. for each type	3000 tiles and more for each manufacturer and thereafter for every 3000 tiles or part thereof.
Natural Stone	Water Absorption	Field / Lab	IS: 3495 (Part-2)	5 Cum	One test for 100 Cum or part thereof
Structural Steel	Tensile Strength Chemical Test	Lab	IS:1608 IS:228	20 MT	Every 20 MT or part thereof
Concrete Paver Block	Dimensions, Water Absorption, Compressive Strength	Lab	IS:15658	25,000 blocks	25,000 blocks and more for each manufacturer and thereafter for every 25,000 blocks or part thereof.
Tile Adhesive	Shear Adhesion Test	Lab	IS:15477	20 MT	Every 20 MT or part thereof
AAC Block	Block Density, Compressive Strength	Lab	IS:6441	Lot of 10,000 blocks or less (As per IS:2185, Part-3)	Every 10,000 block or part thereof
Ready Mix Mortar for plaster & masonry	Pot Life, Compressive Strength	Lab		20 MT	Every 20 MT or part thereof
Ready mix polymer modified repair mortar	Pot Life, Compressive Strength	Lab		20 MT	Every 20 MT or part thereof

OTHER MATERIALS FOR MANDATORY TEST (AS PER CODAL PROVISIONS)

Civil: Mechanical couplers, Insulating Materials (Glass Wool, Phenotherm), Metallic Roofing Sheets, Mangalore Tiles, Physical Tests for Structural Steel including Tubular & Hollow Sections, Zinc Coating on Galvanized Iron Door Frame, Physical & Chemical Tests for Stainless Steel Sheets and Pipes, Chemical Admixtures, Chemical Polymers, Test for Preservatives in Chemically Treated Wood Items, G.I Pipes and RCC Hume Pipes,

ROAD WORK: Soil Core Tests, Grading of Metal for WBM, Crushing and Impact Value Test on Aggregates, Bitumen Grade, Bitumen Content, Precast Concrete Gratings.

OPTIONAL TESTS: Testing Aggregate-Surface Moisture, Petrography Test on Aggregates, Alkali-Aggregate Reaction, Steel Door/ Windows Test for Chemical and Physical Properties, K-Value for Thermal Insulation, NRC value for Acoustic Materials

TESTING, TOLERANCE, ACCEPTANCE AND MODE OF PAYMENT

a) The material should pass all tests and tolerance in dimensional, chemical and physical properties.

b) Payment shall be restricted to standard unit mass, or as specified in the schedule of work, without making any cost adjustment towards mass or any other properties, provided the material pass all thetests and tolerances are within the specified limits.

c) In case of non-standard materials, materials not covered under any IS Specifications, such as aluminium sections, the payment shall be made based on the actual unit weight basis as determined by testing at random sampling.

1. EARTH WORK

1.1 SCOPE OF WORK

The scope of work covered under this specifications pertains to excavation of foundations, trenches, pitsand over areas, in all sorts of soils, soft and hard rock, correct to dimensions given in the drawing including shoring, protections of existing underground utilities if any, such as water lines, electric cables etc., dewatering and shoring if necessary, stacking the useful materials as directed within the lead specified, refilling around the foundation and into the plinth with selected useful excavated earth and disposing off the surplus earth/materials within specified lead and finishing the surface to proper levels, slopes and camber etc. all complete.

1.2 SITE CLEARANCE

Before the earth work is started the area coming under cutting and filling shall be cleared of all obstructions, loose stones, shrubs, rank vegetation, grass, brush-wood, trees and saplings of girth upto 30 cm. measured at a height of one metre above ground and rubbish removed upto a distance of 150 metres outside the periphery of the area under clearance. The roots of trees shall be removed to a minimum depth of 60 cm. below ground level, or a minimum of 30cm. below formation level whichever is lower, and the hollows filled up with earth, leveled and rammed. This work is deemed to be included in the earth work items and no separate payment will be admissible for the work.

The trees of girth above 30 cm. measured at a height of one meter above ground, shall only be cut after permission of the Engineer-in-charge is obtained in writing. The roots shall also be removed as described in the preceding sub-para. Payment for cutting and removing roots of such trees shall be made separately. Any material obtained from the site will be the property of the Department and the useful materials as decided by the Engineer-in-charge will be conveyed and properly stacked as directed within the lead specified.

Existing structures and services such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the Engineer-in- Charge and payment for such diversion/dismantling works shall be made separately.

In case of archaeological monuments within or adjacent to the area, the contractor shall provide necessary fencing alround such monuments as per the directions of the Engineer-in -Charge and protect the same properly during execution of works. Payment for providing fencing shall be made separately.

1.3 SETTING OUT AND MAKING PROFILES

Masonry or concrete pillars will be erected at suitable points in the area to serve as bench marks for theexecution of the work. These bench marks shall be connected with G. T. S. or any other permanent bench mark approved by the Engineer-in-charge. Necessary profiles with pegs, bamboos and strings or Burjis shall be made to show the correct formation levels before the work is started. The contractor shall supply labour and materials for setting out and making profiles and Burjis for the work at his own cost and the same shall be maintained during the excavation work. The Department will show grid co-ordinates or other reference points. It shall be the responsibility of the contractor to set out centre lines correctly with reference to the drawings and install substantial reference marks. Checking of such alignment bythe Department will not absolve the contractor from his responsibility to execute the work strictly in accordance with the drawings.

1.4 EXCAVATION

The contractor shall notify the Engineer-in-charge before starting excavation and before the ground is disturbed, to enable him to take existing levels for the purpose of measurements. The ground levels shall be taken at 5 to 15 metres intervals in uniformly sloping ground and at closer distance where local mounts, pits or undulations are met with, as directed by the Engineer-in-charge. The ground levels shall be recorded in field books and plotted on plans, which shall be signed by the Contractor and the Engineer-in-charge, before the earth work is actually started. The labour required for taking levels, shall be supplied by the Contractor at his own cost. The Contractor shall perform excavation in all types of soils, murrum, soft and hard rock, boulders etc. in foundation, over areas and in trenches to widths, lines,levels, grades and curves as shown in the drawing or lesser widths, lines and levels as directed by the Engineer-in-charge and as per items in the schedule of quantities.

1.4.1 The item in the schedule of quantities shall specify the excavation in trenches or over areas. For this purpose, the excavation for any depth in trenches for foundation not exceeding 1.5 m. in width or 10 sqm. on plan shall be described as **Excavation in foundation trenches.**

1.4.2 Excavation exceeding 1.5m in width as well as 10 SqM on plan (excluding trenches for pipes, cables etc.) and exceeding 30 cm in depth shall be described as **Excavation over areas.**

1.4.3 Excavation exceeding 1.5m in width as well as 10 SqM on plan but not exceeding 30 cm. in depth shall be described as Surface Excavation.

1.5 CLASSIFICATION OF EARTH WORK

The earth work shall be classified under the following main categories and measured separately for eachcategory.

a) All types of soils, murrum, boulders.
b) Ordinary / Soft rock.
c) Hard rock.

1.5.1. All types of Soils, Murrum, Boulders : Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud (disintegrated) concrete and their mixtures which for excavation yields to application of picks, showels, jumper, scarifier, ripper and other manual digging implements.

1.5.2 Ordinary / Soft Rock : Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.

If required light blasting may be resorted to for loosening the materials but this will not in any way entitlethe material to be classified as "Hard rock".

1.5.3 Hard Rock : Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separatedfrom concrete) below ground level and the like.

Hard rock (blasting prohibited): Hard rock requiring blasting as described above but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, use of rock hammers and cutters or any other agreed method.

1.5.3.1 Excavation in Hard Rock by Blasting : Where blasting is permitted the excavation in rock shall be done by means of blasting. No heavy blasting will be permitted and only controlled/muffled blasting will be permitted at the discretion of the Engineer-in-Charge. The Contractor shall be governed by the relevant statutory laws, rules and regulations on explosives, pertaining to the acquisition, transport, storage, handling and use of explosive which shall be rigidly followed and shall obtain himself all necessary materials and equipment for blasting. Blasting

shall be executed through a licensed blaster with prior permission from police authorities. Prior to blasting sufficient notice shall be given to concerned parties to avoid danger to people, materials and nearby structures. All the damages caused by careless blasting if any shall be made good by the contractor at his own expenses.

1.5.3.2 Excavation in Hard Rock by Chiseling and Wedging : Where blasting is not permitted and if the Engineer-in-Charge so desires, the excavation shall be done by chiseling and wedging or any other agreed method.

NOTE: All the excavated hard rock obtained shall be stacked properly and neatly within the specified lead by the contractor as directed by the Engineer-in-Charge.

1.6 EXCAVATION PARAMETERS

Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident(s).

The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cablesetc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.

The excavation shall be done manually or by mechanical means as desired by Engineer-in-Charge considering feasibility, urgency of work, availability of labour /mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment will be made on this account.

Earth work by mechanical means" involves careful planning keeping in view site conditions i.e. type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should be accordingly selected.

The excavation under all classifications in areas in trenches or in pits shall be carried out systematically.Cutting shall be done from top to bottom and no under-pining or undercutting will be allowed. The bottom and sides of excavation shall be dressed to proper level, slopes, steps, camber etc. by removing high spots, and ramming thoroughly as directed by the Engineer-in-charge.

All the excavation shall be carried out strictly to the dimensions given in the drawing. The width shall generally be of the width of mud-mat concrete and depth as shown in drawing or as directed by the Engineer-in-Charge, according to availability of the desired bearing capacity of soil below. Any excavation if taken below the specified depths and levels, the contractor shall at his own cost fill up such overcut to the specified level with cement concrete 1:4:8 in case of excavation in all types of soils and with cement concrete 1:2:4 in case of excavation in soft and hard rock.

After the excavation is completed, the contractor shall notify the Engineer-in-Charge to that effect and nofurther work shall be taken up until the Engineer-in-Charge has approved the depth and dimensions andalso the nature of foundation materials. Levels and measurements shall also be recorded prior to takingup any further work.

1.7 SHORING

Unless separately provided for in the schedule of quantities, the quoted rate for excavation shall include excavation of slopes to prevent falling in soil by providing and/or fixing, maintaining and removing of shoring, bracing etc. The contractor would be responsible for the design of shoring for proper retaining ofsides of trenches, pits etc. with due consideration to the traffic, superimposed loads, etc. Shoring shall be of sufficient strength to

resist the pressure and ensure safety from slips and to prevent damage to work and property and injury to persons. It shall be removed as directed after items for which it is required are completed. Should the slips occur, the slipped material shall be removed and slope dressed to a modified stable slope. Removal of the slipped earth will not be measured for payment.

1.8 DEWATERING

Unless specifically provided for as a separate item in the schedule of quantities, rate shall also include bailing or pumping out all water which may accumulate in the excavation during the progress of further works such as mud mat concrete, R.C. footings, shuttering etc. either due to seepage, springs, rain or any other cause and diverting surface flow by bunds or other means. Care shall be taken to ensure that thewater discharged sufficiently away from the foundations to keep it free from nuisance to other works in the neighborhood.

1.9 EARTH WORK FOR MAJOR WORKS

Excavation shall be undertaken to the width of the Basement/Retaining wall footing including necessary margins for construction operation as per drawing(s) or directed otherwise. Where the nature ofsoil or the depth of the trench and season of the year, do not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or cut slopes with or without steps, to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer in Charge.

All the major excavation shall be carried out by mechanical excavator. No extra payment shall be made for that.

The contractor shall make at his own cost all necessary arrangements for maintaining water level, in the area where works are under execution low enough so as not to cause any harm to the work shall be considered as inclusive of pumping out or bailing out water, if required, for which no extra payment shall be made. This will include water coming from any source, such as rains, accumulated rain water, floods, leakages from sewer and water mains, subsoil water table being high or due to any other cause whatsoever. The contractor shall make necessary provision of pumping, dredging bailing out water coming from all above sources and excavation and other works shall be kept free of water by providing suitable system approved by the Engineer-in-charge. Sub-soil water table at work site is observed low in the month of April/May(pre-monsoon month). The water level is likely to rise significantly during rainy season. In order to avoid possibility of basement floor of main building being getting uplifted/damaged due to water pressure, the contractor shall lower the ground water table below the proposed foundation level by boring tube wells all around the proposed building using well point sinking method or any suitable method as approved by Engineer-in-charge. Sub soil water table shall be maintained at least 50 cm. below the P.C.C. level during laying of P.C.C. water proofing treatment, laying of basement raft and beams including filling of earth/sand under the basement floor. The water table shall not be allowed to rise above base of raft leveluntil completion of outer retaining walls including water proofing of vertical surface of walls and back filling along the walls upto ground level and until the structure attains such height to counter balance the upliftpressure. However, the contractor should inspect the site and make his own assessment about sub-soilwater level likely to be encountered at the time of execution and quote his rates accordingly. Rate of all items are inclusive of pumping out or bailing out water, if required. Nothing extra on this account whatsoever shall be paid . The sequence of construction shall be got approved by the Engineer-in-charge.

The contractor shall take all necessary measures for the safety of traffic during construction andprovide, erect and maintain such barricades including signs, markings, flags, lights and flagman, as necessary at either end of the excavation/embankment and at such intermediate points as directed by the Engineer-in-charge for the proper identification of construction area. The contractor shall be responsible for all damages and accidents caused due to negligence on his part.

The contractor shall provide suitable barricading with suitably painted single row of G.I. Sheets about 3"- 0" wide (90 cms.) nailed or bolted with wooden poles spaced 2 to 3 metre apart and each pole 1.6 m to 2 mlong 8 cm. to 10 cm. dia. The poles will be embedded in mobile iron pedestal rings suitably framed for giving stable support as

per direction of the Engineer-in-charge. All management (including watch and ward) of barricades shall be the full responsibility of the contractor. The barricades shall be removed onlyafter completion of the work or part of the work. The contractor‟s rate shall include all above items of work and nothing extra shall be paid to the contractor over and above his quoted rates.

1.10 DISPOSAL OF EXCAVATED MATERIALS

1.10.1 Antiquities : Any finds of archaeological interest such as relics of antiquity, coins, fossils or otherarticles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government.

1.10.2 Useful materials : Any material obtained from the excavation which in the opinion of the Engineer- in-Charge is useful, shall be stacked separately in regular stacks as directed by the Engineer-in-Chargeand shall be the property of the Government.

No material excavated from foundation trenches of whatever kind they may be are to be placed even temporarily nearer than about 3 m. from the outer edge of excavation. Discretion of the Engineer-in- Charge in such cases is final. All materials excavated will remain the property of the Department. Rate for excavation includes sorting out of the useful materials and stacking them separately as directed within the specific lead.

Materials suitable and useful for backfilling or other use shall be stacked in convenient place but not in such a way as to obstruct free movement of materials, workers and vehicles or encroach on the area required for constructional purposes. It shall be used to the extent required to completely backfill the structure to original ground level or other elevation shown on the plan or as directed by the Engineer-in- Charge. Materials not useful in anyway shall be disposed off, leveled and compacted as directed by theEngineer-in-charge within a specified lead. The site shall be left clean of all debris and leveled on completion.

1.11 BACKFILLING IN SIDES OF FOUNDATIONS, PLINTH, UNDER FLOOR ETC.

The back filling shall be done after the concrete or masonry has fully set and shall be done in such a wayas not to cause under-thrust on any part of the structure. Where suitable excavated material is to be used for back filling, it shall be brought from the place where it was temporarily deposited and shall be used inbackfilling. The scope of work for back filling/filling in foundation, plinth, under floors etc. shall include filling for all the buildings covered under the contract. Surplus earth available from one building, if required, shall be used for backfilling/filling for other buildings also within the specified lead mentioned in the item.

All timber shoring and form work left in the trenches, pits, floors etc. shall be removed after their necessity ceases and trash of any sort shall be cleared out from the excavation. All the space between foundation masonry or concrete and the sides of excavation shall be backfilled to the original surface with approved materials in layers not exceeding 200 mm. in thickness, watered and well consolidated by means of rammers to atleast 90% of the consolidation obtainable at optimum moisture content (Proctor density). Flooding with water for consolidation will not be allowed. Areas inaccessible to mechanical equipment such as areas adjacent to walls and columns etc. shall be tamped by hand rammer or by hand held power rammers to the required density. The backfill shall be uniform in character and free from large lumps, stones, shingle or boulder not larger than 75 mm. in any direction, salt, clods, organic or other foreign materials which might rot. The backfilling in plinth and under floors shall be done in similar way inlayers not exceeding 200 mm. thick and shall be well consolidated by means of mechanical or hand operated rammers as specified to achieve the required density.

Test to establish proper consolidation as required will be carried out by the Department at rates specified.Two tests per 50 SqM. will be taken to ascertain the proper consolidation. The cost of tests carried out will be borne by the contractors.

1.12 FILLING IN PLINTH AND UNDER FLOORS

After the available suitable excavated materials are exhausted as backfilling, the contractor shall notify the Engineer-in-Charge, of the fact and levels taken jointly with Engineer-in-Charge. The earth, murrum, sand, gravel etc. or such materials suitable for filling proposed to be filled under floors and so mentioned in the item of schedule of quantities shall then be brought to site from approved locations and sources.

1.12.1 Earth Filling : The earth, soft murrum etc. so brought shall be filled up in layers of 20 cm depth, each layer being well watered and consolidated by approved hand or mechanical tampers or other suitable means to achieve the required density.

1.12.2 Gravel or Sand Filling : Gravel if required to be filled under floors, shall be single washed gravelof approved quality and of size varying from 12 mm. to 20 mm. it shall be uniformly blinded with approved type of soil and/or sand to obtain full compaction. Gravel shall be filled in specified thickness and shall be well watered and rammed entirely to the satisfaction of the Engineer-in-Charge.

If sand is required to be filled under floors, it shall be clean, medium grained and free from impurities. The filled in sand shall be kept flooded with water for 24 hrs. to ensure maximum consolidation. Any temporary work required to maintain sand under flooded condition shall be done by the contractor at his own cost. The surface shall then be well dressed and got approved from Engineer-in-Charge before any other work is taken over the fill.

1.12.3 Filling with Flyash

Flyash: Flyash be procured from nearest local power plant. To prevent dust, it should be kept moist by sprinkling of water.

Filling: The space around the foundation and drains in trenches shall be cleared of all debris, brick bats etc. Filling with available excavated earth and flyash shall be done in regular horizontal layers. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt and of crow bars where rammers cannot be used. Intermediate layer of compacted earth not exceeding 15 cm shall be placed after every four layers of compacted depth of flyash (each layer should not exceed 15 cm). The sides and top layer of filling shall be done with earth having minimum compacted thickness of 30 cm. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the tranches. In case of filling in embankment, consolidation of flyash/earth shall be done with power roller to achieve soil density of 98%.

1.13 SURFACE DRESSING

Surface dressing shall include cutting and filling upto a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metreabove the ground level and removal of rubbish and other excavated material upto a distance of 50metres or as specified outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depression filled upto the required level with the excavated earth so as to give an even, neat and tidy look.

1.13.1 Measurements: Length and breadth of the dressed ground shall be measured correct to the nearest cm and the area worked out in square metres correct to two places of decimal.

1.13.2 Rates: The rates shall include cost of labour involved in all the operations described above.

1.14 LEAD & LIFT

1.14.1 Lead: The lead for disposal/deposition of excavated materials shall be as specified in the respective item of

work. For the purpose of measurements of lead, the area to be excavated or filled or area on which excavated material is to be deposited/disposed off shall be divided in suitable blocks and for each of the block, the distance between centre lines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route adopted.

1.14.2 Lift: Lift shall be measured from ground level. Excavation up to 1.5 m depth below ground level and depositing excavated material on the ground shall be included in the item of earthwork for various kinds of soil. Extra lift shall be measured in unit of 1.5 m or part thereof. Obvious lift shall only be measured; that is lifts inherent in the lead due to ground slope shall not be measured except for lead upto 250 m. All excavation shall be measured in successive stages of 1.5 m stating the commencing level. This shall notapply to cases where no lift is involved as in hill side cutting.

1.15 MODE OF MEASUREMENTS

1.15.1 All excavation in areas having depth more than 30 cm. pits, trenches etc. shall be measured net. The dimensions for the purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, rafts or other foundations, multiplied by the mean depth from the surface of ground determined by levels. Excavation for side slopes will not be paidfor. Excavation in areas having depths less than 30 cms. shall be measured as surface excavation on square metre basis, mentioning the average depth of excavation.

Reasonable working space beyond concrete dimensions shall be allowed for waterproofing and shuttering works in underground water tanks, sumps, septic tanks etc., where considered necessary in the opinion of the Engineer-in-Charge. However, the same shall be limited to the following

i) Waterproofing and shuttering works upto 2M depth	Maximum upto 600mm from wall face or 300mm from the edge of offset / raft, whichever is more.
ii) Waterproofing and shuttering works below 2M depth and upto 4M.	Maximum upto 900mm from wall face or 300mm from the edge of offset / raft, whichever is more.
iii) Waterproofing and shutteringworks beyond 4M depth	Maximum upto 1200mm from wall face or 300mm from the edge of offset / raft, whichever is more.

1.15.2 Wherever direct measurements of rock excavation are not possible, volume of rock be calculated on the basis of length, breadth and depth of stacks made at site as mentioned in Para 1.5.3. The net volume shall be worked out by reducing it by 50%, taking the voids into consideration as 50%. Similarly to arrive at net quantity to be paid in the case of soil, reduction @ 20% of corresponding stack/truck measurements shall be made.

1.15.3 The rate for excavation shall include carting and disposing and leveling the excavated materials within the specified lead. The rate shall also be inclusive of cost of all tools, plants, explosives, shoring,dewatering at various stages, labour, materials etc. to complete all the operations specified.

1.15.4 The backfilling and consolidation in sides of foundation and in plinth with excavated material will not be paid for separately. The rate quoted for excavation shall be deemed to have been included the cost of stacking of excavated materials, conveying within the specified lead, picking of selected stacked materials, conveying it to the place of final backfill, compaction to the required proctor density etc.

1.15.5 Payment for filling and consolidation inside the trenches, sides of foundations, plinth etc. with selected materials brought by the contractor other than the excavated material, shall be paid for separately as per the rates in schedule of quantities which includes cost of such materials/excavation, royalty, its conveyance within the specified lead, watering, consolidating, dressing etc. Actual quantity of consolidated filling shall be measured and paid in cubic metres upto two places of decimal.

1.15.6 The rate quoted in cum. for items of excavation is deemed to include the necessary additional quantity

of excavation involved beyond the plan dimensions of the work which may be necessary to be carried out for carrying out the work in an engineering manner, decided upon by the contractor. Thereforeno extra payment will be made for any excavation done other than the required quantity as per the plandimension indicated in the drawings.

1.15.7 Measurements for excavation over areas shall be determined by levels or by "Dead mean" or bothat the discretion of the Engineer-in-Charge. If however the Engineer-in-Charge decides on measurement by levels, levels of site shall be jointly taken and recorded by the Engineer-in-Charge or his representatives and the contractor, before commencement of the work and after completion of the work and the quantity of work done shall be computed based on these levels. The volume of earth work shall be computed based on "Simpsons formula" or any other approved method at the discretion of the Engineer-in-Charge.

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2. ANTITERMITE TREATMENT

2.1 GENERAL

Pre-constructional anti-termite treatment is a process in which soil treatment is applied to a building in early stages of its construction. The purpose of antitermite treatment is to provide the building with a chemical barrier against the sub-terranean termites.

Antitermite treatment being a specialized job, calls for thorough knowledge of the chemicals, soils, termite to be dealt with and the environmental conditions, in order to give effective treatment and lasting protection to the property undergoing treatment. It is, therefore, imperative that the works of antitermite treatment should be got executed through specialized agencies only. The specialized agency should be a member of the Indian Pest Control Association and shall have sufficient experience of carrying out similar works of magnitude envisaged in this tender.

The pre-constructional soil treatment is required to be applied during the construction stages of the sub-structure upto plinth level. The contractor has to be watchful of the various stages of sub-structure worksand arrange to carry out the soil treatment in time after proper co-ordination with Department and othercontractors if any, working at site.

2.2 SCOPE

The scope of pre-constructional anti-termite treatment covers the soil treatment with approved chemicals in water emulsion in foundation trenches for columns, plinth beams, pile caps, brick walls, service trenches, lift pits, steps, ramps etc. in top surfaces of plinth filling, at junction of walls and floor, in expansion joints etc. in stages as detailed in this specifications and drawings. Unless otherwise stipulated, the antitermite treatment will be carried out as per I.S.6313 (part 2) - 2001 and/or as per direction of the Engineer-in-Charge.

The work shall be executed through approved specialized agencies who is a member of Indian Pest Control Association, approved by Central Insecticides Board.

2.3 SITE PREPARATION

In order to ensure uniform distribution of the chemical emulsion and to assist penetration, the following site preparation shall be carried out:

a) Remove all trees, stumps, logs or roots from the building site.

b) Remove all concrete form work if left anywhere, leveling pegs, timber off-cuts and otherbuilders debris from the area to be treated.

c) If the soil to be treated is sandy or porous, preliminary moistening will be required to fill capillary spaces in soil in order to prevent the loss of emulsion through piping or excessive percolations.

d) In the event of water logging of foundation, the water shall be pumped out before application of chemical emulsion and it should be applied only when the soil is absorbent.

e) On clays and other heavy soils where penetration is likely to be slow and on sloping sites, where run-off of the treating solution is likely to occur, the surface of the soil should be scarified toa depth of 75 mm. atleast.

f) All sub-floor leveling and grading should be completed, all cutting, trenches and excavationsshould be completed with backfilling in place, borrowed fill must be free from organic debris andshall be well compacted. If this is not done supplementary treatments should be made to complete the barrier.

2.4 CHEMICAL TO BE USED

Chemicals approved by Central Insecticides Board conforming to relevant Indian Standards (IS 8944-Chloripyrifos E.C./ IS 632-Lindane E.C.) in water emulsion or as specified in item may be used for soil treatment in order to protect a building from termite attack. The chemical solutions or emulsions are required to be dispersed uniformly in the soil and to the required strength so as to form an effective chemical barrier which is lethal and repellent to termites.

2.4.1 Soil Treatment : Treatment shall be carried through a specialized Agency who is a member of the Indian Pest Control Association (IPCA) and shall be engaged with prior approval of the Engineer-in- Charge.

The contractor should produce voucher(s) for the chemical purchased and should get verified the sealed container(s) of the specified chemical from the Engineer-in-Charge before preparing the emulsion for the treatment.

2.5 MODE AND RATE OF APPLICATION

The chemical emulsion as stated above will be applied uniformly by sprayers at the prescribed rates as detailed below in all the stages of the treatment as per IS 6313 (Part-2).

2.5.1 Treatment in Foundation Trenches : In case of normal wall load bearing structures, column pits, wall trenches and basement, the treatment shall be @ 5 ltrs./SqM of surface area of the bottom and sides to a height of atleast 300 mm. After the foundation work, the sides shall be treated @ 7.5 ltrs./SqM of vertical surface of substructure on each side. After the earth filling is done, treatment shall be done by rodding the earth at 150 mm. centers close to wall surface and spraying the chemical with the above dose i.e. 7.5 ltrs./SqM

In case of framed structure, the treatment shall start at a depth of 500 mm. below ground level. From this depth the backfill around the columns, beams and R.C.C. basement walls shall be treated @ 7.5 ltrs./SqM of the vertical surface and @ 5 ltrs./Sqm for the horizontal surface at the bottom in thetrenches/pits.

2.5.2 Treatment on Top Surfaces of Plinth Filling : The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 litres/SqM of the surface area before sub-base to floor is laid. If filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes upto 50 to 75mm. deep at 150 mm. centers both ways shall be made with crow bars on the surface to facilitate saturation of the soil with the emulsion.

2.5.3 Treatment at Junction of Walls and Floors : Special care shall be taken to establish continuity of the vertical chemical barrier on the inner wall surfaces from the finished ground level (or from level where the treatment had stopped) upto the level of the filled earth surface. To achieved this a small channel 30 x 30 mm. shall be made at all the junctions of wall/column with floor (before laying sub-grade) and rod holes made in the channel upto the finished ground level at 150 mm apart and the iron rod moved backward and forward to break the earth and chemical emulsion poured along the channel @ 7.5 litres (or at recommended quantity) per SqM of the vertical wall/column surfaces so as to soak thesoil right upto the bottom. The soil shall be tamped back into place after this operation.

2.5.4 Treatment of soil along external perimeter of the Building: After the building is complete, the earth along the external perimeter of the building should be rodded at intervals of 150mm and to a depth of 300mm.In the event of filling more than 300mm, the external perimeter treatment shall extend to the full depth of filling upto the ground level so as to ensure continuity of the chemical barrier. The rods should be moved backward and forward parallel to

the wall to break up the earth and chemical emulsion poured along the wall at the rate of 7.5l/m2 of vertical surface. After the treatment, the earth should be tamped back into place.

2.5.5 Treatment of Soil under Apron Along external perimeter of Building: Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 lit/m^2 of the surface before the apron is laid. If the consolidated earth does not allow emulsion to seep through, holes upto 50 to 75mm deep at 150mm centres both ways may be made with 12mm dia rod onthe surface to facilitate saturation of soil with the chemical emulsion.

2.5.6 Treatment for Expansion Joints : The soil beneath the expansion joints shall receive special attention when the treatment under 2.5.2 above is in progress. This treatment shall be supplemented bytreating through the expansion joint after sub-grade has been laid at the rate of 2 litres per linear metre length of expansion joint.

2.6 PRECAUTIONS DURING TREATMENT

a) Utmost care shall be taken to see that the chemical barrier is complete and continuous. Each part of the area shall receive the prescribed dosage of chemical emulsion.
b) The treatment should not be carried out when it is raining or when the soil is wet with rain or sub-soil water.
c) Once formed, the treated soil barrier shall not be disturbed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

2.7 PRECAUTIONS FOR HEALTH HAZARDS AND SAFETY MEASURES

All the chemicals mentioned above are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapour or spray mist or swallowed. Persons handling or using these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below particularly when handling these chemicals in the form of concentrates

These chemicals are usually brought to the site in the form of emulsifiable concentrates. The containersshould be clearly labeled and should be stored carefully so that children and pets cannot get at them. They should be kept securely closed.

Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly withsoap and water specially before eating and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemicals splash into the eyes they shall be flushed with plenty of soap and water and immediate medical attention should be sought.
The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.

Care should be taken in the application of chemicals/soil-toxicants to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.8 GUARANTEE

The contractor has to furnish the guarantee for 10 (ten) years from the date of completion of work, stating that in case of reappearance of termites within the building area due to defective materials or workmanship or due to any other reasons, the contractor will carry out the necessary post constructional treatment to keep the entire area free from termite, once again, without any extra cost to the Department during the guarantee period.

2.9 MODE OF MEASUREMENT

The payment will be made on the basis of plinth area measurements at ground floor only for all the stages of treatment in SqM correct to two places of decimals. Rate includes the cost of materials, labour and alltools, plants, sprayers required for complete operation as described above..

2.10 POST CONSTRUCTION ANTI-TERMITE TREATMENT

Once the termites have an ingress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against termites. Chemical treatment for the eradication and control of sub-terranean termites in existing building shall bedone as per IS 6313 (Part 3) only through the approved specialized agencies using the approved chemical as directed by Engineer-in-Charge.

2.11 TREATMENT

Anti termite measures described below are necessary for the eradication and control of termites in existing building. To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites in existing building shall be carried out as per IS 6313 (Part III).All other precautions during treatment and safety measures shall generally be as described above under pre-constructional treatment.

2.11.1 Treatment along outside of foundations: The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 litres per square metre of vertical surface of thesub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Rodding with 12 mm diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 litre per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linearmetre.

2.11.2 Treatment of Soil under Floors: The points where the termites are likely to seek entry through the floor are the cracks at the following locations.

(a) At the junction of the floor and walls as result of shrinkage of the concrete
(b) On the floor surface owing to construction defects
(c) At construction joints in a concrete floor, cracks in sections
(d) Expansion joints in the floor
Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever suchcracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor

and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil belowuntil refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

2.11.3 Treatment of Voids in Masonry: The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operatedpump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

2.11.4 Treatment at Points of Contact of Wood Work: The wood work which has already been damaged beyond repairs

by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts withthe adjoining masonry with the chemical emulsion by drilling 6 mm holes at a downward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.

Infested wood work in chaukhats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3 mm diameter with a downward slant to thecore of the wood work on the inconspicuous surface of the frame. These holes should be at least 150 mm centre to centre and should cover in entire frame work. Chemicals shall be liberally infused in these holes. If the wood is not protected by paint or varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

2.11.5 Treatment of Electrical Fixtures

If infestation in electrical fixture (like switch boxes in the wall) is noticed, covers of the switch boxes shall be removed and inside of such boxes shall be treated liberally with 5 per cent Malathion dusting powder. The covers of the switch boxes shall be refixed after dusting.

2.12 GUARANTEE

The contractor has to furnish the guarantee for 10 (ten) years from the date of completion of work, stating that in case of reappearance of termites within the building area due to defective materials or workmanship or due to any other reasons, the contractor will carry out the necessary post constructional treatment to keep the entire area free from termite, once again, without any extra cost to the Department during the guarantee period.

2.13 RATES

The rate shall include the cost of material, labour and all other inputs involved in all the operations described above including drilling, refilling and making good the holes, etc.

2.14 MODE OF MEASUREMENTS

Measurements shall be done separately for treatment of foundations, soils under floors, voids in masonry and wood work as detailed below

(i) Treatment along outside of foundations : The measurements shall be made in running metrestaking length along the plinth of the building.

(ii) Treatment of soil under floors : The measurements shall be made in square metres, inside clear dimensions of rooms, verandah etc. shall be taken.

(iii) Treatment of voids in masonry : The measurements shall be made in running metres along thetreated walls of the building.

(iv) Treatment of wood work : The measurements shall be made in running metres for chowkhats,joints, purlin, beams etc.

(v) Treatment of Electrical fixtures : The measurement shall be made in numbers.

3. HARD CORE / SOLING UNDER FLOORS / FOUNDATIONS

3.1 SCOPE OF WORK

The work covered under this specification includes all type of soling work either by bricks or by rubble stones laid under floors/foundations, hand packed, complete as per under mentioned specification and applicable drawings.

3.2 RUBBLE STONE SOLING

The rubble stone shall be of best variety of black trap/granite/basalt or other approved variety of stone available

locally. The stone shall be hard, durable, free from defects and of required size and shall be approved by the Engineer-in-Charge before incorporation in the work.

3.2.1 Preparation of Surface : The bed on which rubble soling is to be laid shall be cleared of all loose materials, levelled, watered and compacted and got approved by the Engineer-in-Charge before laying rubble soling. Cable or pipe trenches if shown in the drawing and as required by the Engineer-in-Charge shall be got done before the soling is started.

3.2.2 Workmanship : Over the prepared surface, the stone shall be set as closely as possible and well packed and firmly set. The stones shall be of full height and shall be laid so as to have their bases of the largest area resting on the sub-grade. Soling shall be laid in one layer of 230 mm. or 150 mm. or other specified thickness and no stones shall be less than 230 mm. or 150 mm. depth or specified thickness of soling with a tolerance of 25mm.

After packing the stones properly in position, the interstices between them shall be carefully filled with quarry spoils or stone chips of larger size possible, to obtain a hard, compact surface. Spreading of loose spoils or stone chips is prohibited.

The entire surface shall be examined for any protrusions and the same shall be knocked off by a hammer and all interstices shall be filled with approved murrum/ stone dust as specified. Excess murrum/ stone dust if any over the surfaces shall be removed. Unless otherwise specified, the murrum/ stone dust shall be supplied by the contractor at his own cost from the selected areas. The surfaces shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log-rammers as approved by the Engineer-in-Charge to give the required slope or level and dense sub-base. After compaction, the surface shall present clean look. Adequate care shall be taken by the contractor while laying and compacting the rubble soling to see that concrete surfaces in contact with soling are not damaged.

3.3 MODE OF MEASUREMENT

The quoted rate shall be per square metre of the soling of specified thickness. The linear dimensions shall be measured upto two places of decimals of a metre and are worked out correct to the two places of decimals of a square metre. Plan areas of soling work actually done limiting to the dimensions as perdrawings shall be measured for payment. The rate shall include all the materials, labour, transport etc. and no extra payment shall be made for work done at different levels. The rate shall also include the cost of preparation of surface, all materials and labour, watering, consolidation etc. all complete.

4. PLAIN / REINFORCED CONCRETE AND ALLIED WORKS

4.1 SCOPE

Scope of the specification deals with the structural and general use of plain and reinforced cement concrete.. The specifications cover the qualitative and quantitative requirements in respect of selection of ingredients, proportioning, manufacture of concrete, transport, placing, consolidation, curing, finishing, acceptance criteria etc.,.

4.2. BATCHING

The manufacture and placing of concrete shall be done by weigh batching. However, Volume batching may be allowed only where weigh-batching is not practicable and provided accurate used in concrete have earlier been established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given jobbeing determined by Engineer-in-Charge to ensure that the specified grading is maintained.

4.3 CEMENT CONCRETE (PLAIN AND REINFORCED)

The quality of materials and method and control of manufacture and transportation of all concrete work in respect of

mix, whether reinforced or otherwise, shall conform to the applicable portions of these specifications.

4.3.1 Mandatory tests: The Engineer-in-Charge shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipments and the quality control system. The contractor shall arrange such an inspection and the Engineer-in-Charge approval shall be obtained prior to starting the concrete work. Mandatory test and their frequency of testing for RCC and their constituent materials shall be carried out as per provisions mentioned in Chapter-III.

4.3.2 Materials for Concrete : The constituent materials used in the manufacture of concrete shall be as per IS456-2000.

4.3.2.1. Cement: Unless otherwise specified or called for in the contract specifications, cement shall beany of the following and the type selected should be appropriate for the intended use and as per the contract conditions , specifications and drawings.

a) 33 Grade Ordinary Portland cement conforming to IS 269
b) 43 Grade ordinary Portland cement conforming to IS 8112
c) 53 Grade ordinary Portland Cement conforming to IS 12269
d) Portland slag cement conforming to IS 455.
e) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part I)
f) Portland pozzolana cement (calcined clay based conforming to IS 1489 (Part 2)
g) Sulphate resisting Portland cement conforming to IS 12330.

In case the job requires specific use of any of the following cements the same shall be used with the prior approval of the EIC and necessary precautions with regard to their setting and hardening time, time required for de-shuttering, curing etc., shall be taken after carefully complying with specific literature withregard to those types.

1.High Alumina cement - conforming to IS 6452
2. Low heat cement - conforming to IS 12600
3. Super sulphate cement - conforming to IS 6909 4. Rapid Hardening cement - conforming to IS 8041
5. Blended Cement for finishing work as below

Other combinations of Portland Cement with mineral admixtures of quality conforming to relevant Indian Standards laid down may also be used in the manufacture of concrete provided that there are satisfactory data on their suitability, such as performance test on concrete containing them and only in such case where in specifically called for in the contract.

4.3.2.2 Mineral Admixtures

Pozzolana: Pozzolanic materials conforming to relevant Indian Standards may be used with the permission of Engineer-in-charge, provided uniform blending with cement is ensured.

Fly ash (pulverized fuel ash): Fly ash conforming to Grade 1 of IS 3812 may be used as part replacement of ordinary Portland cement provided uniform blending with cement is ensured.

Silica fume: Silica fume conforming to a standard approved by the deciding authority can be used as part replacement of cement provided uniform blending with the cement is ensured.

Note: The silica fume (very fine non -crystalline silicon dioxide) is a by-product of the manufacture of silicon, ferrosilicon or the like, from quartz and carbon in electric arc furnace. It is usually used in proportion of 5 to 10 percent of the cement content of a mix.

Rice husk ash: Rice husk ash giving required performance and uniformity characteristics may be usedwith the approval of the deciding authority.

Note: Rice husk ash is produced by burning rice husk and contain large proportion of silica. To achieve amorphous state, rice husk may be burnt at controlled temperature. It is necessary to evaluate the product from a particular source for performance and uniformity since it can range from being as deleterious as silt when incorporated

in concrete. Water demand and drying shrinkage should be studied before using ricehusk.

Metakaoline: Metakaoline having fineness between 700 to 900m^2/kg may be used as pozzolanic material in concrete.

Note: Metakaoline is obtained by calcination of pure or refined kaolintic clay at a temperature between 650 ^{0}C and 850^{0}C, followed by grinding to achieve a fineness of 700 to 900 m^2/kg. The resulting material has high pozzolanicity.

Ground Granulated Blast Furnace Slag: Ground granulated blast Furnace slag obtained by grinding granulated blast furnace slag conforming to IS 12089 may be used as part replacement of ordinary Portland cement provided uniform blending with cement is assured.

A certified report attesting to the conformity of the cement to I.S. specifications by the cement manufacturers chemist shall be furnished to the Engineer-in-Charge, if demanded. The Contractor, shall make his own arrangements for the storage of adequate quantity of cement at no extra cost at the site of work as per instructions and approval of the Engineer-in-Charge.

Note: Specification for Storage: Stacking and storage of cement and other construction material(s) shall be as per IS 4082-1996. Cement in bags shall be stored and stacked in a shed, which is dry, leak-proof and moisture proof as far as possible. Storage under tarpaulins will not be permitted. Flooring of the shed shall consists of the two layers of dry bricks laid on well consolidated earth to avoid contact of cement bags with the floor. Stacking shall be done about 150 to 200 mm clear above the floor using wooden planks. Cement bags shall be stacked at least 450 mm clear off the walls and in rows of two bags leaving in a space of at least 600 mm between two consecutive rows. In each row the cement bags shall be keptclosed together so as to reduce air circulation. Stacking shall not be more than ten bags high to avoid lumping under pressure. In stacks more than eight bags high, the cement bags shall be arranged in header and stretcher fashion i.e alternately lengthwise and crosswise so as to tie the stacks together and minimize the danger of toppling over.

Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage arrangements shall be such that there is no dead storage consignments in cement shall be stored as received and shall be consumed in the order of their delivery.

Cement held in store for a period of ninety (90) days or longer shall be retested before use in work. Should at any time the Engineer-in-Charge have reasons to consider that any cement is defective, then irrespective of its origin and/or manufacturers test certificate, such cement shall be tested immediately at a National Test Laboratory/Departmental Laboratory or such approved laboratory, and until the results of such tests are found satisfactory, it shall not be used in any work.

4.3.2.3 Aggregates

a) **"Aggregate"** in general designates both fine and coarse inert materials used in the manufacture of concrete.

b) **"Fine Aggregate" is** aggregate most of which passes through 4.75 mm I.S. sieve

c) **"Coarse Aggregate"** is aggregate most of which is retained on 4.75 mm I.S. sieve. Aggregate shall comply with requirement of IS 383. As far as possible preference shall be given to machine broken and graded aggregate.

All fine and coarse aggregates proposed for use in the work shall be subject to the Engineer-in- Charge's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-Charge.

Aggregate shall, except as noted above, consists of natural sand, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion to the reinforcement or may

impair the strength and/or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary test on concrete specified herein-after.

Sampling and testing: Sampling of the aggregates for mix design and determination of suitability shall be taken under the supervision of the Engineer-in-Charge and delivered to the laboratory, well in advance of the schedule for placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Engineer-in-Charge in advance of the work for use, in determining suitability of the proposed aggregate.

Storage of aggregates: All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but also at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregate from bins or stock piles. Coarse aggregate shall be piled in layers not exceeding 1.00 metres in height to prevent conning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after re-mixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

Specific Gravity : Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of the Engineer-in-Charge.

Fine Aggregate: Fine aggregate except as noted above, and for other than light weight concrete shall consist of natural or crushed sand conforming to I.S. 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic

matter, mica, salt or other deleterious substances which can be injurious to the setting qualities/strength/durability of concrete.

Machine Made/Manufactured Sand : Machine made sand will be acceptable, provided the constituent rock composition is sound, hard, dense, non-organic, uncoated and durable against weathering. Machine made sand shall be accepted provided grading & finer particle limits conform to IS 383.

Screening and Washing : Sand shall be prepared for use by such screening or washing or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions. Sand with silt content more than 3 percent will not be permitted to be used unless the same is washed and silt content is brought within 3% by weight.

Foreign Material Limitations : The percentages of deleterious substances in sand, delivered to the mixer shall not exceed the following:

Table 4.1 - Percentage of Foreign Material Limitation

Sl.No	Substances	Percent by weight	
		Uncrushed	Crushed
(i)	Material finer than 75 micron I.S. Sieve	3.00	15.00
(ii)	Shale	1.00	--
(iii)	Coal and lignite	1.00	1.00
(iv)	Clay lumps	1.00	1.00
(v)	Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) and (iv) for crushed sand.	5.00	2.00

Gradation: Unless otherwise directed or approved, the grading of sand shall be within the limits indicated hereunder

Table 4.2 - Standard Grading of Sand

I.S. Sieve Designation	Percentage passing for			
	Grading Zone -I	Grading Zone -II	Grading Zone -III	Grading Zone -IV
9.5 mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	8-30	20-65
150 micron	0-10	0-10	0-10	0-15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron(I.S.) sieve by not more than 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron (I.S.) sieve or to percentage passing any other sieve size on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to Grading Zone IV shall not be used unless mix designs and preliminary tests have shown its suitability for producing concrete of specified strength and workability.

Fineness Modulus : The sand shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentages retained on the following I.S. sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

Coarse Aggregate : Coarse aggregate for concrete, except as noted above and for other than light weight concrete shall conform to I.S. 383. This shall consist of natural or crushed stone and gravel, and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, sag, alkali, mica, organic matter or other deleterious matter.

The coarse aggregate and fine aggregate shall be tested from time to time as required by the Engineer-in- Charge to ascertain its suitability for use in construction and the charges for testing aggregate shall be born by the contractor as specified herein after.

Screening and Washing : Crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so demanded by Engineer-in-Charge.

Grading : Coarse aggregates shall be either in single or graded, in both the cases. The grading shall be within the following limits:

Table 4.3 - Standard Grading Limits of Coarse Aggregate

I.S. Sieve Designation	Percentage passing for single sized aggregates of nominal size						Percentage passing for graded aggregates of nominal size			
	63 mm	40 mm	20 mm	16mm	12 .5mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
75 mm	100	-	-	-	-	-	-	-	-	-
53 mm	85-100	100	-	-	-	-	100	-	-	-
37.5 mm	0-30	85-100	100	-	-	-	95-100	100	-	-
19 mm	0-5	0-20	85-100	100	-	-	30-70	95-100	100	100
13.2 mm	-	-	-	85-100	100	-	-	-	90-100	-
11.2 mm	-	-	-	-	85-100	100	-	-	-	90-100
9.5 mm	-	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	-	0-5	0-5	0-10	0-20	0-20	0-5	0-10	0-10	0-10
2.36 mm	-	-	-	-	0-5	0-5	-	-	-	-

The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only in such quantities that will not, in the opinion of Engineer-in-Charge, affect adversely the strength and/or durability of concrete, the maximum size of coarse aggregate shall be the maximum size specified above, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of form.

Plums above 160 mm. and upto any reasonable size can be used in plain mass concrete work of large dimensions upto a maximum limit of 20% by volume of concrete when specifically approved by Engineer- in-Charge.

For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm. less than the minimum clear distance between the reinforcing main bars or 5mm less than the minimum cover to the reinforcement whichever is smaller.

The amount of fine particles occurring in the Free State or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per I.S. 2386.

After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of itsoven dry weight in air, as determined by I.S.2386.

Foreign Material Limitations : The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following

Table 4.4: Foreign Material Limitations in Coarse Aggregate

Sl.No.	Substances	Percentage by weight of aggregates	
		Uncrushed	Crushed
i)	Material finer than 75 micron I.S. Sieve	3.00	3.00
ii)	Coal and lignite	1.00	1.00
iii)	Clay lumps	1.00	1.00
iv)	Soft fragments	3.00	--
v)	Total of all the above substances	5.00	5.00

4.3.2.4 WATER

Water used for both mixing and curing shall be clean and free from injurious amounts of deleterious materials.viz oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable waters are generally satisfactory for mixing and curing concrete. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in I.S. 456 - 2000. The sample of water taken for testing shall be typicalof the water proposed to be used for concreting, due account being paid to seasonal variation. The samples shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 days compressive strength of at least three 150 mm. concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubesprepared with distilled water as per IS - 516.

The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than (±) 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of I.S. 4031(Part 5).

Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-Charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values:

a) Limits of acidity : To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml. of 0.02 normal NaOH. The details of test shall be as per I.S. 3025 (Part 22)

b) Limits of alkalinity : To neutralize 100 ml sample of water, using mixed indicator , it should not require more than 25 ml. of 0.02 normal H_2SO_4. The details of test shall be as per I.S. 3025 (Part 23).

c) Permissible limits for solids shall be as under (water)

Table 4.5: Permissible limits for solids in Water

Sl.No.	Type of solid	Tested as per	Permissible limit (Max.)
i)	Organic	IS 3025 (Part 18)	200 mg / l
ii)	Inorganic	IS 3025 (Part 18)	3000 mg / l
Iii)	Sulphates (as SO_2)	IS 3025 (Part 24)	400 mg / l
iv)	Chlorides (as Cl)	IS 3025 (Part 32)	2000 mg / l for concrete not containing embedded steel and 500 mg/l for reinforced cement concrete work.
v)	Suspended matter	IS 3025 (Part 17)	2000mg / l

d) The pH value of water shall be not less than 6.

4.4 DESIGN MIX CONCRETE

All reinforced concrete in the works shall be "Design Mix Concrete" as defined in I.S. 456-2000.

4.4.1 Mix Design

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The proportions of the mix shall be determined by weight. Mix proportioning shall be carried out as per I.S. 10262 - 2009 or other standard method(s) approved by Engineer in Charge. The cost of design mix shallbe borne by the contractor.

Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcement and completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

Design mix concrete is preferred to nominal mix. If design mix cannot be used for any reason on the work such as soon after award of the work, if so desired by the contractor, he/they may be allowed by the Engineer-in-Charge, till the designed mix is obtained, to carry out the reinforced concrete work infoundation and plinth as per equivalent nominal mix against the specified design mix concrete. However, all other specification for design mix shall govern for nominal mix also and nothing extra shall be paid foruse of extra cement or else on this account whether the cement is supplied by the Department or procured by the contractor. Where the quantity of RCC is very small, under such circumstance equivalent nominalmix can also be permitted by the Engineer-in-Charge.

Table 4.6: Grades of Concrete (The concrete shall be in grades designated as below)

Group	Grade Designation	Specified Characteristic compressive strength of 150 mm cube at 28 days (N/mm^2)
Ordinary concrete	M 10	10
	M 15	15
	M 20	20
Standard Concrete	M 25	25
	M 30	30
	M 35	35

	M 40	40
	M 45	45
	M 50	50
	M 55	55
	M 60	60
High strength concrete	M 65	65
	M 70	70
	M 75	75
	M 80	80
	M85	85
	M 90	90
	M 95	95
	M100	100

NOTE :

1. The characteristic strength is defined as the strength of material below which not more than 5% of thetest results are expected to fall.

2: In the designation of a concrete mix, letter "M" refers to the mix and the number to the specified characteristic compressive strength of 150 mm. size cubes at 28 days expressed in N/ mm^2.

3. Minimum Cement Content, Maximum Water Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum size are as follows.

Table 4.7: Minimum Cement Content, Maximum Water Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum size

Sl No.	Exposure	Plain concrete			Reinforced concrete		
		Minimum cement content Kg/m^3	Maximum Free Water Cement Ratio	Minimum grade of concrete	Minimum Cement Content Kg/m^3	Maximum Free Water Cement Ratio	Minimum Grade of concrete
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	Mild	220	0.60	-	300	0.55	M-20
(ii)	Moderate	240	0.60	M-15	300	0.50	M-25
(iii)	Severe	250	0.50	M-20	320	0.45	M-30
(iv)	Very severe	260	0.45	M-20	340	0.45	M-35
(v)	Extreme	280	0.40	M-25	360	0.40	M-40

NOTE

1. Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in mineral admixtures. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2. Minimum grade for plain concrete under mild exposure condition is not specified.

Table 4.8: Nominal cover to meet Durability Requirements

Exposure	Nominal concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

NOTES

1. For main reinforcement up to 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm
3. For exposure conditions „severe" and „ very severe" , reduction of 5 mm may be made, where concrete grade is M 35 and above.

Table 4.9: Nominal cover to meet specified period of fire resistance

Fire resis--tance	Nominal cover						
	BEAMS		SLABS		RIBS		COLUMNS
	Simply Supported	Continuous	Simply Supported	Continuous	Simply Supported	Continuous	
Hr.	mm	mm	mm	mm	mm	mm	mm
0.5	20	20	20	20	20	20	40
1	20	20	20	20	20	20	40
1.5	20	20	25	20	35	20	40
2	40	30	35	25	45	35	40
3	60	40	45	35	55	45	40
4	70	50	55	45	65	55	40

NOTES

1 The nominal covers given relate specifically to the minimum member dimensions as per drawing
2 Cases that lie below the bold line require attention to the additional measures necessary toreduce the risks of spalling.

Table 4.10 Adjustments to Minimum cement contents for Aggregates other than 20 mm NominalMaximum size

Sl.No	Nominal maximum Aggregate size mm	Adjustments to Minimum cement content kg/ m^3
(1)	(2)	(3)
i)	10	+40
ii)	20	0
iii)	40	-30

For concrete of compressive strength greater than M55 design parameters given in the standard may not be applicable and the values may be obtained from specialized Literatures and experimental results.

The mix shall be designed to produce the grade of concrete having the required workability andcharacteristic strength not less than appropriate values given in the table above.

4.4.2 Approval of Design Mix: The calculated mix proportions shall be checked by means of trial batches as per IS 10262. The contractor shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer-in-Charge for his comments and approval. Concrete of any particular design mix and grade shall be produced/ manufactured for works only on obtaining written approval of the Engineer-in-Charge.

For any change in quality/ quantity in the ingredients of a particular concrete, for which mix has been designed earlier and approved by the Engineer-in-Charge, the mix has to be redesigned and approval obtained again. Cost of such mix design shall be borne by the contractor.

Whenever there is a change either in required strength of concrete or water cement ratio or workability orthe

source of aggregates and/or cement, fresh trial mix shall be carried out to determine the revised proportion of the mix to suit the altered conditions.

4.4.3 Standard Deviation: Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with IS 456.

Standard Deviation Based on Test Results

a) Number of test results - The total number of test results required to constitute and acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 test results, as early as possible, when a mix is used for the first time.

b) Standard deviation to be brought up to date - The calculation of the standard deviation shall be brought upto date after every change of mix design and at least once a month.

Determination of standard deviation

i) Concrete of each grade shall be analysed separately to determine its standard deviation.

The standard deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified for test strength of sample:

Estimated standard **deviation**

$$S = \sqrt{\frac{\sum \Delta^2}{(n-1)}}$$

ii) Where Δ = Deviation of the individual test strength from the average strength of a sample and
n = Number of sample test results.

iii) When significant changes are made in the production of concrete (for example changes in the materials used, mix design, equipments or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

Assumed Standard Deviation

Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in table below may be assumed for design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix designed properly. However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in table below, it shall be permissible to use that value.

Table 4.11: Assumed Standard Deviation

Grade of Concrete	Assumed Standard Deviation N/ mm^2
M 10 M 15	3.5
M 20 M25	4.0
M30 M35 M40 M45 M50 M55 M60	5.0

Note: The above values correspond to the site control having proper storage of cement: weigh batching of all materials: controlled addition of water: regular checking of all materials: aggregate grading and moisture contents : and periodical checking of workability: and strength. Where there is deviation from the above the values given in the

above table shall be increased by 1 N / mm.^{2}
For grades above M-60, the standard deviation shall be established by actual trials based on assumed proportions before finalizing the mix.

4.4.4 Proportioning, Consistency, Batching and Mixing of Concrete

4.4.4.1 Proportioning

Aggregate : The proportions which shall be decided by conducting preliminary tests shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weigh batchers conforming to I.S. 2722, capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Engineer-in-Charge that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stacked in separate stock piles. The grading of coarse and fine aggregates shall be checked as frequently as possible, as determined by the Engineer- in-Charge, to ensure maintaining of grading in accordance with samples used in preliminary mix design. The materials shall be stock piled well in advance of use.

Cement : The cement shall be measured by weight. Every facility should be provided to the Engineer-in- Charge for sampling and inspection of stored cement at site of work.

Table 4.12 - Exposure conditions

S.No:	Environment	Exposure Conditions
(1)	(2)	(3)
i)	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wetConcrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground waterConcrete surfaces sheltered from saturated salt air in coastal area
iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea waterConcrete exposed to coastal environment.
iv)	Very severe	Concrete surfaces exposed to seawater spray, corrosive fumes or severe freezing conditions whilst wet. Concrete in contact with or buried under aggressive sub-soil/ground water .
v)	Extreme	Surface of members in tidal zone Members in direct contact with liquid/solid aggressive chemicals.

WATER : Only such quantity of water shall be added to the cement and aggregate in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause segregation of materials or the collection of excessive free water on the surface of the concrete.

Definition of water cement ratio : The water cement (W/C) ratio is defined as the weight of water in mix (including the surface moisture of the aggregates) divided by the weight of the cement in the mix.

Water cement ratio : The actual water cement ratio to be adopted shall be determined in each instance by contractor and approved by the Engineer-in-charge.

Proportioning by water-cement ratio : The W/C ratio specified for use by the Engineer-in-Charge shall be maintained. Contractor shall determine the water content of the aggregate as frequently as directed by the Engineer-in-Charge

as the work progresses and as specified in I.S. 2386 part III and the amount of mixing water added at the mixer shall be adjusted as directed by the Engineer-in-charge so as to maintain the specified W/C ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

4.4.4.2 Consistency and slump : Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of mix shall be maintained throughout the progress of the corresponding parts of the work and approved tests e.g. slump tests, compacting factor tests etc. in accordance with I.S. 1199, shall be conducted from time to time to ensure the maintenance of such consistency.

The following tabulation gives a range of workability which shall generally be used for various types of construction unless other wise instructed by the Engineer-in-Charge.

Table 4.13 - Workability of concrete

Placing condition	Degree of workability	Slump (mm)
(1)	(2)	(3)
Blinding Concrete; Shallow Sections; Pavement using pavers	Very low	See note 2
Mass concrete; Lightly reinforced Sections in slabs, Beams, walls, columns; Floors; Hand placed pavements; Canal lining; Strip footings	Low	25-75
Heavily Reinforced Sections In slabs, beams, walls, columns	Medium	50-100
Slip form work; pumped concrete	Medium	75-100
Trench fill,	High	100-150
Tremie Concrete	Very High	See note 3

Notes

1: For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

2: the "very low" category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

3: In the „Very high" category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

Production of concrete Quality assurance measures

In order that the properties of the completed structure be consistent with the requirements and the assumptions made during the planning and the design, adequate quality assurance measures shall be taken. The construction should result in satisfactory strength, serviceability and long term durability so as to lower the overall life-cycle cost. Quality assurance in construction activity relates to proper design useof adequate materials and components to be supplied by the producers, proper workmanship in the execution of works by the contractor and ultimately proper care during the use of structure including timely maintenance and repair by the owner.

Quality assurance measures are both technical and organizational. Some common cases should be specified in a general Quality Assurance Plan which shall identify the key elements necessary to providefitness of the

structure and the means by which they are to be provided and measured with the overall purpose to provide confidence that the realized project will work satisfactorily in service fulfilling intendedneeds. The job of quality control and quality assurance would involve quality audit of both the inputs as well as the outputs. Inputs are in the form of materials for concrete; workmanship in all stages of batching, mixing, transportation; placing, compaction and curing; and the related plant, machinery and equipments; resulting in the output in the form of concrete in place. To ensure proper performance, it is necessary that each step in concreting which will be covered by the next step is inspected as the work proceeds.

Each party involved in the realization of a project should establish and implement a Quality Assurance Plan, for its participation the project. Suppliers and contractors activities shall be covered in the plan. The individual quality assurance plans shall fit into the general Quality Assurance Plan. A quality assurance

plan shall define the tasks and responsibilities of all persons involved ,adequate control and checking procedures, and the organization maintaining adequate documentation of building process and its results.
Such documentation should generally include

(a) test reports and manufacturers certificate for materials, concrete mix design details;
(b) pour cards for site organization and clearance for concrete placement;
(c) record of site inspection of workmanship, field tests
(d) non-conformance reports, change orders;
(e) quality control charts;
(f) statistical analysis.

NOTE - Quality control charts are recommended wherever the concrete is in continuous production over considerable period.

4.4.4.3 Batching and mixing of concrete

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixes on any site or in any one plant. In batching concrete, the quantity ofboth cement and aggregate shall be determined by mass; admixture, if solid, by mass; liquid admixture may however be measured in volume or mass; water shall be weighed or measured by volume in a calibrated tank (see also IS4925)

Ready mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and mediumproject sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926)

Except where it can be shown to the satisfaction of the engineer-in-charge that supply of properly gradedaggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportionswhen required, the different sizes being stocked in separate stock - piles. The material should be stock- piled for several hours preferably a day before use. The grading of coarse and fine aggregate should bechecked as frequently as possible , the frequency for a given job being determined by the engineer-in- charge to ensure that the specified grading is maintained.

The accuracy of the measuring equipment shall be within ± 2 % of the quantity of cement being measured and within ± 3 percent of the quantity of aggregate, admixtures and water being measured.

Proportion / Type and grading of aggregate shall be made by trial in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

Volume batching may be allowed only where weigh-batching is not practical and provided accurate bulkdensities of materials to be actually used in concrete have earlier been established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by engineer-in-charge to ensure that the specified grading is maintained.

It is important to maintain the water-cement ratio constant at its correct value. To this end determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible the frequency for a given job being determined by the engineer-in-charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture content. For the determination of moisture content in the aggregates IS 2386 (Part 3) may be referred to. To allow for the variation in mass of aggregate due to variation in their moisture content, suitable adjustments in the masses of aggregates shall also be made. In the absence of exact data only in the case of nominal mixes the amount of surface water may be estimated from the values given in table below.

Table 4.14 - Surface water carried by aggregate

Sr. No.	Aggregate	Approximate quantity of surface water	
		Percent by mass	l/m^3
(1)	(2)	(3)	(4)
	Very wet sand	7.5	120
	Moderately wet sand	5.0	80
	Moist sand	2.5	40
	Moist gravel or crushed rock	1.25 -2.5	20 - 40
	(Coarser the aggregate less water it will carry)		

No substitutions in materials used on the work or alterations in the established propositions except as permitted as above shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

4.4.4.4 Mixing: Concrete shall be mixed in a mechanical mixer. The mixer should with IS 1791 and IS 12119. The mixers shall be fitted with water measuring (metering) devices. The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. Ifthere is segregation after unloading from the mixer, the concrete should be remixed.

For guidance, the mixing time shall be at least 2 min. For other types of more efficient mixers, manufacturers recommendations shall be followed; for hydrophobic cement it maybe decided by the Engineer-in-Charge.

Workability should be checked at frequent intervals.

Dosage of retards, plasticizers and super plasticizers shall be restricted to 0.50,1.0 and 2.0 % respectively by weight of cementicious materials and unless higher value is agreed upon between the manufacturer and constructor based on performance test.

Each time the work stops, the mixer shall be cleaned out and when next commencing the mixing, the first batch shall have 10% additional cement to allow for sticking in the drum.

4.5 SAMPLING AND TESTING CONCRETE IN THE FIELD

Facilities required for sampling materials and concrete in the field, if Engineer-in-Charge so desires, shall be provided by contractor at no extra cost. The following equipment with operator shall be made available at Engineers request (all must be in serviceable condition)

Table 4.15: Testing equipments required at site

1.	Cast iron cube moulds 15 cm. Size	12 Nos.(min.)
2.	Slump cone complete with tamping rod	1 Set
3.	Lab. balance to weigh upto 5 kg. with sensitivity of 10 gm.	1 No.
4.	Laboratory balance of 2 kg. capacity and of sensitivity of 1 gm.	1 No.
5.	I.S. sieves for coarse and fine aggregates.	1 Set

6.	A set of measures from 5 ltrs. to 0.1 ltr.	1 Set
7.	Electric oven with thermostat upto 120 ^{0}C.	1 No.
8.	Pycnometer	1 No.
9.	Calibrated glass jar 1 ltr. Capacity	2 Nos.
10	Glass flasks and metal containers	As required
11	Concrete cube testing machine (optional)	1 No.

4.6. TESTING CHARGES: Different tests required to be carried out for concrete works including the mix design, cube tested as per the above specifications shall be got done by the contractor at his own cost in one of the government/ NABL approved laboratories. The choice of laboratory shall rest with the Department. All incidental charges / cost shall be borne by the contractor

4.7 SAMPLING AND STRENGTH TEST OF CONCRETE

4.7.1 General: Samples from fresh concrete shall be taken as per I.S. 1199 and cubes shall be made,cured and tested at 28 days in accordance with I.S. 516 .

In order to get a relatively quicker idea of the quality of concrete, option tests on beams for modulus of rupture at 72 (±) 2 hours or at 7 days or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose, the values given in table below may betaken for general guidance in the case of concrete made with ordinary cement. In all cases, the 28 dayscompressive strength specified shall alone be the criterion for acceptance or rejection of the concrete. Ifhowever, from test carried out in particular job over a reasonably long period, it has been established to the satisfaction of the Engineer-in-Charge that a suitable ratio between 28 days compressive strength and modulus of rupture at 72 (±) 2 hours or 7 days or compressive strength at 7 days may be accepted, the Engineer-in-Charge may suitably relax the frequency of 28 days compressive strength, provided the expected strength values at the specified early age are consistently met.

Table 4.17 - Optional Tests Requirements of Concrete

Grade of Concrete	Compressive strength on 15 cm cubes min. at 7 days	Modulus of rupture by beam test min.	
		At 72 (±) 2 hours N / mm2	At 7 daysN / mm2
M 10	7.0	1.2	1.7
M 15	10.0	1.5	2.1
M 20	13.5	1.7	2.4
M 25	17.0	1.9	2.7
M 30	20.0	2.1	3.0
M 35	23.5	2.3	3.2
M 40	27.0	2.5	3.4

4.7.2 Frequency of Sampling :Sampling Procedure : A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, i.e. the sampling should be spread over the entire period of concreting and cover all mixing units.

Frequency : The minimum frequency of sampling of concrete of each grade shall be in accordance with following

Table 4.18: Frequency of Sampling for Concrete

Quantity of Concrete in the work (in cum.)	Number of samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional for each additional50 cum. or part there of

At least one sample shall be taken from each shift. Where concrete is continuous production unit, such as ready - mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and purchasers.

4.7.3 Test Specimen : Three test specimen shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7days or at the time of striking the form work or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in I.S. 9013 - 1978. The specimen shall be tested as described in I.S. 516 - 1959.

4.7.4 Test Strength of Samples : The test strength of the samples shall be the average of the strength of three specimen. The individual variation should not be more than (±) 15 percent of the average.

4.7.5 Consistency : Slump test shall be carried out as often as demanded by the Engineer-in-Charge and invariably from the same batch of concrete from which the test cubes are made. Slump tests shall be done immediately after sampling

4.7.6 Standard Deviation : Vide clause 4.4.3 of this specification.

4.8 ACCEPTANCE CRITERIA

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met

(a) The mean strength determined from any group of four non overlapping consecutive test results complies with the appropriate limits in column 2 of Table below

(b) Any individual test result complies with the appropriate limits in column 3 of Table below.

Table 4.19 - Characteristic Compressive Strength Compliance Requirement

Specified grade	Mean of the Group of 4 Non-overlapping consecutive test results in N / mm2	Individual test results in N/mm^2
(1)	(2)	(3)
M 15 and above	≥ fck + 0.825 x established standard deviation (rounded offto nearest $0.5\ N/mm^2$ or ≥ fck + 3 N / mm^2 whichever is greater	≥fck - 3 N/ mm^2

Note -

i. In the absence of established value of standard deviation, the values given in (assumed standard deviation) may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

ii. For concrete of quantity up to 30 m^3 (where the number of samples to be taken is less than four as per the frequency of sampling), the mean of test results of all such samples shall be fck+4N/mm^2, minimum and the requirement of minimum individual test results shall be fck-2 N/mm^2, minimum. However, when the number of sample is only one, the requirement shall be fck+4 N/mm^2, minimum.

Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexuralstrength.

(a) The mean strength determined from any group of four consecutive test results exceedsthe specified characteristic strength by at least 0.3 N/mm^2

(b) The strength determined from any test result is not less than the specified characteristicstrength less 0.3N/mm^2

Quantity of Concrete Represented by Strength Test Results

The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in column 2 of above table or in item (b) of flexural strength, only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m^3

If the concrete is deemed not to comply pursuant to above the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately

Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge.

4.9 ADMIXTURES

Admixtures, if used shall comply with IS 9103. Previous experience with and data on such materials should be considered in relation to the likely standards of supervision & workmanship to the work being specified. Admixtures should not impair durability of the concrete not combined with the constituent to form harmfulcompounds nor increase the risk of corrosion of reinforcement.

The workability, compressive strength and the slump loss of concrete with & without the use of admixtures shall be established during the trial mixes before use of admixtures.

The relative density of liquid admixtures shall be checked for such drum containing admixtures and compared with the specified value before acceptance.

The chloride content of the admixtures shall be independently tested for each batch before acceptance. If two or more admixtures are used simultaneously in the same concrete mix data should be obtained to assess their interaction and to ensure their compatibility.

Admixtures may be any one of the following classes for use in concrete: -

(a) Water Reducing Admixtures
(b) Retarding Admixtures
(c) Accelerating Admixtures.

(d) Water Reducing and Retarding Admixtures.
(e) Water Reducing and Accelerating Admixtures.
(f) Permeability Reducing (water proofing) Admixtures.

Liquid Admixtures: Admixtures introduced into the concrete as liquids generally fall into the following categories.
(a) Air Entraining.
(b) Water Reducing.
(c) Water Reducing Retarders.
(d) Retarders.
(e) Water Reducing Accelerators.
(f) Accelerators.

Dosage of these admixtures may vary according to manufacturer's specification.

Two or more admixtures may not be compatible in the same solution. It is therefore mandatory that when two admixtures manufactured by the same manufacturers is being used simultaneously, the manufacturer shall certify their compatibility. In case the two or more admixtures are produces by different manufacturers, then, before their use in concrete, test shall be performed by the manufacturer to establish their compatibility, all such test reports shall be furnished to the Engineer-in-Charge for his approval before their use in concrete.

Some admixture may be in the form of powder, particle or high concentration liquids which may require mixing with water prior to dosing. Under these conditions water in solution shall be considered as part of total water content in the batch in order to maintain the water-cement ratio.

Admixture manufacturer's recommendation shall be carefully followed so as to ensure complete solution of the product or to prepare a standard solution of uniform strength for easier use.

Certain admixtures may contain significant amounts of finely divided insoluble materials or active ingredients which may or may not be readily soluble. It is essential for such admixtures that precautions be taken to ensure that these constituents be kept in a state of uniform suspension before actual batching. When relatively small amounts of powered admixtures are to be used directly, these shall be pre-blended with cement.

Admixtures are sold under various trade names and may be in the form of liquids or powders. The proprietary name and the net quantity of content shall be clearly indicated in each package or container of admixtures. The admixtures shall be uniform within each batch and uniform between all batches.

No admixtures shall be accepted for use in concrete unless these are tested in accordance with IS 9103 and the test results are approved by the Engineer-in-Charge.

General

Admixture may be used in concrete only with the approval of Engineer-in-charge based upon evidence that, with the passage of time neither the compressive strength nor its durability reduced. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturers instructions and in the manner and with the control specified by Engineer-in-Charge.

i) **Calcium Chloride :** Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in anamount not to exceed 1.5 percent of the weight of cement in each batch of concrete.

ii) Air Entraining Agents : Where specified and approved by Engineer-in-charge, neutralized vinsol resin or any other approved air entraining agent may be used to produce the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6.260, Air Entraining admixtures for concrete. The recommended total air content of the concrete is 4% (±)1%. The method ofmeasuring air content shall be as per I.S.1199.

iii) Retarding Admixtures : Where specified and approved by Engineer-in-Charge, retarding agents shall be added to the concrete mix in quantities specified by Engineer-in-Charge.

iv) Water Reducing Admixtures : Where specified and approved by Engineer-in-Charge, water reducing lignosulfonate mixture shall be added in quantities specified by Engineer-in-Charge. The admixtures shall be added in the form of a solution.

v) Water Proofing Agents : Where specified and approved by Engineer-in-Charge, chloride and sulphate free water proofing agents shall be added in quantities specified by Engineer-in-Charge.

vi) Other Admixtures : Engineer-in-Charge may at his discretion, instruct contractor to use any other admixture in the concrete.

4.10 INSPECTION OF STRUCTURES

Immediately after stripping the form work, all concrete shall be carefully inspected and any defective work or small defects, either removed or made good before concrete has thoroughly hardened, as instructed by Engineer-in-Charge.

In case of doubt regarding the grade of concrete used or results of cube strength are observed to be lower than the designed strength as per specifications at 28 days, compressive strength test of concrete basedon core test, ultrasonic test and/or load test shall be carried out by the digital ultrasonic concrete tester by an approved agency as directed by the Engineer-in-Charge all at the cost of the contractor. In case these tests do not satisfy the requirements, the Department will be at liberty to reject the concrete, and the contractor, at his own cost, has to dismantle and re-do the same or carry out such remedial measures asapproved by the Department.

4.11 TESTING OF STRUCTURES :

4.11.1 Optional Tests : Engineer-in-charge, if he so desires, may order for tests to be carried out on cement, sand, coarse aggregate, water etc. in accordance with the relevant Indian Standards.

Tests on cement will be carried out by Department and shall include (i) fineness test, (ii) test for normal consistency, (iii) test for setting time, (iv) test for soundness, (v) test for compressive strength, (vi) test forheat of hydration (by experiment and by calculations) in accordance with I.S.269.

Tests on sand shall include (i) sieve test, (ii) test for organic impurities, (iii) decantation test for determining clay and silt content, (iv) specific gravity test, (v) test for unit weight and bulkage factor, (vi) test for sieve analysis and fineness modulus.

Tests on coarse aggregate shall include (i) sieve analysis, (ii) specific gravity and unit weight of dry, loose and rodded aggregate, (iii) soundness and alkali aggregate reactivity, (iv) petrographic examination, (v) deleterious materials and organic impurities, (vi) test for aggregate crushing value.

The test on aggregates would normally be ordered to be carried out only if Engineer-in-charge feels the materials are not in accordance with the specifications or if the specified concrete strengths are not obtained and shall be performed by contractor at an approved test laboratory. Contractor shall have to pay all the testing charges. If the work cubes do not give the stipulated strengths, Engineer-in-Charge reserves the right to ask contractor to dismantle such portions of the work, which in his opinion are unacceptable and re-do the work to the standards stipulated at contractors cost.

The unit rate for concrete shall be all inclusive including making preliminary mix design and test cubes, works cubes, testing them as per specifications, slump tests, etc. complete.

In case of doubt regarding the grade of concrete used, either due to poor workmanship or based on cube strength tests, tests such as rebound hammer test, ultrasonic pulse test, core test, load test etc. shall becarried out to prove the suitability of concrete as decided by Engineer-in-Charge. The cost of the such tests shall be borne by the contractor.

4.11.2 Core Test : The points from which cores are to be taken and the number of cores required, shallbe at the discretion of the Engineer-in-Charge and shall be representative of the whole of concrete concerned. In no case, however, shall fewer than three cores be tested. Cores shall be prepared and tested as described in I.S. 516

Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75%.

In case the core test results do not satisfy the requirements as above or where such tests have not beendone, load test (see 4:11:3) may be resorted to.

4.11.3 Load Tests on Parts of Structure

Load tests should be carried out as soon as possible after expiry of 28 days from the time of placing of concrete.

The structure should be subjected to a load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed.

Note: Dead load includes weight of the structural members plus weight of finishes and walls or partitions, if any, as considered in the design.

The deflection due to imposed load only shall be recorded. If within 24 hours of removal of the imposedload, the structure does not recover at least 75% of the deflection under super imposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80%, the structure shall be deemed tobe unacceptable.

If the maximum deflection in mm. shown during 24 hours under load is less than $40L^2/D$, where L is the effective span in M. and D the overall depth of the section in mm, it is not necessary for recovery to be measured and the recovery provision as above will not apply.

4.11.4 Other non-destructive test methods may be adopted, in which case the acceptance criteria shall be agreed upon between the Engineer-in-Charge and the Contractor and the test shall be done under expert guidance.

Members Other than Flexural Members

Members other than flexural members should be preferably investigated by analysis.

Non - destructive tests

Non-destructive tests are used to obtain estimation of properties of concrete in the structure. The methods adopted include ultrasonic pulse velocity [see IS 516, Part-5, Sec-1] and rebound hammer [IS 516, Part-5, Sec-4], probe penetration, pull out and maturity. Nondestructive tests provide alternatives to core tests for estimating the strength of concrete in a structure, or can supplement the data obtained from a limited number of cores. These methods are based on measuring a concrete property that bears some relationship to strength/ the accuracy of these methods, in part is determined by the degree of correlation between strength and the physical quality measured by the non-destructive tests.

Any of these methods may be adopted, in which case the acceptance criteria shall be agreed upon prior to testing.

4.11.5 Testing of Underground Water Tank/Septic Tank/Underground Structures

The tank will be tested after the completion according to the procedure laid down here

The middle compartment shall be filled first to its full height and the leakage if any shall be checked on its outer surfaces and if found, the same shall be examined carefully and defects rectified/grouted if necessary. The drop in level of surface of water shall also be recorded for 48 hours. If this drop in levelexceeds 20 mm. and shows any leakage in the said walls, necessary steps shall be taken in consultation with the Engineer-in-Charge.

After this compartment is tested to the satisfaction of the Engineer-in-Charge, all water from middle compartment shall be pumped into side compartment to the full height and checked for water leakages from the outer surfaces of the tank as well as inner surface of the middle compartment. The drop in level of surface of water shall also be checked as stated above and defects rectified.

The external surface of the tank shall then be plastered and cured as per the specifications and back filling shall be taken up thereafter. The water from the compartments shall then be pumped out and the inner surface of the tank in all compartments then be checked and defects rectified.

After satisfactory completion of checks, internal plaster shall be taken up as specified in the specifications.

The contractor shall be responsible for carrying out the complete test, rectifying the leakages if any. Thecost of providing all equipments, labour for carrying out tests shall be borne by the contractor. The rates quoted for concreting items for constructing underground water tank shall be inclusive of testing of RCCtank for water tightness as per above specifications. The contractor shall make his own arrangement totap the water from the departmental supply line for filling the tank, if supply of water stipulated under Schedule „A". If supply of water not stipulated under Schedule „A", the contractor shall make his own arrangement as per contract conditions at his own cost.

4.11.6 Unsatisfactory Tests

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction, contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by Engineer-in-Charge. Contractor shall bearthe cost of so doing, unless the failure of the member or members to fulfill the test conditions is proved to be solely due to faulty design. The cost of load and other tests shall be borne by Contractor if the tests show unsatisfactory results; otherwise such costs will be borne by the Department.

4.12 CONCRETE IN ALKALI SOILS WATER & AGGREGATES

Some aggregates containing particular varieties of silica may be susceptible to attack by alkalis (Na_2O and K_2O) originating from cement and other sources, producing an expansive reaction which can cause cracking and disruption of concrete. Damage to concrete from this reaction will normally only occur whenall the following are present together.

a) A high moisture level, within the concrete
b) A cement with high alkali content, or another source of alkali
c) Aggregate containing an alkali reactive constituent

Where the service records of particular cement / aggregate combination are well established, and do notinclude any instances of cracking due to alkali-aggregate reaction, no further precautions should be necessary. When the materials are unfamiliar, precautions should take one or more of the following forms:

a) Use of non-reactive aggregate from alternate sources

b) Use of low alkali ordinary Portland cement having total alkali content not more than 0.6 percent (as Na_2O equivalent).

c) Further advantage can be obtained by use of fly ash (Grade I) conforming to IS 3812 orgranulated blast furnace slag conforming to IS 12089 as part replacement of ordinary Portland cement (having total alkali content as Na_2O equivalent not more than 0.6 percent) provided fly ash content is at least 20 % or slag content is at least 50 percent.

d) Measures to reduce the degree of saturation of the concrete during service such as use of impermeable membranes

e) Limiting the cement content in the concrete mix and thereby limiting total alkali content in the concrete

mix as per approval of Engineer- in-charge.

4.12.1 Chlorides in the concrete: Whenever there is chlorides in concrete there is an increased risk ofcorrosion of embedded metal. The higher the chloride content or if subsequently exposed to warm moist conditions, the greater the risk of corrosion. All constituents may contain chlorides and concrete may be contaminated by chlorides from the external environment. To minimise the chance of deterioration of concrete from harmful chemical salts, the levels of such harmful salts in concrete materials, that is, cement, aggregates, water and admixtures, as well as by diffusion from the environment should be limited. The total amount of chloride content (as Cl) in the concrete at the time of placing shall be as given below in the table.

Table 4.20 - Limits of Chloride Content of Concrete

Sl.No	Type or Use of Concrete	Maximum Total Acid Soluble Chloride Content Expressed as kg/m^3 of Concrete.
i)	Concrete containing metal and steam cured at elevated temperature and pre-stressedconcrete	0.4
ii)	Reinforced concrete or plain concretecontaining embedded metal	0.6
iii)	Concrete not containing embedded metal or any material requiring protection form chloride	3.0

The total acid soluble chloride content should be calculated from the mix proportions and the major chloride contents of each of the constituents. Whenever possible the total chloride content of the concrete should be determined as per the approval of the Engineer-in-Charge.

4.12.2 Sulphates in concrete: Sulphates are present in most cements and in some aggregates; excessive amounts of water-soluble sulphate from these or other mix constituents can cause expansionand disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as SO_3, should not exceed 4 per cent by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix as per the approval of the Engineer-in-Charge.

The 4 percent limit does not applied to concrete made with super sulphated cement complying with IS 6909 or as approved by the Engineer-in-Charge.

4.13 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION & APPROVAL

Before the concrete is actually placed in position, the inside of the form work shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottom of columns and wall forms, to permit removal of saw dust, wood shavings, binding wire, rubbish, dirt etc. Opening shall be placed or holes drilled so that these materials and water can be removed easily. Such openings / holes shall be later suitably plugged.

The various traders shall be permitted ample time to install drainage and plumbing lines, floor and trenchdrain, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as indicated on the drawing or as necessary for the proper execution of the workAll such embedment shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

Slots, openings, holes, pockets etc. shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer-in-Charge.

Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

Prior to concrete placement, all works shall be inspected and approved by Engineer-in-Charge, and if found unsatisfactory, concrete shall not be poured until all defects have been corrected at contractors cost.

Approval by Engineer-in-Charge of any and all materials and work as required herein shall not relieve contractor from his obligations to produce finished concrete in accordance with the drawings and specifications.

4.13.1 Rain or Wash Water: No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rain shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage which may becaused by rain, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newlyplaced concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drainsand sumps shall be provided.

4.13.2 Bonding Mortar: Immediately before concrete placement begins, prepared surfaces, except form work, which will come in contact with concrete to be placed, shall be covered with a bonding mortar of same strength of concrete.

4.13.3 Transportation: All buckets, containers or conveyers used for transporting concrete shall be mortar-tight. All means of conveyance shall be adopted to deliver concrete of the required consistency and plasticity without segregation or loss of slump whatever method of transportation is employed. Chute shall not be used to transport the concrete without the written permission of the Engineer-in-Charge and concrete shall not be re-handled before placing.

4.13.4 Re-tempered or Contaminated Concrete: Concrete must be placed in its final position before itbecomes too stiff to work. On no account water shall be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials and which has not been placed within half an hour of mixing water with cement shall be rejected.

4.13.5 Cleaning of Equipment: All equipments used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipe lines and other equipments shall be thoroughly cleaned after each period of placement.

4.13.6 Procedure for Placing of Concrete

4.13.6.1 Engineers Approval of Equipment and Methods : Before any concrete is placed, the entire placing programme, consisting of equipment, layout proposed procedures and methods shall be submitted to Engineer-in-Charge and no concrete shall be of such size and design to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

4.13.6.2 Time Interval Between Mixing and Placing : Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer and once compacted it shall not be disturbed.

4.13.6.3 Avoiding Segregation : Concrete shall in all the cases be deposited as nearly as practicable directly in its final position and shall not be re-handled or caused to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, and in narrow forms, contractor shall provide suitable prop and Elephant Trunks to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin walls.

4.13.6.4 Placing by Manual Labour : Except when otherwise approved by Engineer-in-Charge, concrete shall be placed in the shuttering by shovels or other approved implements and shall not be dropped from a height more than 1.0 m. or handled in a manner which will cause segregation.

4.13.6.5 Placing by Mechanical Equipment : The following specifications shall apply when placing of concrete by use of mechanical equipment is specially called for while inviting bids or is warranted, considering the nature of work involved.

The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the

middle of the bucket of hopper and this principle of a vertical discharge of concrete shall be adhered-to through out all stages of delivery until the concrete csomes to rest in its final position.

Type of buckets : All concrete shall be conveyed from the mixer to the place of final deposit in suitable buckets, dumpers, containers which shall be leak-tight. All means of conveyance shall be adopted for delivering concrete to the required consistency/ workability and plasticity without segregation.

Central bottom dump buckets of a type that provides for positive regulation of the amount and rate deposition of concrete in all dumping position shall be employed.

Operation of Bucket : In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.0 m. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner which results in separation of ingredients or disturbance of previously placed concrete will not be permitted.

4.13.6.6 Placement in Restricted Forms : Concrete placed in restricted forms by borrows, buggies, cars, short chutes or hand shoveling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

4.13.6.7 Chutting: Where it is necessary to use transfer chutes, specific approval of Engineer-in-Charge must be obtained to type, length, slopes, baffles, vertical terminal and timing of operations. These shall be so arranged that almost continuous flow of concrete is obtained at the discharge and without segregation. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the waste water shall be kept clear of the forms. The concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. Chutes, when approved for use, shall have slopes not flatter than 1 vertical to 3 horizontal and not steeper than 1 vertical to 2 horizontal, chutes shall be of metal or metal line and of rounded cross section. The slopes of all chute sections shall be approximately same. The discharge end of the chutes shall be maintained above the surfaces of the concrete in the forms.

4.13.6.8 Placing by Pumping/ Pneumatic Placers : Concrete may be conveyed and placed by mechanically operated equipment e.g. pumps or pneumatic placers, only with the written permission of Engineer-in-Charge. The slump shall be held to the minimum, necessary for conveying concrete by thismethod.
When pumping is adopted, before pumping of concrete is started, the pipelines shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. The concrete mix shall specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

When pneumatic placer is used, the manufacturers advice on layout of pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at the end.

Manufacturers advice shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placing equipments are used.

4.13.6.9 Concrete in Layers : Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm. to 90 cm. as directed by Engineer-in-Charge. These shall be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layers within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with aminimum of shovelling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by Engineer-in-Charge.
Bedding of Layers : The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed.

4.13.7 Compaction : Concrete shall be compacted during placing, with approved vibrating equipment, until the concrete has been

consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular careshall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution is to be exercised not to over vibrate the concrete to the point of segregation.

4.13.7.1 Type of Vibrators : Vibrators shall conform to I.S. specifications. Type of vibrators to be used shall depend upon the structure where concrete is to be placed. Shutter vibrators, to be effective, shall be firmly secured to the form work which must be sufficiently rigid to transmit the vibrations and strong enough not to be damaged by it. Immersion vibrators shall have No load frequency amplitude and acceleration as per I.S.2505 depending on the size of the vibrator. Immersion vibrators in sufficient numbers and each ofadequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

4.13.7.2 Use of Vibrators : The exact manner application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm. apart and withdrawn when air bubbles cease tocome to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of lift, e.g. in a column or wall.

4.13.7.3 Melding successive batches : When placing concrete in layers, which are advancing horizontally as the work progress, great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the successive layers.

4.13.7.4 Penetration of vibrators : The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

4.13.7.5 Vibrating against reinforcement : Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

4.13.7.6 Use of Form Attached Vibrators : Form attached vibrators shall be used only with specific authorisation of Engineer-in-Charge.

4.13.7.7 Use of surface vibrators : The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, such as highways, runways and similar construction, surface vibrations by specifically designed vibrators may be permitted, upon approval of Engineer-in-Charge.

4.13.8 Stone Pockets and Mortar Pondages : Formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to a sufficient depth and shape for thorough bounding as directed by Engineer-in- Charge.

4.13.9 Placement Interval : Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete and beforethe start of a subsequent placement.

4.13.9.1 Special Provision in Placing : When placing concrete in walls with openings, in floors of integral slab and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slabs as the casemay be. Placing shall be resumed before the concrete in place takes initial set, but not until it has hadtime to settle as determined by Engineer-in-charge.

4.13.9.2 Placing Concrete Through Reinforcing Steel : While placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congregation of steel make placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position.

4.13.10 Bleeding : Bleeding or free water on top of concrete being deposited in to the forms, shall be caused to stop the concrete pour and the conditions causing this defect corrected before any further concreting is resumed.

4.14 CONSTRUCTION JOINTS AND KEYS

Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints, as specified therein after. Time lapse between the pouring of adjoining units shall be as specified in the drawings or as directed by Engineer-in-Charge.

4.14.1 Construction joints and cold joints: Joints are a common source of weakness and therefore it is desirable to avoid them. If this is not possible, their number shall be minimized. Concreting shall be carried out continuously up to construction joints the position and arrangement of which shall be indicated by the designer. Construction joints should comply with IS 11817.

Construction joints shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete, in order to create rough/uneven surface. It is recommended to clean out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete and to clean at the same immediately thereafter. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed, against it. In the case of construction joints at locations where the previous pour has been cast against shuttering the recommended method of obtaining a rough surface for the previously poured concrete is to expose the aggregate with a high pressure waterjet or any other appropriate means. At high pressure with a lower flow, water jet shall remove all loose laitance, cement slurry and unsound concrete without damaging the sound concrete below.

Fresh concrete should be thoroughly vibrated near construction joints so that mortar from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys may be provided. Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made where the work is stopped. Joints shall be either vertical or horizontal, unless shown otherwise in drawing. In case of an inclined or curved member, the joints shall be at right angles to the axis of the member. Vertical joints in walls shall be kept to a minimum. Vertical joints shall be formed against a stop board, horizontal joints shall be level and wherever possible, arranged, so that the joint lines coincide with the architectural features of the finished work. Battens, shall be nailed to the form work to ensure a horizontal line and if directed, shall also be used to form a grooved joint. For tank walls, similar work joints shall be formed as per I.S. 3370. Concrete that is in the process of setting shall not be disturbed or shaken by traffic either on the concrete itself or upon the shuttering. Horizontal and vertical construction joints and shear keys shall be located and shall conform in detail to the requirements of the plans unless otherwise directed by Engineer-in-Charge. Where not described, the joints shall be in accordance with the following:

Column Joints : In a column, the joint shall be formed 75 mm. below the lowest soffit of the beams including haunches if any. In flat slab construction the joint shall be 75 mm. below the soffit of column capital. At least 2 hours shall elapse after depositing concrete in column, piers or walls, before depositing in beams, girders or slabs supported thereon.

Beam and Slab Joints : Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and at the centre or within the middle third of the span unless otherwise shown in drawing. Where a beam intersects a girder, the joints in the girder shall be offset a distance equal to twice the width of the beam and additional reinforcement provided for shear. The joints shall be vertical throughout the full thickness of the concrete member. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidable at right angles to the principle reinforcement, the joint shall be vertical and at the middle of span.

Joints in Liquid Retaining Structures : Vertical construction joints in watertight construction will not be permitted unless indicated on the drawings. Where a horizontal construction joint is required to resist water pressure, special care shall be taken in all phases of its construction to ensure maximum water tightness.

Dowels : Dowels for concrete work, not likely to be taken up in the near future, shall be wrapped in tar paper and burlap.

Mass Foundations : Mass foundations shall be poured in lifts not exceeding 1.5 m. in height unless, otherwise indicated on the drawings and approved by Engineer-in-Charge.

Treatment of Construction Joints on Resuming Concreting : Drier shall be used for the top lift or horizontal pours to avoid a laitance. All laitance and loose stones shall be thoroughly and carefully removed by wire brushing/ hacking and surface washed.

Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned and loose matter removed and then treated with a thin layer of cement grout of proportion specified by Engineer-in-Charge and worked well into the surface. The new concrete shall be well worked specially against the prepared face before the grout mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

4.15 CURING, PROTECTING, REPAIRING, AND FINISHING

4.15.1 Curing : All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or ponded water, continuously saturated covering of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

Certain types of finish or preparation for overlaying concrete must be done at certain stages of curing process and special treatment may be required for specific concrete surface finish.

Curing of concrete made of high alumina cement and supersulphated cement shall be carried out as directed by Engineer-in-Charge.

4.15.2 Curing with Water : Fresh concrete shall be kept continuously wet for a minimum period of 14 days from the date of placing of concrete, following a lapse of 12 to 24 hours after laying concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin immediately the concrete has hardened. Water shall be applied to unformed concrete surfaces within 1 hour after concrete has set. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

4.15.3 Continuous Spraying : Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by Engineer-in-Charge.

4.15.4 Alternate Curing Methods : Whenever in the judgment of Engineer-in-Charge, it may be necessary to omit the continuous spray method, covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. Any type of

covering which would stain or damage the concrete during or after the curing period, will not be permitted. Covering shall be kept continuously wet during the curing period.

For curing of concrete in pavements, side-walks, floors, flat roofs or other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by Engineer-in-Charge. Special attention shall be given to edges and corners of the slab to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

4.15.5 Curing Compounds : Surface coating type curing compound shall be used only on special permission

of Engineer-in-Charge. Curing compounds shall be liquid type while pigmented, conforming to U.S. Bureau of Reclamation Specification. No curing compound shall be used on surface where future blending with concrete, water or acid proof membrane or painting is specified.

4.15.6. Curing Equipment : All equipments and materials required for curing shall be on hand and ready for use before concrete is placed.

4.15.7. Moist Curing: Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking , canvas, hessian or similar materials and kept constantly wet for at least seven days from the date of placing concrete. In case of ordinary Portland cement and at least ten days where mineral admixtures or blended cement are used. The period of curing shall not be less than ten days of concrete exposed to dry and hot wheather conditions. In the case of concrete the mineral admixtures or blended cement are used, it is recommended that the above minimum periods may be extended to fourteen days as per the approval of the Engineer-in-Charge.

4.15.8. Membrane Curing: Approved curing compounds may be used in lieu of moist curing with the permission of Engineer-in-charge. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membranes such as poly ethylene sheeting covering, closely the concrete surface may also be used to provide effective barrier against evaporation.

For the concrete containing Portland pozzolona cement, Portland slag cement or mineral admixtures increased period of curing may be decided by Engineer-in-charge.

The rate of strength development at early age of concrete made with super sulphated cement is significantly reduced at lower temperatures. Super sulphated cement concrete is seriously affected by inadequate curing and the surface has to be kept moist for at least seven days or more as per the approval of the Engineer-in-Charge.

4.16 PROTECTING FRESH CONCRETE

Fresh concrete shall be protected from the elements, from defacements and damage due to construction operations by leaving forms in place for ample period as specified later in this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by Engineer-in-Charge, shall also be taken to protect immature concrete from damage by debris, excessive loading, vibrations, abrasion or contact with other materials etc. that may be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, Engineer-in-Charge may require that bridges be placed over the area.

4.17 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of Engineer-in-Charge who may permit patching of the defective areas or else reject the concrete unit either partially or entirely. Rejected concrete shall be removed and replaced by Contractor at no additional expense to the Department. Holes left by form bolts etc. shall befilled up and made good with mortar composed of one part of cement to one and half parts of sand passing

through 2.36 mm. I.S. sieve after removing any loose stones adhering to the concrete. Mortar filling shallbe struck off flush at the face of the concrete. Concrete surface shall be finished as described under the particular item of work.

Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of Engineer-in-Charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with wooden float. Excess water shall be avoided. Unless instructed otherwise by Engineer-in-Charge, the surface of the exposed concrete placed againstshuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surfaces. Surface irregularities shall be removed by grinding.

If reinforcement is exposes or the honey combing occurs at vulnerable position e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of Engineer-in-Charge

shall be final in this regard. If only patching is necessary, the defective concrete shall be cut out till solid concrete is reached (or to a minimum depth of 25 mm.), the edges being cut perpendicular to the affected surface or with a small under cut if possible, anchors, tees or dowels shall be provided in slots whenever necessary to attach the new concrete securely in place. An area extending several centimetres beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

4.17.1 Use of Epoxy : The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Engineer-in-Charge. Epoxies shall be applied in strict accordance with the instruction of the manufacturer.

4.17.2 Method of Repair : Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows:

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

A 5 mm. thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly proud of the surrounding surface. The concrete patch shall be built up in 10 mm. thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. Steel trowel shall not be used forthis purpose. The mix for patching shall be of the same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

Mortar filling by air pressure (guniting) shall be used for repair of areas to large and/ or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture ofthe surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by Engineering-in-Charge, to match the shade of the patch with the original concrete.

4.17.3 Curing of Patched Work : The patched area shall be covered immediately with an approved non- staining water-saturated material such as gunny bags, which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray of sprinkling water for not less than 10 days.

4.17.4 Approval by Engineer-in-Charge : All materials, procedures and operations used in the repair of concrete and also the finished repair work shall be subject to the approval of Engineer-in-Charge. All fillings shall tightly bonded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

4.18 FINISHING

This specification is intended to cover the treatment of concrete surfaces of all structures.

4.18.1 Finish for Formed Surfaces : The type of finish for formed concrete surfaces shall be as follows, unless otherwise specified by the Engineer in charge:

For surfaces against which backfill or concrete is to be placed, no treatment is required except repair of defective areas.

For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of surface irregularities which would interfere with proper application of the water-proofing materials which is specifiedfor use.

Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling ofholes left by form ties and rods and clean up of loose or adhering debris.

Surfaces which will be exposed to the weather and which would normally be leveled, shall be sloped for drainage. Unless the drawing specify a horizontal surface or shows the slope required, the tops of narrow surfaces such as

staircase treads, walls, curbs and parapets shall be sloped across the width approx. as 1 in 30. Broader surfaces such as walkways, roads, parking areas and platforms shall be sloped about 1in 50. Surfaces that will be covered by backfill or concrete, sub floors to be covered with concrete topping, terrazzo or quarry tile and similar surfaces shall be smooth, screeded and leveled to produce even surfaces. Surface irregularities shall not exceed 6mm. Surfaces which will not be covered by backfill, concrete or tile topping such as outside decks, floors of galleries and sumps, parapets, gutters, sidewalks, floors and slabs shall be consolidated, screeded and floated.

Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screeded surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as called for on the drawings or as directed by Engineer-in-Charge.

4.18.2 Standard Finish for Exposed Concrete : Exposed concrete shall mean any concrete other than floors or slabs exposed to view upon completion of the job. Unless otherwise specified on the drawings, the standard finish for exposed concrete shall be of smooth finish.

A smooth finish shall be obtained with use of lined or plywood forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms, the joint marks shall be smoothed off and all blemishes, projections etc. removed, leaving the surfaces reasonably smooth and unmarred.

4.18.3 Integral Cement Concrete Finish : When specified on the drawings, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified in the drawings and as per I.S.2571. The surface shall be compacted and then floated with a wooden float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

4.18.4 Rubbed Finish : A rubbed finish shall be provided only on exposed concrete surfaces as specified on the drawings. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, off sets leveled and voids and/ or damaged sections immediately saturated with water and repaired by filling with concrete or mortar of the same composition as was used in the surfaces. The surfaces shall then be thoroughly wetted and rubbed with carborandum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

4.19 PROTECTION

All concrete shall be protected against damage until final acceptance by Engineer-in-Charge.

4.20 FOUNDATION BEDDING, BONDING AND JOINTING

All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering as may be indicated in the plans or as Engineer-in-Charge may direct to meet the various situations encountered in the work.
Soft or spongy areas shall be cleaned out and back filled with either a soil cement mixture, lean concreteor clean sand fill compacted to minimum density of 90% Modified Proctor, unless otherwise mentioned in schedule of quantities.

Prior to construction of form work for any item where soil will not act as bottom form, approval shall be obtained from Engineer-in-Charge as to the suitability of the soil.

4.21 PREPARATION OF ROCK STRATA OF FOUNDATIONS

To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed:

Concrete shall not be deposited on large sloping rock surface. Where required by Engineer-in-Charge or as indicated on the plans, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.

Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.

Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jeteven though it may have been previously cleaned in that manner.

Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.

Before placing concrete on rock surfaces, all water shall be removed from depressions to permit through inspection and proper bonding of the concrete to the rock.

4.22 PREPARATION OF EARTH STRATA OF FOUNDATIONS

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soils shall be removed and replaced with suitable earthand well compacted as directed by the Engineer-in-Charge. Where specified, lean concrete shall be provided in the earth stratum for eceiving concrete. The surface of absorptive soil against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn form the freshly placed concrete and later shall help to cure the concrete.

4.23 PREPARATION OF CONCRETE SURFACES

Preparation of concrete surface upon which additional concrete is to be placed later, shall preferably bedone by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by Engineer-in-charge. Great care shall be taken in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregate. When it is not practicable to follow the above method, it will be necessary to employ air tools to remove laitance and roughen the surface.

The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

4.24 BONDING TREATMENT (MORTAR)

After rock or concrete surfaces upon which new concrete is to be placed have been scarified, cleaned and wetted as specified herein, it shall receive a bonding treatment, immediately before placement of the concrete.

The bonding medium shall be a coat of cement sand mortar. The mortar shall have the same cement-sand proportion as the concrete which shall be placed on it. The water cement ratio shall be determined by placing conditions and as approved by Engineer-in-Charge.

Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 10 mm. thick for rock surface and about 5 mm. thick for concrete surfaces. It shall be brushed or broomed over the surface and worked thoroughly into all cracks, crevices and depressions. Accumulations or puddles of mortar shall not be allowed to settle in depressions and shall be brushed out to a satisfactory degree asdetermined by Engineer-in-Charge.

Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of placementof concrete. Only as much area shall be covered with mortar as can be covered with concrete before initial set in the mortar takes place. The amount of mortar that will be permitted to be placed at any one-time, orthe area which is to cover, shall be in accordance with Engineer-in-Charge.

4.25 CLEANING AND BONDING OF FORMED CONSTRUCTION JOINTS

Vertical construction joints shall be cleaned as specified above or by other methods approved by Engineer-in-

Charge. In placing concrete against formed construction joints, the surfaces of the joints, where accessible, shall be coated thoroughly with the specified bed-joint bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms, dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint by carefully puddling and spading with aid of vibrators and suitable tools.

4.26 EXPANSION AND CONTRACTION

Provision shall be made for expansion and contraction in concrete by use of special type joints located as shown in the drawings. Construction joint surfaces shall be treated as specified in the specifications, shown in the drawings or as directed by Engineer-in-Charge.

4.27 Work in Extreme Weather Conditions & HOT WEATHER REQUIREMENTS

During hot and cold weather, the concreting shall be done as per the procedure set out in IS 7861 (Part-I)-1975 and IS 7861 (Part II)-1981 respectively. Concreting shall not be done when the temperature falls below 4.5ºC. In cold weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38ºC.

All concrete work performed in hot weather shall be in accordance with I.S. 456, except as herein modified. Admixtures may be used only when approved by Engineer-in-Charge.

Adequate provision shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyers to direct sunlight and the use of reflective paint, on mixers etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38^0C.

Consideration shall be given to shading aggregate stock piles from direct rays of the sun and spraying stock piles with water, use of cold water available and burying, insulation, shading and/ or painting white the pipe lines and water storage tanks and conveyances.

In order to reduce loss of mixing water, the aggregates, wooden forms, subgrade, adjacent concrete andother moisture absorbing surfaces, shall be well wetted prior to concreting. Placement and finishing shall be done as quickly as possible.
Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot wind for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

4.28 PLACING CONCRETE UNDER WATER

Under all ordinary conditions all foundations shall be completely dewatered and concrete placed in the dry & dewatered condition. However, when concrete placement under water is necessary, all work shall conform to I.S.456 andprocedure shall be as follows:

Method of Placement: Concrete shall be deposited under water by means of tremies or drop bottom buckets of approved type.

Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be submitted to and approved by the Engineer-in-Charge before the work is started. Under-water concrete should have a slump recommended as per IS:456. The water- cement ratio shall not exceed 0.6 and may need to be smaller, depending on the grade of concrete or the type of chemical attack. For aggregates of 40 mm maximum particle size, the cement content shall be at least 350 kg/m^3 of

concrete.

Concrete in Sea Water: Concrete in sea-water or exposed directly along the sea-coast shall be at least M20 Grade in the case of plain concrete and M30 in case of reinforced concrete. The use of slag or pozzolana cement is advantageous under such conditions.

Special attention shall be given to the design of the mix to obtain the densest possible concrete: slag, broken brick, soft lime stone, soft sandstone, or other porous or weak aggregates shall not be used.

As far as possible, preference shall be given to precast members unreinforced, well-cured and hardened, without sharp corners, and having trowel-smooth finished surfaces free from crazing, cracks or other defect; plastering should be avoided.

No construction joints shall be allowed within 600 mm below low water-level or within 60 mm of the upper and lower planes of wave action. Where unusually severe conditions or abrasion are anticipated, such parts of the work shall be protected by bituminous or silico- fluoride coatings or stone facing bedded with bitumen.

In reinforced concrete structures, care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods.

4.29 DIRECTION, INSPECTION AND APPROVAL

All work requiring placement of concrete underwater shall be designed, directed and inspected with regard to the local circumstances and purposes. All under water concrete shall be placed according to the plans or specifications and as directed and approved by Engineer-in-Charge.

4.30 PRECAST CONCRETE & PRECAST REINFORCED CONCRETE

Precast concrete & precast reinforced concrete shall comply with I.S. 456, and with the following requirements:

4.30.1 General requirements: Precast reinforced concrete units such as columns, fencing posts, doorand window frames, lintels, chajjas, copings, sills, shelves, slabs, louvers etc. shall be of grade of mix asspecified and cast in forms or moulds. The forms / moulds shall be of fiber glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. Precast concrete shall be cast on suitable bed or platform with firm foundation and free from wind. The contractor may precast the units on a cement orsteel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in the forms. Each unit shall be cast in one operation. Contractor shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

Concrete used for precasting the units should be well proportioned as specified, mixed, placed and thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and honeycombing.

Precast articles shall have a dense surface finish showing no coarse aggregate and shall have no cracksor crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units. All angles of the precast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the lines. Onbeing fractured, the interior of the units should present a clean homogenous appearance.

The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed in respect of all items except fencing posts or electric postswhere the

minimum cover shall be 25 mm.

4.30.2 CURING

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold.

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each units shall be kept constantly watered or preferably by completely immersed in

water if the size of unit so permits. Otherwise curing practices as given in clauses stated earlier shall be followed.

4.30.3 The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled. Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of lifting.

4.30.4 Marking: Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

4.30.5 Precast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged. The lifting and removal of precast units shall be undertaken without causing shocks, vibration or under bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy Engineer-in-Charge or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise affect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

4.31 SLOTS, OPENINGS ETC.

Slots, openings or holes, pockets etc. shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer-in-Charge. Any deviation from the approved drawings shall be made good by contractor at his own expenses without damaging any other work. Sleeves, bolts, inserts etc. shall also be provided in concrete work where so specified.

4.32 GROUTING

4.32.1 Standard Grout : Grout shall be provided as specified in the drawing.

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as follows.

Table 4.21: Grout Properties

Use	Grout thickness	Mix. proportions	W/C. Ratio in (Max.)
a)Fluidmix	Under 25 mm.	One part Portland cementto one part sand.	0.44
b) General	25 mm. and over but less than 50 mm.	One part Portland cement to 2 parts of sand.	0.53
c) Stiff mix.	50 mm. and over	One part Portland cement to 3 parts of sand.	0.53

Sand shall be such as to produce a flowable grout without any tendency to segregate. Sand, for generalgrouting purposes, shall be graded within the following limits:

Table 4.22 - Sand for General Grouting

Passing I.S. sieve 2.36 mm.	95 to 100%
Passing I.S. sieve 1.18 mm.	65 to 95%
Passing I.S. sieve 300 micron above	10 to 30%

Passing I.S. sieve 150 micron above	3 to 10%

Sand for fluid grouts shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.

Sand for stiff grouts, shall meet the usual grading specifications and concrete.

Surface to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.

Anchor bolts, anchor bolt holes and bottom of equipment and column base plates shall be cleaned of alloil, grease, dirt and loose material. The use of hot, strong, caustic solution for this purpose will be permitted.

Prior to grouting, the hardened concrete surfaces to be grouted, shall be saturated with water. Water in anchor bolt holes shall be removed before grouting is started.
Forms around base plates shall be, reasonably, tightened to prevent leakage of the grout.

Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more release from entrapped air, link chains can be used to work the grout into place.

Grouting through holes in base plate shall be by pressure grouting.

Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-Charge.

4.32.2 Special Grout : Special grout where specified on the drawing shall be provided in strictaccordance with the manufacturers instructions/ specifications on the drawings.

4.33 INSPECTION

All materials, workmanship and finished construction shall be subject to the continuous inspection andapproval of Engineer-in-Charge.

All rejected materials supplied by contractor and all rejected work or construction performed by contractor, as is not in conformance with the specifications and drawings, shall immediately be replaced at no additional expense to the Department.

Approval of any preliminary material or phase of work shall in no way relieve the contractor from the responsibility of supplying concrete and/ or producing finished concrete in accordance with the specifications and drawings.

All concrete shall be protected against damage until final acceptance by the Department or its representatives.

4.34 CLEAN UP

Upon the completion of concrete work, all forms, equipments, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.

All debris i.e. empty containers, scrap wood etc. shall be removed to dump daily or as directed by the Engineer-in-Charge.

The finished concrete surfaces shall be left in a clean condition to the satisfaction of the Engineer-in- Charge.

4.35 PLAIN CEMENT CONCRETE FOR GENERAL WORK

For plain cement concrete work, the specification for materials viz. cement, sand, fine and coarse aggregates and water shall be the same as that specified in reinforced concrete work specification.

But the proportion of mix will be nominal and the ratio of fine and coarse aggregate may be slightly adjusted within limits, keeping the total value of aggregates to a given volumes of cement constant to suitthe sieve analysis

of both the aggregates. Cement shall on no account be measured by volume, but it shall always be used directly from the bags (i.e. 50 kg/bag).

The proportion of cement, sand, aggregate and water for concrete of proportion 1:5:10, 1:4:8, 1:3:6 & 1:2:4 by volume shall generally consist of quantities as given below :

Table 4.23: The proportion of cement, sand, aggregate and by volume

Proportionof Ingredients	Cement	Quantity of materials used per bag of cement			
		Fine aggregate (sand)	Coarse aggregate	Total of fine sandcoarse aggregates	Water
1:5:10	1	175 ltrs.	350 ltrs.	800 kgs.	60 ltrs.
1:4:8	1	140 ltrs.	280 ltrs.	625 kgs.	45 ltrs.
1:3:6	1	105 ltrs.	210 ltrs.	480 kgs.	34 ltrs.
1:2:4	1	70 ltrs.	140 ltrs.	330 kgs.	32 ltrs.

The quantity of water used shall be such as to produce concrete of consistency required by the particular class of work and shall be decided by the use of a slump cone. Sufficient care should be taken to see that no excess quantity of water is used. The final proportion of the aggregate and quantity of water shall bedecided by the Engineer-in-charge on the basis of test in each case.

Table 4.24: Proportion of The Aggregate And Quantity of Water

Mix proportion	Cementin bags	Sandin cum	Coarse Aggregate in CUM			Water
Ordinary mix in volume			40 mm	20 mm	12 mm	
1:5:10	2.60	0.475	0.6623	0.2583	-	156
1:4:8	3.40	0.500	0.6883	0.6883	-	153
1:3:6 (with 40mm aggr.)	4.4	0.485	0.672	0.672	0.262	176
1:3:6 (with 20 mm aggr.)	4.4	0.485	-	0.727	0.242	162.5
1:2:4 (with 20 mm aggr.)	6.4	0.47	-	0.705	0.235	205
1:2:4 (with 40 mm aggr.)	6.4	0.47	0.544	0.241	0.126	235
1:1.5:3	8.0	0.441	-	0.6615	0.2205	240
1:1:2	12.20	0.45	-	0.675	0.225	330

The slump shall be specified for each class of work and shall in general be as follows:

Table 4.25: Maximum Slump in Concrete

Type of concrete	Max. slump (in mm.)
Mass concrete	50
Concrete below water proofing treatment	50
Coping	25
Floor paving	50

All plain concrete should be preferably mixed in a drum type powder driven machine with a loading hopper which will permit the accurate measure of various ingredients. If hand mixing is authorised, it should be done on a water tight platform.

The mixing of each batch in the concrete mixer shall continue for not less than 1.5 minutes after the materials and water are in the mixer. The volume is mixed materials per batch shall not exceed the manufacturers rated capacity of the mixer. The mixer shall rotate at a peripheral speed of about 60 metres per minute.

Concrete shall be poured and consolidated in its final position within half an hour of mixing. The retempering of concrete which has partially hardened, that is remixing with or without additional cementaggregate or water shall not be permitted. Concrete of mix 1:3:6 and 1:2:4 will be required to be vibrated if specified and directed by the

Engineer. In case of the thickness of concrete is more than 150 mm., it may be vibrated as directed by the Engineer.

The concrete shall be cured for 10 days in ordinary weather and 15 days in hot weather.

Measurements for the work done shall be exact length, breadth and depth shown in figures on the drawings or as directed by the Engineer and after the concrete is consolidated. No extra shall be paid for excess quantity resulting from faulty workmanship.

4.36 FINISHING OF CONCRETE

4.36.1 General : Unless otherwise specified, concrete finishes shall conform to the following specifications:

Finish F1, F2 and F3 shall describe formed surface. Finish U1, U2 and U3 shall describe un-formed surface.
Off sets or fins caused by disposed or misplaced form sheathing lining or form sections or by defective form lumber shall be referred to as abrupt irregularities. All other irregularities shall be referred to as gradual irregularities. Gradual irregularities shall be measured as deviation from a plane surface with a template 1.5 m. long for formed surface and 3 m. long for unformed surfaces.

4.36.2 Formed Surfaces

Finish F1– shall apply to all formed surfaces for which finish F2, F3 or any other special finish is not specified and shall include filling up all form tie holes.

Finish F2– shall apply to all formed surfaces so shown on the drawings or specified by the Engineer-in- Charge. This shall include filling all form tie-holes, repair of gradual irregularities exceeding 6 mm., removal of ridges and abrupt irregularities by grinding.

Finish F3– shall apply to all formed surfaces exposed to view or where shown in the drawings or specified by the Engineer-in-Charge. Finish F3 - shall include all measures specified for Finish-F2 and in addition, Filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include clean up of loose and adhering debris. Where a sack rubbed finish is specified, the surfaces shall be prepared within two days after removal of the forms.

The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part cement to one and half parts by volume of fine (minus No. 16 mesh) sand. Only sufficient mixing water to give the mortar a workable consistency shall be used. The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids. The mortar rubbed in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean so that the surface presents a uniform appearance without air holes, irregularities etc. Curing of the surface shall be continued for a period of ten (10) days.

4.36.3 Unformed Surfaces

Finish U1– shall apply to all unformed surfaces for which the finish U2, U3 or any other special finish is not specified and shall include screeding the surface of the concrete to the required slope and grade. Unless the drawing specifies a horizontal surface or shows the slope required, the tops of narrow surfaces such as stair, treads, walls, curbs and parapets shall be sloped approximately 10 mm. per 300 mm. width. Surfaces to be covered by backfill or concrete sub-floors to be covered with concrete topping, terrazzo and similar surfaces shall be smooth screeded and leveled to produce even surface, irregularities not exceeding 6 mm.

Finish U2– shall apply to all unformed surfaces as shown in the drawing or specified by the Engineer-in- Charge and shall include screeding and applying a wood float finish to the surface of the concrete to the required slopes and grade.

Repair of abrupt irregularities unless a roughened texture is specified. Repair of gradual irregularities exceeding 6 mm.

Finish U3– shall apply to unformed surfaces for which a high degree of surface smoothness is required, where

shown on the drawing or specified by the Engineer-in-Charge. This shall include screeding, floating and applying a steel trowel finish to the surface of the concrete to the required slopes and grade.

Repair of abrupt irregularities: Repair of gradual irregularities exceeding 6 mm., finishing joints andedges of concrete with edging tools.

4.37 MODE OF MEASUREMENT FOR CONCRETE WORK

General : Concrete as actually done shall be measured for payment, subject to the following tolerances, unless otherwise stated hereinafter. Any work done extra over the specified dimensions shall not be measured for payment.

a) Linear dimensions shall be measured in full centimetres except for the thickness of slab which shall be measured to the nearest half centimetre.
b) Areas shall be worked out to the nearest 0.01 sqm.
c) Cubic contents shall be worked out to the nearest 0.001 cum.
d) The concrete shall be measured for its length, breadth and height/ depth limiting dimensions to those specified on drawings or as directed by the Engineer-in-Charge.

NOTE : The sizes of RCC members as assumed in the estimate are based on preliminary drawingsand are likely to be changed. The contractor is not entitled to any extra claim due to such changes.

Deductions: No deductions shall be made for the following
a) Ends of dissimilar materials e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc. upto 500 sq cm. in cross section.
b) Opening upto 0.1 sqm. (1000 sq cm)
c) Volume occupied by reinforcement.
d) Volume occupied by pipes, conduits, sheathing etc. not exceeding 25 sq cm. each in crosssectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

i) COLUMN FOOTING

R.C.C. in foundation and footings shall be measured for its length, breadth and depths limiting dimensions to those specified in drawing or as ordered in writing by the Engineer-in-Charge. In case of tapering portions of column footings, the quantities shall be calculated by the Formula :

Volume $V = H/3 \times [A1 + A2 + \sqrt{\{A1 \times A2\}}]$;

where A_1 = Area at top of footing, A_2 = Area at bottom of footing and H = Height of footing.

ii) COLUMN

Column shall be measured from top of footings to the plinth level and from plinth level to the structural slab level and to the subsequent structural slab levels. Measurements for higher grade concrete in columns at its junction with lower grade concrete beams shall be restricted to the column section supporting the beam in question.

iii) WALL

All walls shall be measured from top of the wall footing to the plinth level and from plinth level to the topof structural first floor and to subsequent floors.

iv) BEAM AND LINTEL

Beam shall be measured from face to face of the columns, walls, cross beams including haunches if any. The depth of the beams shall be measured from the top of the slab to the bottom of the beam except in the case of inverted beam where it shall be measured from top of slab to top of beams. The beams andlintels with narrow width even though acting as facia in elevation in some cases, will be measured as beams and lintels only.

v) SLAB

The length and breadth of slab laid to correct thickness as shown in the detailed drawings or as ordered by the Engineer-in-Charge shall be measured between beams, walls and columns.

vi) CHAJJAS, FACIAS, FINS AND MULLIONS

a) Chajjas shall be measured net from supporting faces upto the edges of chajjas without any facia.
b) Facia shall be measured full excluding chajja thickness.
c) End fins shall be measured full.
d) Intermediate fins, mullions shall be measured between chajjas or other supporting structural members.
e) Parapets shall be measured from top of slab/ chajja.

vii) STAIRCASE

The concrete in all members of staircase like waist slabs, steps, cantilever steps, stringer beams etc. shall be measured for their length, breadth and depth, limiting dimensions to those specified on drawings. No deductions shall be made for embedded plugs, pockets.

Rates: The rate for P.C.C/ R.C.C. shall include the cost of all materials, labour, transport, tools and plants and all the operations mentioned hitherto, including or excluding the cost of form work and/ or reinforcement as mentioned in the schedule of quantities. The rates also shall include the cost of testing materials, mix design, cube test and allied incidental expenses.

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5. FORM WORK

5.0 GENERAL

The form work shall consist of shores, bracings, sides of beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned forthe work. The false work shall be so constructed that up and down vertical adjustment can be made smoothly. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical adjustment or dismantling of form work.

5.1 DESIGN OF FORM WORK

The design and engineering of form work as well as its construction shall be the responsibility of Contractor. If so instructed, the drawings and calculations for the design of the form work shall be submitted well in advance to the Engineer-in-Charge for approval before proceeding with work, at no extra cost to the Department. Engineer-in-Charges approval shall not however, relieve Contractor of the full responsibility for the design and construction of the form work. The design shall take into account all theloads vertical as well as lateral that the forms will be carrying including live and vibration leadings.

5.2 TOLERANCES

Tolerances are a specified permissible variation from lines, grade or dimensions given in drawings. No tolerances specified for horizontal or vertical building lines or footings shall be constructed to permit

encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted

5.2.1 Tolerances for R.C. Buildings

i) Variation from the plumb

a) In the line and surfaces of columns, piers, walls and in buttresses: 5 mm. per 2.5 m., but not more than 25 mm.

b) For exposed corner columns and other conspicuous lines.

In any bay or 5 m. maximum:	(±) 5 mm.
In 10 m. or more:	(±) 10 mm.

ii) Variation from the level or from the grades indicated on the drawings.

a) In slab soffits, ceilings, beam soffits and in arrises.

In 2.5 m.: (±) 5 mm.
In any bay or 5 m. maximum: (±) 8 mm.
In 10 m. or more: (±) 15 mm.

b) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.

In any bay or 5 m. maximum: (±) 15 mm.
In 10 m or more: (±) 10 mm.

iii) Variation of the linear building lines from established position in plan and related position ofcolumns, walls and partitions.

In any bay or 5 m. maximum: (±) 10 mm.
In 10 m. or more: (±) 20 mm.

iv) Variations in the sizes and locations of sleeves, openings in walls and floors except in the case of and for anchor bolts: (±) 5 mm.

v) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls: (+) 10 mm./(-) 5 mm.

vi) Footings

a) Variation in dimensions in plan: (+) 50 mm./(-) 5 mm.

b) Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50 mm.

c) Reduction in thickness: (-) 5% of specified thickness subject to maximum of 50 mm.

vii) Variation in steps.

a) In a flight of stairs.

Rise: (±) 3.0 mm.
Tread: (±) 5.0 mm.

b) In consecutive steps.

Rise: (±) 1.5 mm.
Tread: (±) 3 mm.

5.2.2 Tolerances in other Concrete Structure

A) All structures:

i) Variation of the constructed linear outline from established position in plan.

In 5 m.: (±) 10 mm.
In 10 m. or more: (±) 15 mm.

ii) Variation of dimensions to individual structure features from established positions in plan. In 20 m. or more: (±) 25 mm.
In buried constructions: (±)150 mm.

iii) Variation from plumb, from specified batter or from curved surfaces of all structures.

In 2.5 m.: (±) 10 mm.
In 5.0 m.: (±) 15 mm.
In 10.0 m. or more: (±) 25 mm.

In buried constructions: (±) Twice the above limits.

iv) Variation from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible arises.

In 2.5 m.: (±) 5 mm.
In 7.5 m. or more: (±) 10 mm.
In buried constructions: (±) Twice the above limits.

v) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members. **(+)12 mm./(-) 6 mm.**

vi) Variation in the thickness of slabs, walls, arch sections and similar members. **(+)12 mm./ (-) 6 mm.**

(B) Footings for columns, piers, walls, buttresses and similar members:

i. Variation of dimensions in plan: (+)50 mm./(-)12 mm.

ii. Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50mm.

iii. Reduction in thickness: 5% of specified thickness subject to a maximum of 50 mm.

Tolerances in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for concrete form work (ACI 347)

5.3 TYPE OF FORMWORK

Form work may be of timber, plywood, metal, plastic or concrete. For special finishes, the formwork may be lined with plywood, steel sheets, oil tempered hard board etc. Sliding forms and slip forms may be used with the approval of Engineer-in- Charge.

5.4 FORMWORK REQUIREMENTS

Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for in the drawings. Ample studs, waler braces, straps, shores etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases, fromvibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free form sap, shakes, loose knots, worm holes, warps or other surface defects in contact with concrete. Faces coming in contact with concrete shall be free from adhering grout, plaster, paint, projecting nails, splits orother defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

Plywood shall be used for exposed concrete surfaces, where called for. Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete surfaces which are to be rubbed finished shall be planed to remove irregularities or unevenness in the face. Form work with lining will be permitted.

All new and used from lumber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces. Form lumber unsatisfactory in any respect shall not be used and if rejected by Engineer-in-Charge shall be removed from the site.

Shores supporting successive stories shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed supports shall be provided for shores that cannot be secured on adequate foundation.

Formwork, during any stage of construction showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings, shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be entirely removed and the formwork corrected prior to placing new concrete.

Excessive construction camber to compensate for shrinkage settlement etc. that may impair the structural strength of members will not be permitted.

Forms for substructure concrete may be omitted when, in the opinion of Engineer-in-Charge, the open excavation is firm enough to act as the form. Such excavations shall be slightly larger than required by the drawings to compensate for irregularities in excavation and to ensure the design requirement.

Forms shall be so designed and constructed that they can be stripped in the order required and their removal do not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conforming to the architectural features of the structure as to location of joints and be as directed by Engineer-in-Charge.

Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the desired concrete surfaces could be obtained which require a minimum finish.

5.4.1 Bracings, Struts and Props: Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bracings.

The shuttering for beams and slabs shall be so erected that the shuttering on the sides of beams and under the soffit of slab can be removed without disturbing the beam bottoms.

Re-propping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported onwedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.
If the shuttering for a column is erected for the full height of the column, one side shall be left open and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m. or as directed by Engineer-in-Charge.

5.5 INSPECTION OF FORM WORK

Following points shall be borne in mind while checking during erection of form work and form work got approved by the Engineer-in-charge before placing of reinforcement bars :

a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.
b) Material used should be checked to ensure that, wrong items / rejects are not used.
c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
d)
i. The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
ii. Sole plates shall be properly seated on their bearing pads or sleepers.
iii. The bearing plates of steel props shall not be distorted.
iv. The steel parts on the bearing members shall have adequate bearing areas.
e) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.
f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.
g) The stacked materials shall be placed as catered for, in the design.
h) When adjustable steel props are used, they should :

i) be undamaged and not visibly bent.
ii) have the steel pins provided by the manufacturers for use.
iii) be restrained laterally near each end.
iv) have means for centralising beams placed in the fork-heads.
i) Screw adjustment of adjustable props shall not be over extended.
j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened / clamped down after adjustment to prevent their shifting.
k) No member shall be eccentric upon vertical member.
l) The number of nuts and bolts shall be adequate.
m) All provisions of the design and / or drawings shall be complied with.
n) Cantilever supports shall be adequate.
o) Props shall be directly under one another in multistage constructions as far as possible.
p) Guy ropes or stays shall be tensioned properly.
q) There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.
r) Required camber shall be provided over long spans.

s) Supports shall be adequate, and in plumb within the specified tolerances.

5.6 FORM OIL

Use of form oil shall not be permitted on the surface which require painting. If the contractor desire to use form oil on the inside of formwork of the other concrete structures, a non staining mineral oil or other approved oil CEMOL-35 of Ms. Hindustan Petroleum Co. Ltd. may be used, provided it is applied beforeplacing reinforcing steel and embedded parts. All excess oil on the form surfaces and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil, formsshall be thoroughly cleared of dried splatter of concrete from placement of previous lift.

5.7 CHAMFERS AND FILLERS

All corners and angles exposed in the finished structure shall be formed with mouldings to form chamfersor fillers on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 x 20 mm. Care shall be exercised to ensure accurate mouldings. The diagonalface of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

5.8 VERTICAL CONSTRUCTION JOINT CHAMFERS

Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not permitted by Engineer-in-Charge for structural or hydraulic reasons.

5.9 WALL TIES

Wire ties passing through the walls, shall not be allowed. Also through bolts shall not be permitted. For fixing of formwork, alternate arrangements such as coil nuts shall be adopted at the contractors cost.

5.10 REUSE OF FORMS

Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary repaired and the inside retreated to prevent adhesion, to the satisfaction of Engineer-in-charge. Warped lumber shall be resized. Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

5.11 REMOVAL OF FORMS

Contractors shall record on the drawings or a special register, the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed there from. In no circumstancesshall forms be struck until the concrete reaches a strength of the at least twice the stress due to self weight

and any construction erection loading to which the concrete may be subjected at the time of striking formwork.

In normal circumstances (generally where temperatures are above 15 ^{0}C) forms may be struck after expiry of the following periods

Table 5.1 - Stripping time of Formwork

S.No	Part of Structure	Earliest concrete age at stripping	
		Ordinary Portland cement concrete	Portland Pozzolana / C.C Fly Ash Based
a)	Walls, columns and vertical sides of beams	16 to 24 hours	24 to 36 hours
b)	Slabs(Props left Under)	3 days	4 days
c)	Beam, soffits (Props left under)	7 days	10 days
d)	Removal of props i)Spanning upto 4.5m ii) Spanning over 4.5m	 7 days 14 days	 10 days 20 days

e)	Removal of props in beams & arches i) Spanning upto 6m ii) Spanning over 6m	14 days21days	 20 days 30 days

Note: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally If Portland pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

The number of props left under the sizes and the position shall be such as to able to safely carry the full dead load of the slab, beam or arch., as the case may be together with any live load likely to occur during curing or further constructions.

Where the shape of the element is such that the form work has the reentrant angles the form work shall be removed as soon as possible. After the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

Striking shall be done slowly with utmost care to avoid damage to arise and projection and without shockor vibration, by gently easing the wedges. If after removing the formwork, it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provided, as directed by Engineer-in-Charge, to facilitate removalof formwork which otherwise may be in-accessible.

Tie rods, clamps, form bolts etc. which must be entirely removed from walls or similar structures shallbe loosened not sooner than 24 hours nor later than 40 hours after concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of walls and grade beams will not be permitted. Work damaged due to premature or careless removal of formsshall be re-constructed at contractors cost.

5.12 HACKING OF CONCRETE: Other than for requirement of form finish concrete surface, all the concrete surface immediately after removal of formwork shall be closely hacked with hand chiseled hacking tool in order to make it rough for proper bond/grip to receive plaster (wherever specified) finish over concrete surface. As a guideline for close hacking, hacking strokes shall be approx. 15 to 20 mm centre to centre and 3 to 4 mm deep.

5.13 MODE OF MEASUREMENT

In case the items of concreting are inclusive of cost of form work, no separate measurements shall be taken for form work. However, if the form work is to be paid separately and the item exists in the Schedule of Quantities for various types of form work, the net area of exposed surface of concrete members as shown in drawings coming in contact with form work shall be measured under item offormwork in Sqm.

All temporary formwork such as bulk heads, stop boards provided at construction joints which are not shown in the drawings shall not be measured.

No deductions shall be made for openings/ obstructions upto an area of 0.1 sqm and nothing extra shall be paid for forming such openings.

The rate shall include the cost of erecting, centering, shuttering materials, transport, de-shuttering, close hacking of concrete (wherever specified) and removal of materials from site and labour required for all such operations etc.

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6. STEEL FOR CONCRETE REINFORCEMENT

6.1 SCOPE OF MATERIAL

The contractor shall make his own arrangement for procurement of Reinforcement steel bars and wires for use in

Reinforced Cement Concrete works. Unless otherwise specified in drawings / Schedule of quantities, the steel bars shall be of "High strength deformed steel bars and wires" conforming to the IS 1786-2008 (Amendment 1)), in the following strength grades:

a) Fe 415, Fe 415D, Fe415S
b) Fe 500, Fe 500D, Fe500S
c) Fe 550, Fe 550D, and
d) Fe 600.

i) Where **"Fe"** stands for specified minimum 0.2% proof / yield stress in N/mm^2 and
ii) **"D" and S** following the strength grade indicates the categories with same specified minimum 0.2% proof / yield stress but with enhanced and additional requirements.

6.1.1 Special coating to steel Reinforcement: For important structures under aggressive environment, if structural requirement specifies for additional protection against corrosion to reinforcement bars, the above mentioned high strength deformed bars with a protective coating as specified in item, may be used. These coatings may be in the form of „Galvanized reinforcement, or „Fusion Bonded Epoxy coated" reinforcement". Both these process is a specialized job carried out in a factory and care must be taken for site treatment of bar after cutting, bending and placement. Touch up on the galvanized/epoxy coating have to be carefully done to the satisfaction of Engineer-in-Charge.

i) Galvanized Reinforcement: Galvanizing of reinforcement consists of dipping the steel bars in molten zinc. The zinc surface reacts with calcium hydroxide in the concrete to form a passive layer and prevents corrosion. Hot Dip Galvanize (HDG) coating is highly impact and abrasion resistant with alloy layers harder than the underlying steel. Galvanized steel bars for concrete reinforcement shall conform to ASTM A767. The thickness of coating shall be minimum 150microns.

ii) Fusion Bonded Epoxy coating: The Fusion bonded Epoxy coating provides excellent protection against corrosion under very aggressive condition. Fusion bonded Epoxy coated reinforcement bars shall conform to ASTM specification: A775/775M.

Initially the bar is shot blasted to remove all mill scale and to give kind of surface finish required for adequate bonding between epoxy and steel. The bar is then heated to a carefully controlled temperature(200-250deg.C) chamber and then passed through a spray booth where electrostatically charged epoxy powder particles are deposited evenly(fused) on the surface of bar. The thickness of coating shall be minimum 150 microns(0.005 to 0.009inch) for effective protection against chloride and adequate flexibility during bending.

6.1.2 Stainless Steel Rebars: Under special functional requirement such as use in the vicinity of magnetic sensitive equipment (MRI-Magnetic Resonance Imaging), to prevent magnetic foot print non-magnetic stainless steel rebars of grade S-304/S-316(preferred) conforming to BS 6744 shall be used. The yield stress (0.02% proof stress) of plain SS Rebars shall be 500N/mm^2 (U.T.S=550N/mm^2) and elongation shall be more than 14% as per BS 6744. High strength and high bond strength stainless steel rebars (also known as Grip-Rib Bar) having yield strength of 650N/mm^2 and UTS of 750N/mm^2 conforming to BS-6744 may be used if specified. Binding wires used for tying shall be 1.2mm dia. S.S wire of similar grade stainless steel. Chemical Composition of Stainless Steel Grade S-304/S-316 shall be as per IS 6911-1992

6.2 TERMINOLOGY

Elongation: The increase in length of a tensile test piece under stress, expressed as a percentage of the original gauge of a standard piece.

Longitudinal Rib: A uniform continuous protrusion, parallel to the axis of the bar/wire (before cold- working, if any).

Nominal Diameter or Size: The diameter of a plain round bar/wire having the same mass per metre length as the deformed bar/wire.

Nominal Mass: The mass of the bar/wire of nominal diameter and of density 0.00785 kg/mm^2 per meter.

Nominal Perimeter: 3.14 times the nominal diameter of a deformed bar/Wire.

Percent Proof Stress: The stress at which a non-proportional elongation equal to 0.2% of the original gauge length takes place.

Uniform elongation: The elongation corresponding to the maximum load reached in a tensile test (alsotermed as percentage total elongation at maximum force).

Tensile Strength: The maximum load reached in a tensile test divided by the effective cross-sectional area of the gauge length portion of the test piece (also termed as ultimate tensile stress).

Transverse Rib: Any rib on the surface of a bar/wire other than a longitudinal rib

Yield Stress: Stress (that is, load per unit cross sectional area) at which elongation first occurs in the test piece without increasing the load during the tensile test. In the case of steels with no such definite yield point, proof stress shall be applicable.

The high strength deformed steel bars and wires for concrete reinforcement shall be hot rolled steel without subsequent treatment or hot rolled steel with controlled cooling and tempering and cold worked steel, and reinforcing bars and wires which may be subsequently coated.

Steel bars shall be supplied from M/s. Steel Authority of India Ltd. (SAIL), M/s. TATA Steel (TISCO), M/s. Rashtriya Ispat Nigam Ltd (RINL), M/s. JSW Steel, M/s. JSPL from their own plants rolled from virgin material, and shall be procured directly or from their authorised dealers and not from re-rollers or conversion agents. The contractor shall supply copy of Documentary evidence of purchase of steel from the specified manufacturers.

6.3 TESTS

The contractor shall submit the test certificate of manufacturer. Regular tests on steel supplied by the contractor shall be performed by the contractor at the approved lab, in presence of the Departmental Engineers as per relevant Indian Standards. Engineer-in-charge may require Contractor to perform necessary tests of samples at random as per relevant B.I.S. All cost of such tests and incidentals to such tests shall be borne by the Contractor. The quality, grade, colour coding embossing marks etc. all shall be to the entire satisfaction of the Engineer-in-Charge. Steel not conforming to above test criteria shall be rejected.

The Chemical, Physical & Mechanical properties of the steel reinforcement bars shall be as per IS 1786.Unless otherwise specified, Selection and Preparation of Test Sample shall be as per the requirements ofIS 2062.

All test pieces shall be selected either from the cuttings of bars / wires; or from any bar/wire after it has been cut to the required or specified size and the test piece taken from any part of it. In neither case, thetest piece shall be detached from the bar/wire except in the presence of the EIC or his authorized representative.

The test pieces shall be full sections of the bars/wires and shall be subjected to physical tests without any further modifications. No reduction in size by machining or otherwise shall be permissible, except in caseof bars of size 28 mm and above. No test piece shall be annealed or otherwise subjected to heat treatment. Any straightening which a test piece may require shall be done cold.

For the purpose of carrying out tests for tensile strength, proof stress, percentage elongation and percentage elongation at maximum force for bars 28 mm in diameter and above, deformations of the bars only may be machined. For such bars, the physical properties shall be calculated using the actual area obtained after machining. The following IS codes shall be referred for test methods:

Table 6.1: Indian Standards for Steel Tests

SN	Title	IS No	ISO No.
i	Mechanical testing of metals -Tensile testing	1608	6892
ii	Methods for bend test	1599 7438 & 1786	15630-1
iii	Method for re-bend test for metallic wires & bars	1786	15630-1

THE PROPERTIES AS PER IS 1786 - 2008 ARE REPRODUCED BELOW

Table 6.2: Chemical Composition of the bars

Constituents	Maximum Permissible Percent							Permissible max. Variation
	Fe 415	Fe 415D/ Fe 415S	Fe 500	Fe 500D/ Fe 500S	Fe 550	Fe 550D	Fe 600	
Carbon	0.300	0.250	0.300	0.250	0.300	0.250	0.300	0.020%
Sulphur	0.060	0.045	0.055	0.040	0.055	0.040	0.040	0.005%
Phosphorus	0.060	0.045	0.055	0.040	0.050	0.040	0.040	0.005%
Sulphur & Phosphorus	0.110	0.085	0.105	0.075	0.100	0.075	0.075	0.010%

Notes:

i. For welding of deformed bars, the recommendations of IS 9417 shall be followed.

ii. In case of deviations from the specified maximum, two additional test samples shall be taken from the same batch and subjected to the test or tests in which the original sample failed. Should bothadditional test samples pass the test, the batch from which they were taken shall be deemed to comply with this standard. Should either of them fail, the batch shall be deemed not to comply with this standard

Table 6.3: Mechanical Properties of High Strength Deformed Bars and Wires

Sl. No.	Property	Grades Of High strength Deformed Bars and Wires						
		Fe 415	Fe 415D / Fe 415S	Fe 500	Fe 500D / Fe 500S	Fe 550	Fe 550D	Fe 600
1	2	3	4	5	6	7	8	9
i	0.2 percent proof stress / yield stress, Min, N/mm^2	415.0	415.0	500.0	500.0	550.0	550.0	600.0
ii.	0.2 percent proof stress / yield stress, Max, N/mm^2	--	---/ 540.0 for Fe 415 S	---	---/ 625.0 for Fe 500S	---	---	---
ii	Elongation, percent, Min. on gauge length 5.65 √A, where A is the Cross - sectional area of the test piece	14.5	18.0	12.0	16.0	10.0	14.5	10.0

iii	Tensile strength, Min	10% more than theactual 0.2% proof stress/yield stress but not less than 485.0 N/mm^2	12% more than theactual 0.2% proof stress/yield stress but not less than 500.0 N/mm^2	8% more than the actual 0.2% proof stress/yield stress but not less than 545.0 N/mm^2	10% more than theactual 0.2% proof stress/yield stress but not less than 565.0 N/mm^2	6% more than the actual 0.2% proof stress/yield stress but not less than 585.0 N/mm^2	8% more than the actual 0.2% proof stress/yield stress but not less than 600.0 N/mm^2	6% more than the actual 0.2% proof stress/yield stress but not less than 660.0 N/mm^2
iv	Total elongation at maximum force, percent, Min of gauge length 5.65 $\sqrt{A}$, where A is the cross sectional area of the testpiece	-	5	-	5	-	5	-

Note: To satisfy Clause 26 of IS 456 -2000, no mixing of different types of grades of bars shall be allowed in the same structural members as main reinforcement, without prior written approval of the Engineer-in-Charge.

6.4 STACKING & STORAGE

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. The steel for reinforcement shall not be kept in direct contact with ground. Fresh / Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deteriorations. Care shall be taken to protect steel from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different

classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

6.5 QUALITY

Steel not conforming to specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill, scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-Charge. If welding is approved, the work shall be carried as per I.S. 2751, according to best modern practices and as directed by the Engineer-in-Charge. In all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded. Substitution of reinforcement will not be permitted except upon written approval from Engineer-in-charge.

6.6 NOMINAL SIZES

The nominal sizes of bars/wires shall be 4mm, 5mm, 6mm, 8mm, 10mm, 12mm, 16mm, 20mm, 25 mm,28mm, 32mm, 36mm and 40 mm.

6.7 NOMINAL MASS

For the purpose of checking the nominal mass, the density of steel shall be taken as 0.00785 kg/mm^3 ofthe cross-sectional area per metre. Unless otherwise specified, the tolerances on nominal mass shall be as per following

Table.

Table 6.4: Tolerances on Nominal Mass

SN	Nominal Size in mm	Tolerance on the nominal mass in Percent		
		Batch	Individual sample	Individual sample for coils only
1	2	3	4	5
i)	Up to and including 10	± 7	- 8	± 8
ii)	Over 10 up to and including 16	± 5	- 6	± 6
iii)	Over 16	± 3	- 4	± 4

6.8 ASSEMBLY OF REINFORCEMENT

Reinforcement shall be bent and fixed in accordance with procedure specified inIS2502.The high strength deformed steel bars should not be re-bent or straightened without the approval of Engineer-in- Charge.

Bar bending schedules shall be prepared for all reinforcement work and shall be get approved by Engineer-in- Charge.

All reinforcement shall be placed and maintained in position shown in the drawings by providing propercover blocks, spacers, supporting bars etc.

Crossing bars should not be tack-welded for assembly of reinforcement unless permitted by Engineer-in-Charge.

6.9 PLACING AND TOLERANCE ON PLACING

Reinforcement shall be accurately fixed by any approved means maintained in the correct position as shown in the drawings by the use of blocks, spacers and chairs as per I.S. 2502 to prevent displacementduring placing and compaction of concrete. Bars intended to be in contact at crossing point shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

6.9.1 Tolerance on Placing of Reinforcement: Unless otherwise specified, reinforcement shall be placedwithin the following tolerances :

Tolerance in spacing

a) For effective depth, 200 mm or less + /- 10 mm

b) For effective depth, more than 200 mm + /- 15 mm

6.10 COVER TO REINFORCEMENT

Nominal cover is the design depth of concrete cover to all steel reinforcements, including links. It is the dimension used in design and indicated in the drawings. It shall be not less than the diameter of the bar.Unless otherwise specified, cover to reinforcement shall be provided generally as per guidelines of IS 456.

6.10.1 Nominal cover to meet durability requirement: Minimum values for the nominal cover of normal weight aggregate concrete which should be provided to all reinforcement, including links depending on the condition of exposure described in 4.4 above and as per (nominal cover to meet durability requirements).

However for a longitudinal reinforcing bar in a column nominal cover shall in any case not be less than 40 mm or less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under, whose reinforcing bar do not exceed 12 mm , a nominal cover of 25 mm may be used.

For footings minimum cover shall be 50 mm.

Nominal cover to meet specified period of fire resistance

Minimum values of nominal cover of normal-weight aggregate concrete to be provided to all reinforcement including

links to meet specified period of the resistance as per the tables given under clause 4.4.1 of this specifications.

The cover shall in no case be reduced by more than one third of specified cover or 5 mm whichever is less.

Unless indicated otherwise on the drawings, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish shall be as follows:

a) At each end of reinforcing bar not less than 25mm., nor less than twice the diameter of such bar.

b) For a longitudinal reinforcing bar not less than 25 mm., nor more than 40 mm., nor less than the diameter of such bar. In the case of column of maximum dimensions of 200 mm. or under, whose reinforcing bars do not exceed 12 mm., a cover of 25 mm. may be used.

c) For longitudinal reinforcing bar in a beam, not less than 25mm., nor less than diameter of such bar.

d) For tensile, compressive, shear, or other reinforcement in a slab, not less than 25 mm, nor less than the diameter of such bar, and

e) For any other reinforcement not less than 15 mm., nor less than the diameter of such bar.

f) Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals (as in the case of concrete in contact with earth faces contaminated withsuch chemicals), acid, vapour, saline atmosphere, sulphurous smoke (as in the case of steam- operated railways) etc. and such increase of cover may be between 15 mm. and 50 mm. beyond the figures given in (a to e) above as may be specified by the Engineer-in-Charge.

g) For reinforced concrete members, totally immersed in sea water, the cover shall be 40 mm. more than specified (a to e) above.

h) For reinforced concrete members, periodically immersed in sea water or subject to sea spray, the cover of concrete shall be 50 mm. more than that specified (a to e) above.

i) For concrete of grade M 25 and above, the additional thickness of cover specified in (f), (g) and (h) above may be reduced to half. In all such cases the cover should not exceed 75 mm.

j) Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing dense impermeable concrete with approved protective coating, as specified on the drawings. In such case the extra cover, mentioned in (h) and (i) above, may be reduced by the Engineer-in-Charge, to those shown on the drawing.

k) The correct cover shall be maintained by cement mortar briquettes or other approved means. Reinforcement for footings, grade beams and slabs on subgrade shall be supported on precast concreteblocks as approved by the Engineer-in-Charge. The use of pebbles or stones shall not be permitted.

l) The minimum clear distance between reinforcing bars shall be in accordance with I.S. 456 or as shown in drawing.

6.11 LAPS

Reinforcement splicing, if required shall be done as per provisions in IS 456. Laps and splices for reinforcement shall as far as possible be away from the sections of maximum stress and be staggered and shall be as shown in the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified in the drawings, shall be approved by the Engineer-in-Charge. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site. Lap splices shall not be used for bars larger than 32mm; for larger diameters, bars may be welded.

6.12 WELDED JOINTS OR MECHANICAL CONNECTION

Welded joints or mechanical connections in reinforcement may be used provided tests shall be made toensure that the joints are of full strength of bars connected.

6.12.1 Welded Splicing: Welding of reinforcements shall be done in accordance with the recommendations of IS 2751 and IS 9417.Welded splices shall not be used within a distance equal to twice the member depth from the column or beam face for special moment frames or from sections where yielding of the reinforcement is likely to occur as a result of inelastic lateral displacements.

Welding of stirrups, ties, inserts or other similar elements to longitudinal reinforcement shall not be permitted.

6.12.2 Mechanical splicing: Mechanical splicing (coupler) system shall conform to International codes ACI-318-08 or BS8110, BS5400 and shall be of approved manufacturer. The Couplers shall be properlyfixed at site by specialized workman as per manufacturer"s specification. Manufacturer shall submit all test certificates of the couplers supplied tested as per relevant codes.

Mechanical splicing shall be of standard threaded mechanical splice coupler. Splicing procedure and qualification, testing shall be done as per relavent Indian/ International standards. The cutting, Cold forging and threading of reinforcement bars shall be done as per manufacturer specifications. Reduction of nominal cross section area of the parent bar is not allowed. This type of splicing shall be carried out using necessary type threaded couplers including locking arrangements wherever required as per approved manufacturers specification. The coupler shall be such that there should not be any requirement of rotating the rebars for connection. The nominal cross section of the bar at the root of the thread shall not be lessthan nominal cross section of the parent bar. Actual performance of the coupler joint shall be atleast equivalent to the characteristic strength of the parent bar i.e tensile failure should occur in the bar and shall be satisfactorily away from the joint. Elongation after failure must be equivalent to the parent bar. Permanent elongation after loading upto 0.6 fy shall not exceed 0.1mm.

Technical Requirement

In case of mechanical connection, a full mechanical splice shall develop in tension or compression, as required, at 1.25 times specified yield strength (fy). As per ACI-318 Mechanical couplers shall be of the two types:

Type-1: Type-1 Couplers are where minimum load in tension/compression should be 1.25fy of the bar. Type-1 splices shall not be used within a distance equal to twice the member depth from the column or beam face for special moment frames or from sections where yielding of the reinforcement is likely to occur as a result of inelastic lateral displacements

Type-2: Type-2 Couplers must achieve under tension/compression 1.25 times fy of the bar and also achieve the ultimate tensile strength of the parent bar.Type-2 mechanical splices shall be permitted to beused at any location including in yielding regions where the tensile stresses in reinforcement may approach the tensile strength of the reinforcement.

Based on functional requirement mechanical coupler shall be of following type;

i) Bar break coupler :For joining two same diameter bars(standard coupler).

ii) Bar reducer coupler: For joining two different diameter bars(Reducer or Transition coupler).

Some other types on functional basis are anchor couplers, crimpers, positioner couplers etc.

Procedure for splicing

The reinforcement rod to be spliced shall be cut by a hacksaw to get a perfectly plane end surface. The portion of the bar being engaged with the splice sleeve shall be cleaned with the power brush. The innersurface of the sleeve shall be cleaned with acetone or any other approved solvent.

The splicing shall be carried out either by manufacturers technician or personnel of contractor having been trained by the manufacturer. Some of the guidelines in coupler manufacturing are as follows

i. The system involves cold forging of the ends of the bar for enlarging the size, cutting square threads such that root thread diameter is slightly bigger than parent bar. The bars are joined at site with coupler. Unless otherwise specified the coupler shall be such that there should not be any requirement of rotatingthe rebars for connection

ii. The system should be capable in using effectively for following elements of the following structural locations

a. Main column/ Wall reinforcement.

b. Column beam junction - Column can be taken up independent of beam by providing L - barswith threaded couplers.
c. Shear wall slab junction - shear wall can be taken up independent of beam providing L - barswith threaded couplers.
d. Creating temporary access for final cleaning of pour.
e. Avoiding laps in slab pours/ Raft pours/ Circumferential reinforcement and thereby reducing congestion of reinforcement.

iii. The system should be capable for joining bars from 16mm dia to 40mm dia.

iv. Reducers/transition Couplers are to be used for joining bars at different diameter.

v. Instructions for preparing joints at site are as under.
a. Only hand tightening of couplers to be done. No wrench to be used. Use of wrench may damagethe threads and weaken the joint.
b. The bars are to be aligned properly by holding the bar by two labourers as close to each other as possible(not more than 3mm) and the coupler is to be hand tightened .Assembly until the shorter length thread is fully engaged in the position coupler and the longer length rebar thread is engagedapproximately half of its overall threaded length.
c. To be assured that the position setting bar threads have been fully engaged into the Bar splicer Position coupler, use a pipe wrench or chain wrench to snug and tighten the setting bar threads (Note: Splice bar threads will remain loose within coupler.)
d. Inspection to be visual i.e to ensure that all the threads are covered by a coupler. However, there should be adequate margin in designing the joints such that even if 4 (four) threads are covered bycoupler, guaranteed bar break is ensured.
e. Ensure that same type joints are not provided fully at any joint.
f. For mixed construction where reinforcement bars are to be welded to steel structure, weldable couplers are to be used.

Quality checks for threads and joints
i. Double forging is not allowed. In case of improper forging, such as bucking, re-cut the bar andrepeat forging.
ii. Check the threaded end of the bar with „go" and „no go" gauge. The „go" gauge must go over the full thread length. The „no-go" gauge must not go over more than half of the full thread length. However this check is required to be done after every setting of machine for particular type of couplers

Testing Requirements: Tensile test of joint is to be conducted on 3 specimens per diameter at start of work/ project. Then minimum one specimen is to be tested per 100 joints for the particular diameter upto1000 joints. Afterwards, one specimen is to be tested per 1000 joints for the particular diameter. However the Engineer-in-Charge at his discretion can increase the number of samples for testing to ensure the quality at no extra cost to the department. Acceptance criteria are that bar braking shall be away from the coupler joint and also away from the forged area. Mechanical joints with Couplers of each type and eachdiameters shall be tested for strength, slip test, bend and re-bend test etc. as per relevant standards.

Mode of Measurement: (Mechanical Coupler)
The coupler shall be measured on number basis separately for each dia. and type of mechanical couplers and rate shall include cost of all materials, fixing, testing ,assembly, equipments and all labours involved for the work.

6.13 BENDING

All bars shall be accurately bent according to the sizes and shapes shown on the detailed working drawing / bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcingbars shall not be straightened and re-bent in a manner that will injure the materials. Bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25 mm. in diameter which may be bent hot if specifically approved by the Engineer-in-Charge. Bars that depend for their strength on cold working shall not be bent hot. Bars bent hot shall not be heated beyond cherry red colour (not exceeding 645^0C) and after bending shall be allowed

to cool slowly without quenching. Bars incorrectly bent shall be used only after straightening and re-bending be such as shall not, in the opinion of the Engineer-in-Charge, injure the material. No reinforcement bar shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

16.13.1: Bending at Construction Joints: Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

6.14 THE BARS SHALL BE KEPT IN CORRECT POSITION BY THE FOLLOWING METHODS

a) In case of beam and slab construction precast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand) about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.

b) In case of cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.

c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of cement mortar 1:2 (1 cement : 2 coarse sand) of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.

d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

6.15 INSPECTION

Erected and secured reinforcement shall be inspected and approved by Engineer-in-Charge prior to placement of concrete.

6.16 MODE OF MEASUREMENT FOR REINFORCEMENT FOR R.C.C. WORKS

Reinforcement as detailed in schedule of quantities shall be measured for payment lineally as per the cutting length nearest to a centimetre shown in bar bending schedule submitted by the contractor and approved by the Engineer-in-Charge and weight calculated based on the standard weights as per I.S.1786, as indicated in the following table:

Table 6.5: Standard Weights for Reinforcement Bars

Nominal size in mm	6	8	10	12	16	20
Cross Sectional area in mm^2.	28.30	50.30	78.60	113.10	201.20	314.30
Mass / Weight in Kg / RM	0.222	0.395	0.617	0.888	1.580	2 .47
Nominal size in mm	**25**	**28**	**32**	**36**	**40**	
Cross Sectional area in mm^2	491.10	614.00	804.60	1018.30	1257.20	
Mass / Weight in Kg / RM	3.85	4.83	6.31	7.99	9.86	

Note: For standard weights of other type of reinforcement bars (eg: Stainless Steel Rebars) relevant codesor manufacture‟s Standard Tables as approved by Engineer-in Charge, shall be followed.

No allowance shall be made/ be measured in the weight for rolling margin. If weight of bar(s) found to be more than the standard weights, the measurement / payment shall be restricted to the standard weights as above. However, if weight of bar(s) found to be less than the standard weights (but within the permissible limit), the measurements / payment for the same shall be as per standard weights.

Only authorised laps shall be measured. The cost of steel used by the contractor in the reinforcementof beams, slabs and columns etc. will be paid as per the rate of reinforcement only upto the extent shown in the drawings. As far as possible laps in bars shall be avoided. Any laps and hooks provided bythe contractor other than authorised as per approved bar bending schedule will be considered to have been provided by the

contractor for his own convenience and shall not be measured for payment. Pins, chairs, spacers shall be provided by the contractor wherever required as per drawing and bar bending schedule and as directed by the Engineer-in-Charge and shall be measured for payment. Fan hooks asrequired shall be provided by the contractor under this item and shall be measured for payment.

The rate shall include the cost of all materials and labour required for all above operations including transport, wastage, straightening, cutting, bending, binding and the binding wire required.

7. PILE FOUNDATION

7.1 SPECIFICATIONS FOR BORED CAST-IN-SITU R.C.C. PILES

7.1.1 Scope: This specification covers the design and construction of load bearing concrete bored cast-in- situ piles of appropriate diameter which can transmit the load of the structure to the soil by both resistance developed at the tip by end bearing and along the surface of the pile shaft by friction.

This specification also covers the design and construction of R.C.C. pile caps and plinth beams appropriate for the piles offered and structure to be supported.

Tenderer shall be responsible for the construction of the entire pile foundation system as proposed by the Department in its tender drawing and schedule and shall guarantee the stability of the pile foundation system offered against the risks of settlement and other type of damage to the structure.
The Tenderer shall submit his offer as per Department‟s schedule of work, specifications and drawings.

7.1.2. Equipment & Accessories: The equipment and accessories shall depend on the type of bored cast-in-situ piles chosen for the job and shall be selected giving due consideration to the sub-soil strata,ground water conditions, type of founding materials and the required penetration, manner of operation etc. For Bored cast-in-situ piles percussion boring by suitable drilling rigs using direct mud circulation (DMC)methods is to be adopted and the size of the cutting tool shall not be less than the diameter of the pile bymore than 75mm Bentonite shall be used as drilling mud and its basic properties shall conform to Annex Dof I.S. 2911 (Part-I/Section-2) 2010. Tremie shall be used for placing concrete into the bore holes.

7.1.3. General Considerations: The construction of pile foundation shall be in such a way that the loadfrom the structure it supports, can be transmitted to the soil without causing any soil failure & without causing such settlement, differential or total under permanent transient loading as may result in structural damage and/or functional distress to the buildings.

When working near the existing structures, any damage to such structures shall be made good at no extra cost to the Department. The contractor shall, therefore, take adequate care to avoid any damage to the existing structures.

In case of deep excavations adjacent to piles proper shoring or other suitable arrangement shall be doneat no extra cost to the Department to guard against the lateral movement of soil or releasing the confining soil stress.

As per loading details, piles will be required to withstand vertical load axial or otherwise and horizontal load associated with moments. Axial load from a pile should be transmitted to the soil through skin friction along the shaft and end-bearing at its tip. A horizontal load shall be transmitted to the sub-soil by horizontal sub-grade reaction generated in the upper part of the pile shaft.

7.1.3.1 Coarse Aggregate, Fine Aggregate & Water: Coarse aggregate fine aggregate and water shall be conforming to IS 456 (L.R) and I.S 383 (L.R)

7.1.3.2 Concrete: Concrete to be used for the pile shaft shall be M 25 or higher grade. Materials and method of manufacture for cement concrete shall, in general, be in accordance with the method of concrete under the condition of pile installation. Consistency of concrete mix for cast-in-situ piles shall be suitable to the method

of installation of piles. Concrete mix shall be so designed as to have a homogeneous mix having a flowable character consistent with the method of concreting of pile. The slump of concrete shall range between 150 to 180 mm depending on the method/manner of concreting. Minimum cement content shall be 400 kg per cubic metre. In case of piles where concreting is done under water or drilling mud using

methods other than tremie 10% extra cement over that required for the design grade of concrete at specified slump shall be used subject to a minimum quantities of cement specified above. Cost of excess cement over the minimum quantity specified shall be borne by the contractor. For mix design, manufacture, placing etc. specification for cement concrete given hereinafter shall be referred.

7.1.4. Workmanship

7.1.4.1 Control of piling installation: Boring operation shall be done by rotary percussion type drilling rigs using direct mud circulation or reverse mud circulation methods to bail out the cuttings or as specified. In soft clays and loose sand, bailer and chisel method should be used with caution to avoid the effect of suction. Rope operated grabbing tool Kelly mounted hydraulically operated grab are also used. This method of advancing the hole avoids suction. The size of cutting tool shall be as per [IS 2911 (Part I Section 2)] and not less than the diameter of pile by more than 75 mm.

7.1.4.2 Control of Alignment: Piles shall be installed as accurately as possible as per the designs and drawings. Greater care should be exercised in respect of installation of single pile or piles in two pile groups. The piles shall be installed vertically with tolerance as stipulated by I.S 2911 (Part-I/Section-2) (Latest revision). Piles shall not deviate more than 75mm or D/6 whichever is less in case of piles having diameter less than 600mm, 75 mm or D/10 whichever is more in the case of piles having diameters more than 600mm from their designed positions at the working level. In the case of a single pile in a column, positional tolerance should not be more than 50mm or D/6 which ever is less (100 mm in case of piles having diameter more than 600 mm). In case of piles deviating beyond these limits, contractor shall carry out necessary remedial measures duly approved by the Department at no extra cost. Piles that are deviated to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pilecap or plinth beams, the piles should be re-placed or supplemented by one or more additional piles at no extra cost to the Department.

A minimum length of two/three metres of temporary guide casing upto piling platform shall be inserted in each bored pile after completion of bailer driving. Additional length or temporary casing may be used depending on the condition of the strata, ground water level etc.

7.1.4.3 Founding Level: The bore hole shall be advanced by chisel and direct mud circulation method after installation of guide casing till the required founding level is reached. The founding level shall be as per the drawings and as directed by the Engineer-in-Charge.

In case, drilling mud within the hole stabilizes a bored pile, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. The cleaning of the hole shall be ensured by careful operation of boring tool and/or flushing of the drilling mud through the bottom of the hole by tremie for half an hour minimum.

In case, a hole is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, wherever practicable, be determined by suitable, slurry sampler and recorded. Consistency of the drilling mud suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud. The concreting operations should not be taken up when the specific gravity of bentonite slurry is more than 1.2.

In addition to the normal precautions to be taken in tremie concreting, the following requirements shall be applicable to the use of tremie concrete in piles:

i) The concrete should be coherent, rich in cement (not less than 400 kg/cum) & of slump not less than 150mm.

ii) When concreting is carried out under water, a temporary casing should be installed to the full depth of the bore hole or 2 to 3 M into the top stratum, so that fragments of ground cannot drop from the sides of the hole into the concrete as it is placed.

iii) The hopper & tremie should be a closed system embedded in the placed concrete, through which

water can"t pass.

iv) The first charge of concrete should be placed with a sliding plug pushed down the tube aheadof it or with a steel plate of adequate charge to prevent mixing of concrete and water. However,the plug should not be left in the concrete as a lump.

v) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal of the pipe is surged to discharge the concrete.

vi) The pile should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile, to prevent the laitance from being entrapped within the piles.

vii) All tremie tubes should be scrupulously cleaned after use.

Normally concreting of the piles should be uninterrupted. In the exceptional case of interruption of concreting, but which can be resumed within 1 or 2 hours, the tremie shall not be taken out of the concrete. Instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremiefrom setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for easy displacement of the partly set concrete.

If the concreting cannot be resumed before final set of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete either accidentally or to remove a choke in the tremie,the tremie may be reintroduced in the following manner to prevent impregnation of laitance or scum lyingon the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug should be introduced in the tremie. Fresh concrete of slump between 150mm and 175 mm should be filled in the tremie, which will push the plug forward and will emerge out of the tremie displacing the laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

During installation bored cast-in-situ piles, the convenience of installation may be taken into account while determining the sequence of piling in a group.

The top of concrete in a pile shall generally be brought above the cut-off level, upto ground level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap. When concrete is placed by tremie method, concrete shall be cast to the piling platform level at ground level to permit overflow of concrete for visual inspection.

7.1.4.4 Procedure of Driving Pile Bore

(i) Bored cast-in-situ concrete piles are installed by making a bore into the ground and removing out the material.

(ii) The ground shall be roughly leveled and position of pile marked. The boring shall be done with or without the use of temporary casing. The sides of bore hole; shall be stabilized with the aid of temporary casing or with the aid of drilling mud of suitable consistency.

(iii) The equipment and accessories shall depend upon the type of bored pile chosen for the job, consideration of sub-soil strata, ground water condition, type of founding material. Boring operation normally are done by rotary or percussion type drilling rigs using direct mud circulation on reverse mud tool shall be as detailed in IS 2911 (Part 1/Sec.2).

(iv) In case permanent/temporary casing is not used then bored pile is stablised with drilling fluid. Bentonite supplied to site shall conform to IS 2720 (Part V). A certificate shall be obtained by the contractor from the manufacturer showing properties of each consignment and should be submitted to the Engineer- in-charge. Bentonite shall be mixed thoroughly with fresh clean water to make a suspension which will maintain the stability of the pile excavation for the period necessary to place concrete and complete construction. The temperature of the water used in mixing the bentonite suspension and when supplied to bore hole shall not be lower than 5ºC. Consistency of the drilling fluid suspension and when controlled throughout the boring as well as in concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with thick suspension of mud.

Frequency and methods of testing drilling fluid shall be as specified and the test results shall be as specified in IS 2720 (Part V).

(v) Bored cast-in-situ piles in soils which are stable may often be installed with a small casing length at the top. A minimum of 2.0 m length of top of bore shall; invariably be provided with casing to ensure against loose soil falling in to drilling mud, or a suitable steel casing. The casing may be left in place permanently especially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour.

(vi) For bored cast-in-situ piles, casing/liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as directed by the Engineer-in-charge. Materials inside the casing shall be removed progressively by air lift, grap or percussion equipment or other approved means.

(vii) Where bored cast-in-situ piles are used in soils liable to inflow, the bottom of the casing shall be kept low enough in advance of the boring tool; to prevent the entry of soil into the casing, thus presenting the formation of settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimize inflow of water or leakage of slurry during concreting.

(viii) Boring shall be carried out using rotary or percussion type equipment. Unless otherwise directed by the Engineer-in-charge the diameter of the bore holes shall be not more than the inside diameter of the liner.

(ix) After the boring has reached the required depth, the steel reinforcement shall be lowered in position maintaining the specified size of cover on all sides. The bore shall then be flushed with bentonite slurry and concreting shall be taken up exactly as described under clause 20.1.6.8.

7.1.4.5 A proper record of pile driving and other details such as sequence of installation of piles, dimension of piles, depth bored, time taken for concreting etc. shall be maintained in sequence of occurrence at site. A proper record of pile driving and other details such as depth driven, sequence of installation in a group, cut off level/working level shall be mentioned in sequence of occurrence worksheet for the inspection of Engineer-in-charge.

While drilling mud is used, the specific gravity of fresh supply and contaminated mud in the hole before concreting is taken up shall be recorded for first ten piles and subsequently at interval of 10 piles or as specified.

7.1.4.6 Defective Pile: In case defective piles are formed, they shall be removed or left in place whicheveris convenient without affecting, performance of the adjacent piles or the cap as a whole without any extracost to the Department. Additional piles shall be provided to replace them as directed.

Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting of the pile cap and plinth beam if the deviations arebeyond the permissible limit.

During chipping of the pile top manual chipping maybe permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting. Before chipping/ breaking the pile top, a 40mm deep groove shall be made manually all around the pile at the required cut off level.

After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

7.1.4.7 Ready Mix Concrete (RMC)

Alternatively, the contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of Engineer-in-Charge, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under relevant or alternatively he can propose his own sampling and testing procedure which should in turn be approved by the Engineer-in -Charge. Normally, RMC supplied to site are mixed with certain admixtures which enables the concrete to be used within 3 hours of supply at site. In case RMC supplied is not consumed within 3 hours of supply the quantity of RMC remaining unused beyond 3 hours shall be rejected and removed from site.

7.1.5. Routine Load Test: The contractor shall be required to carry out routine load tests as directed bythe Engineer-in-charge on an individual pile or on a group of piles or on both. The routine load tests shall be carried out generally as per IS 2911 (Part-IV) - 1985. Report on routine load tests shall be submitted in an approved format for Department‟s approval at no extra cost. In case the tests on the routine piles reveal safe capacity less than specified, the contractor shall, at his own cost, provide suitable modifications to the pile or other remedial measures after obtaining approval of the Engineer-in-Charge. In case of an unsatisfactory results being revealed on any routine tests it shall be the contractor‟s responsibility to carryout additional routine tests, at his own cost till the criteria laid down are fulfilled.

Rate for routine load test shall be inclusive of providing kentledges, making other arrangements for the test loading platforms, providing tools and plants, equipments like hydraulic jack, dial gauges etc. other measuring instruments and all labour involved in carrying out tests. Cost of pile shall, however, be paid forby the Department at the rates accepted in the tender since the piles are working piles.

7.1.6. Mode of Measurement of Piles: the piles shall be measured in running metres from the pile cut-off level to the founding level. The rates quoted for piling work shall include the cost of boring, concrete, hire charges of tools and plants, bailing out of water, breaking of pile heads to required level and shape, breaking, cutting through and removing the boulders or any other obstructions, if met with before reaching the required founding level etc. complete.

7.1.7. Guarantee for the Pile Foundation System (Applicable in case the pile foundation system design is under the scope of contractor)

The contractor shall guarantee the stability of the pile foundation system and shall indemnify the department against risks of settlement and against all damages caused to building erected on the pile foundation system for a period of 5 (five) years from the certified date of completion. Certificate of completion shall be issued by the Engineer-in-Charge after the satisfactory completion of the job.

NOTE: Pro-forma for guarantee to be executed by contractors for stability of pile foundation system against risk of settlement & other type of distress to the building(s) is attached in this book as **Appendix "D".**

7.2 STEEL SHEET PILE

7.2.1 General : Sheet piles are used to restrain soft soil above the bedrock in deep excavation. For a construction project where a supported excavation is required, steel sheet piling is the foremost solution.The fundamental properties of strength, ease of use and its ability to extract and re-use make steel sheetpiling a very effective design solution as temporary work.

Sheet piling is a form of driven piling using thin interlocking sheets of steel to obtain a continuous barrier in the ground. The main application of sheet piles is in retaining walls and cofferdams erected to enable permanent works to proceed. Some of the important aspects in the use of sheet piles are:

i) They shall have resistance to bending forces which depends on their shape(Profile) and section moduli of the sections.
ii) Ease with which these piling sections can be driven and reclaimed for re-use,
iii) Interlocking joints arrangement should be efficient and water tight to meet the site requirement.

7.2.2 Material: Piling sections shall be made from steel of any grade conforming to, IS 2062-2011. Where steel is

required in copper bearing quality, the copper content shall be between 0.20% to 0.35%.

7.2.3 Steel Sheet Piling Sections: Hot rolled Steel sheet piling sections shall be any of the following specified profile:

i) Z-Type,
ii) U-Type, or
iii) Flat Type,(Also termed as Straight Web type)They shall be conforming to IS 2314 -1986.

Sections are designated with the letters ISPS followed by section modulus per running meter of wall in Cm^3 and followed by letter symbol Z, U or F denoting profile.

Piling sections shall have manufacturer"s identification mark, IS Designation and colour code to identify grade of steel in accordance with the standard mark. Weight of some of the commonly used sections are:

Section Designation	Weight per Rm.	Weight per Sq.mOf wall
ISPS1021Z	49.20 Kg.	123.10 Kg.
ISPS1481Z	63.80 Kg.	159.50 Kg.
ISPS1888Z	73.20 Kg.	183.10 Kg.
ISPS2322Z	81.60 Kg.	204.10Kg.
ISPS1625U	65.40 Kg.	162.40Kg.
ISPS2222U	82.70 Kg.	195.70Kg.
ISPS100F	55.20 Kg.	138.0 Kg.

7.2.4 Tolerance on Mass: As per IS 2314-1986 the tolerance on mass shall be between (+)4% and (-)2.5%.

Note: In addition to above profiles/sections of steel sheet pile as per IS, other profiles/sections (H-Profileetc.) meeting the design requirements and conforming to other standard codes can also be used if specified in item or as approved by Engineer-in-Charge.

7.2.5 Installation of Sheet Pile: Normally following two methods of Steel sheet pile installation are adopted:

- Pitch and Drive Method and,
- Panel Drive Method.

i) In „Pitch and Drive method" sheet piles are pitched and driven one by one. To control verticality of the sheet pile during installation additional equipment arrangement is required. Pitch and Drive Method is mostly suited to loose soils and short piles.

ii) Panel Drive method involve threading together of piles above the ground in a supported frame to form a panel prior to driving. The piles are then driven in stages and in sequence into the ground. Sequential driving enables verticality to be maintained and also proper alignment is achieved. Neighboring sheet piles are leveled up at the head before commencing the hard driving operations with heavier hammers. Paneldriving is the best method for driving sheet piles in difficult ground (such as Penetrating Rock).

Sheet piles shall generally be installed using „Panel Drive Technique" to ensure that good verticality and alignment is achieved. The method also reduces the risk of declutching problem of sheet piles during installation.

7.2.6 Pile Driving Equipment: Pile Driving Equipments shall generally be one of the following types:

1) Impact Hammers Type Driver: a) Hydraulic single-acting Hammer, b) Hydraulic double-acting Hammer.

2) Vibratory Pile Driver(Vibrodrive): Vibratory Pile Driver is the quickest and most effective equipment for driving sheet piles in loose to medium dense cohesionless soil. Vibratory driving works by reducing the friction between the pile and soil. The vibrations imparted to the pile temporarily disturb the surrounding soil causing minor liquefaction, which results into an appreciable decrease in resistance to movement ofthe pile through the soil. To control possible vibration nuisance and as a precautionary measure against the detrimental effect of overdriving the

driving/penetration rate should be limited to 50cm. per minute.
For rope suspended operations, Crawler cranes are generally used.

3) Vibration-less Sheet Pile Pressing: Sheet piles can be installed without noise and vibration using Pressing or silent vibration-free Hydraulic jacking. This type of driver is especially suited to the installation of sheet piles in the vicinity of existing structures.

Pile Driving Equipment shall be selected taking into consideration the soil strata, design and safety requirement, site location and space limitations etc. The agency has to deploy appropriate equipments for sheet pile installation as approved by Engineer-in-Charge.

Any one of the above methods specified or a combination of the two if required may be used to drive the complete sheet pile walls as per design/drawing and as directed by Engineer-in-Charge and nothing extra shall be claimed by the agency.

Removal of Temporary Sheet Piles: The sheet piles provided for the purpose of supporting earth as retaining walls to enable other permanent works to proceed, shall be carefully removed using appropriate equipment (Vibro-drive etc.) once the purpose is achieved to the satisfaction of Engineer-in-Charge.

The sections/profiles of sheet piles of temporary works shall be removed and taken away from site by agency as and when instructed by Engineer-in-Charge.

7.2.7 Rate and Mode of Measurements (For Temporary Sheet Piles): The item of works shall be measured on weight basis of structural steel profile/sections used in sheet piling work. The rate shall include all labours, equipments, materials- their transportation, installation, removal after achieving intended purpose and taking away the retrieved material from site.

7.2.8. Permanent works of Sheet Piles: (Materials and installation same as described above.)

7.2.9 Mode of Measurement (For Permanent Sheet Piles): The item of permanent works of sheet piling wall shall be paid on the weight basis of structural steel profiles/sections used in works and rate shall include cost of all materials including wastages, labours, equipments for installation of sheet piles in position, sealants at joints etc. complete as specified in item.

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8. READY MIX CONCRETE

8.1. INTRODUCTION

Concrete mixed in a stationery mixer in a central batching and mixing plant or in a truck mixer and supplied in fresh condition to purchaser (contractor) either at site or into purchaser"s vehicle. RMC produced andsupplied shall conform to provision of IS : 4926-2003 (or latest revision). Plant of RMC Producer shall befirst got approved from Engineer-in-Charge. The contractor shall arrange with RMC producer for facilitating thorough inspection of RMC plant for the purpose of approval.

8.2. MATERIALS

Materials used should satisfy the requirements for the safety, structural performance durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between IS 4926 and materials used. Also, prior permission of the Engineer-in-Charge shall be obtained before use of such materials

8.2.1 Cement : cement for concrete shall be as specified and shall be in accordance with the requirements of IS 456-2000.

8.2.2 Mineral Admixtures : Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

Fly ash when used for partial replacement of cement, shall conform to Grade I of IS-3812 and meet the physical and chemical requirements as per IS 3812(Part-I)-2013. Percentage of fly ash as part replacement of OPC shall be guided as per IS 1489-2005(Part 1). Blending operation of fly ash with cement should be properly designed for uniform and intimate blending.

Specific care shall be taken in terms of curing, protecting, repairing, finishing, de-shuttering etc. as detailed in the relevant Chapter of "Fly Ash Concrete "and "Formwork".

8.2.3 Aggregates shall comply with the requirements of IS: 383. Natural aggregates shall be given preference. Use of other types of aggregate meeting suitability requirements, may be permitted by Engineer-in-Charge, if satisfied with the data on the properties of concrete made with them.

8.2.4 Water used for concrete shall conform to the requirement of IS 456-2000.

8.2.5 The Chemical admixtures may be permitted in accordance with the provisions of IS: 456-2000 andIS: 9103.

It shall be the responsibility of the producer to establish compatibility and suitability of any admixture withthe other ingredients of the mix and determine the dosage required to give the desired effect.

The amount of admixture added to mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser (contractor).

8.3. SUPPLY

The ready-mixed concrete shall be manufactured and supplied on either of the following basis

i) Specified strength based on 28-day compressive strength of 15 -cm cubes tested in accordance with IS : 456-2000.

ii) Specified mix proportion.

NOTE : Under special circumstances and as specified the strength of concrete in (a) above may be based on 28-day or 7-day flexural strength of concrete instead of compressive strength of 15-cm cube tested inaccordance with IS : 456-2000.

8.3.1 When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer and the concrete shall conform to the requirements specified.

8.3.2 When the concrete is manufactured and supplied on the basis of specified mix proportions, the responsibility for the design of the mix shall be that of the purchaser and the concrete shall conform to the requirements specified.

8.4. GENERAL REQUIREMENTS

The manufacturer shall keep batch records of the quantities by mass of all the solid materials, total amount of water used in mixing and results of all ingredients of concrete. If required/insisted, the manufacturer shall furnish certificates, at agreed intervals, giving these information's. It shall be obligatory on part of RMC manufacturer to allow inspection of their plant including control room during supply of RMC to site.

8.4.1 Transport of Concrete : Ready-mixed concrete shall be transported from the mixer to the point ofplacing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by

vibration. If required by the purchaser the producer can utilize admixtures to

slow down the rate of workability loss, however this does not remove the need for the contractor to placethe concrete as rapidly as possible. The contractor should plan his arrangements so as to enable a full load of concrete to be discharged within 30 minutes of arrival on site.

8.4.2 Time in Transport: The general requirement is that concrete shall be discharged from the truck- mixer within 2 hour of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

8.4.3 Workability: The test for acceptance is to be performed upon the producer"s delivery vehicle discharge on site or upon discharge into the purchaser"s vehicle. If discharge from the producers" vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate: Slump: ± 25 mm or 1/3 of the specified value, whichever is less.

Compacting factor : ± 0.03, where the specified value is 0.90 or greater,

± 0.04, where the specified value is less than 0.90 but more than 0.80,

± 0.05, where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (IS 9103)

The compressive strength and flexural strength tests shall be carried out in accordance with the requirement of IS: 516 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall conform to the requirements and other related requirements of IS: 456 -2000.

8.5 QUALITY CONTROL

Quality control of ready-mixed concrete may be divided into three components, forward control, immediate control and retrospective control.

8.5.1 Forward control: Forward control and consequent corrective action are essential aspects of quality control. Forward control includes the following.

(i) Control of purchased material Quality

(ii) Control of Materials storage

(iii) Mix design and mix design modification

(iv) Transfer and Weighing Equipment : The producer shall be able to demonstrate that a documented calibration procedure is in place. The use of electro-mechanical weighing and metering systems, that is, load cells, flow meters, magmeters, etc, is preferable over purely mechanical system, that is, knife edge and lever systems.

(v) Plant mixers where present and truck mixers used shall be in an operational condition.

8.5.2 Immediate Control: Immediate control is concerned with instant action to control the quality of the concrete being produced or that of deliveries closely following. It includes the production control and product control.

(i) Production Control : The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specifications that has formed the basis of the agreement between the producer and purchaser.

Each load of mixed concrete shall be inspected before dispatch and prior to discharge. The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.

For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated

slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

Regular routine inspections shall be carried out on the condition of plant and equipment including delivery vehicles.

(ii) Product Control : Concrete mixes shall be randomly sampled and tested for workability and where appropriate, plastic density, temperature and air content. Where significant variations from target valuesare detected, corrective action shall be taken.

It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (As per IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forwardcontrol by suitable modifications to mix design.

8.5.3 Retrospective Control : Retrospective control is concerned with those factors that influence the control of production. Retrospective control may cover any property of materials or concrete, such as aggregate grading, slump, or air content, but is particularly associated with 28-day cube strength because by its very nature it is not property which can be measured ahead of, or at the time of, manufacture.

8.5.4 Mix Performance : The producer shall be responsible for ensuring that suitable control procedures are in place ensure the following.

(i) Design Mixes : A quality control system shall be operated to control the strength of design mixes to the levels required as per IS 456 and shall be based on random tests of mixes which form the major proportion of production. The system shall include continuous analysis of results from cube tests to compare actualwith target values together with procedures for modifying mix proportions to correct for observed differences. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.

(ii) Prescribed Mixes : Periodic and systematic checks shall be made to ensure that the cementitious material contents of prescribed mixes comply with their mix descriptions.

8.5.5 Stock Control of Materials: The producer shall operate a materials stock control procedure to enable verification of total quantities used and to confirm that only approved materials have been received.

8.5.6 Complaints: The producer shall have a procedure in place to enable the diagnosis and correction of faults identified from complaints.

8.6 MODE OF MEASUREMENT

The mode of measurement for ready mixed concrete (RMC) will be the same as mentioned under mode of measurement for conventional concrete work. However, consumption of RMC shall be maintained at site. Wastage, spillover, wastage due to pump blockage etc. shall not be considered for payment

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9. FLY ASH CONCRETE AND OTHER SPECIAL TYPE CONCRETE(S)

9.1 FLY ASH CONCRETE

9.1.1 Introduction: In environment subjected to aggressive chloride or sulphate attach in particular, use of fly ash admixed or PPC based concrete is recommended. Fly Ash admixed cement concrete (FACC) and

fly ash Blended cements conforming to IS-1489 (Part I) may be used in RCC structures as per guidelines given below

a) The fly ash should have consistent quality satisfying the requirements of Grade-I of IS 3812 andClass-F of ASTM C-618.

b) The source of fly ash should be so selected that test results of fly ash samples collected from these sources during last one year at frequency of maximum one month interval should satisfy the requirements of

above codes.

c) The characterization of fly ash proposed to be used, should be done as per above two codes foreach batch of fly ash.

d) The fly ash should be stored in bins at the plant.

e) All concrete should be manufactured at RMC plant to ensure uniform blending of fly ash.

f) The mix proportion should conform to provisions of IS codes.

g) Samples to be taken, at each time of casting, for 7 days and 28 days. Sampling shall be as per relevant IS provisions.

h) All ingredients of concrete should satisfy the requirements of relevant IS codes and specifications.

9.1.2 Curing, protecting, repairing and finishing

9.1.2.1 Curing: All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or ponded water, continuously saturated covering of sacking, canvas, hessian or other absorbentmaterials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter the quality of curing water shall be the same as that used for mixing concrete.

Certain types of finish or preparation for overlaying concrete must be done at certain stages of curing process and special treatment may be required for specific concrete surface finish.

Curing of concrete made of high alumina cement and super sulphated cement shall be carried out as directed by Engineer-in-charge.

Curing of concrete with low water binder ratios having partial replacement of cement by pozzolanic materials.

The structural elements with concrete having water binder ratio less than or equal to 0.4 or partial replacement of cement by pozzolanic materials (5% or above replacement by silica fume or high reactivity metakaoline, or 15% or above by fly ash) shall be cured in two stages, initial curing and final curing.

i) The initial curing should be started not later than 3 hours or initial setting time, whichever is lower, after placement of concrete. The concrete surface exposed to environment should be covered by plastic sheetor other type of impermeable covers. The initial curing should be continued upto a minimum period of 12hours or 2 hours plus final setting time of concrete, whichever is higher.

ii) Final curing should be done with water. It should commence immediately after initial curing and continue upto a minimum period of 14 days.

9.1.2.2 Curing with Water : Same as 4.15.2

9.1.2.3 Continuous Spraying : Same as 4.15.3

9.1.2.4 Alternate Curing Methods : Same as 4.15.4

9.1.2.5 Curing Compounds :. Same as 4.15.5

9.1.2.6 Curing Equipment: Same as 4.15.5

9.1.2.7 Form Work : Same as Chapter - 5 (Form Work)

9.2 HIGH VOLUME FLY ASH CONCRETE

High Volume Fly Ash Concrete is a concrete where in High percentage (50 to 60%) of fly ash conforming to Grade1 of IS3812(or Class F of ASTM C-618) is used as part replacement of OPC Cement. Many Investigations and field demonstration projects carried out by CANMET and also within India have shownthat high volume fly ash concrete has excellent structural and durability characteristics, when mixed withlow water to cementitious ratio

and super-plasticiser for ease of work. On account of low cement content,the heat of hydration generated is rather low and so HVFA concrete shall be used advantageously in mass concreting.

As the water content is low in high volume fly ash concrete, it can advantageously be used as zero slump concrete without plasticizer for roller compacted concrete application in pavement.

High volume fly ash concrete mix shall be designed for specified grade and trial mixes shall be made and tested for required strength parameters before use at site. Utmost care should be taken for production ofdesired quality mix by keeping checks on quality of all the ingredients of HVFA concrete. Care shall be taken for longer curing period (21 days) and also with respect to stripping time of formwork as directed by Engineer-in-Charge.

All other details with respect to placing, compaction, mode of measurement and rate shall generally be same as mentioned for Conventional concrete.

9.3 HIGH PERFORMANCE CONCRETE

High Performance Concrete is a term used for specifically designed concrete mix which possess attributes, in addition to high strength of concrete, like high workability, high modulus of elasticity, high dimensionalstability, highly dense, low permeability and high resistance to chemical attack.

These additional desired attributes in HPC is achieved by densification and strengthening of porous andweak transition zone which exists at the cement paste-aggregate interface.

To achieve high strength (M-60 and above), low water-cement ratio (0.25 to 0.30) is kept and to achieve high workability and to retain rheological properties for a sufficiently long time till concrete is placed and compacted, optimum design dose of a compatible super plasticizer is mixed with concrete.

To improve the qualities of transition zone, mineral admixtures (conforming to respective IS) like fly ash, silica fumes, slag"s are used (in combination or otherwise) for designing the mix of High Performance Concrete. Care shall be taken that the shape of aggregates being used should generally be cubic with negligible amount of flaky or elongated particles. For concrete grade of M-100 or above the maximum nominal size of aggregate shall be 12mm.

Other Details: Other details such as mixing, placing, testing, mode of measurements, rate etc. shall generally be similar to as described previously under conventional concrete.

9.4 SELF COMPACTING CONCRETE

The term „Self Compacting Concrete" is generally associated with high performance concrete which can be successfully placed at site without vibration. Making of conventional concrete structures of normal strength(M-30 or so) without vibration such as tremie concreting in case of pile foundation or under water concreting does not come under the term of „Self Compacting Concrete".

9.4.1 Mix Design: Mix Design of Self Compacting concrete shall be carried out through Reputed concrete Laboratory approved by Engineer-in-Charge and the cost shall be borne by the contractor. The Contractor has to provide all the required ingredients such as cement, aggregates, mineral admixtures(as required),

fines, viscosity modifier agent(VMA),Superplasticizer(Poly-caboxylated ethers-PCE),etc. out of same source/manufactures which he proposes to use in production of SCC for the work .

After laboratory Mix Design, the mix shall be tested at full scale at the batching plant at site for satisfactory performance of mix.

The special ingredients such as VMA, admixtures(fines, powder), Superplasticizer (PCE) shall be of approved standard manufactures.

9.4.2 Requirement of SCC: The foremost characteristic of SCC is its flowing properties without segregation in the fresh state. Fresh self compacting concrete should be:

i) able to flow under its own weight without vibration(Filling ability),

ii) able to flow through heavily congested reinforcement (Passing ability) and

iii) able to retain homogeneity without segregation(Segregation resistance).

Note: For the initial mix design of SCC all the three workability parameters need to be assured.

Table 9.1: Workability for SCC

Test methods of Workability	Typical Range of Values
Slump flow by Abram‟s Cone,(Filling Ability)	650mm to800mm
T50cm Slump Flow, (Filling Ability)	2 Second to 5 Second
J-Ring Test , (Passing Ability)	Nil to 10mm
Fill Box Test , (Passing Ability)	90% to 100%
V-funnel Test ,(Filling Ability)	8 second to 12 second
V-funnel Test at T-5 minutes,(Segregation Resistance)	Nil to 3 second
Orimet Test, (Filling Ability)	Nil to 5 second

At site for quality control, minimum two tests methods(as per decision of Engineer-in-Charge) out of above mentioned tests shall be carried out in order to monitor production quality. Post placement qualifying criterion shall be same as normal concrete.

9.4.3 Placing: Form work shall be checked for any minor gaps and sealed properly to prevent leakage. Following care shall be taken while placing SCC

i) Vertical free fall shall preferably be limited to 3.0m. Only in exceptional situational demand it may be allowed upto 5m that too under strict observational care that no segregation takes place.

ii) Height of pour lifts(layer) should not be more than 500mm.

iii) Horizontal flow distance from point of discharge should be preferably limited to 10m.

9.4.4 Curing: Initial curing should be commenced as soon as practicable to avoid plastic shrinkage cracking. Alternatively, the poured concrete surface should be effectively be covered by polyethylene sheet. Afterwards normal curing shall continue for a minimum period of 14 days.

9.4.5 Mode of Measurement & Rate: Mode of measurement for SCC shall be same as conventional concrete on volume basis in CuM. upto three decimal place. Rate shall include cost of all materials, testing‟s, placing and labours involved in the all the operations described above.

9.5 HIGH DENSITY CONCRETE (HEMATITE CONCRETE)

High Density Concrete is an excellent radiation shielding material that possesses the needed characteristic for attenuation of neutron and gamma-ray. It has low initial and maintenance cost and ease of construction makes it a suitable choice for radiation shielding. Its only disadvantage is space due to thickness requirement.

Effectiveness of radiation shielding quality of concrete increases with increased density of concrete,thereby resulting in considerable reduction in space requirement due to thinner concrete section.

High density concrete where heavier aggregates (fine as well as coarse) such as iron ores namely hematite, magnetite is used in production of concrete, the density of resultant concrete normally increases by 1.5 times(3600kg/m^3) than normal concrete(2400kg/m^3).Thickness requirement of concrete for radiation shielding reduces in that proportion.

9.5.1 Materials

i) Cement: Same as normal concrete conforming to relevant IS Codes.

ii) Water: As per requirements for construction use of IS-456-2000.

iii) Fine Aggregates: Basic material shall be iron ores-hematite/magnetite and properties and grading should generally conform to IS-383. Specific gravity shall be generally in the range of 4.5 (4.3 to 4.8).

iv) Coarse Aggregate: Basic material shall be iron ores-hematite/magnetite and properties and grading should generally conform to IS-383. Specific gravity shall be generally in the range of 4.5 (4.3 to 4.8).

9.5.2 Mix: Concrete shall be of specified grade with specified minimum cement content (400kg/m^3 or so) to have good workability and help in reducing segregation.

9.5.3 Placing: Form work shall be sturdy enough to withstand the load of placement of high density concrete.

Concrete produced shall be rich, cohesive and of good workability to minimize segregation

As heavy aggregates are used in concrete due care and necessary pour arrangement shall be made while placement that no segregation takes place.

9.5.4 Curing: Same as described for normal concrete.

9.5.5 Mode of Measurement & Rate: Same as described for Plain/ Reinforced Cement Concrete.

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10. DAMP PROOF COURSE

10.1 SCOPE OF WORK

The work covered under this specifications consists supplying and laying plain cement concrete of specified nominal mix and thickness at plinth level of building as damp proof course with approved waterproofing admixture in accordance with this specification and applicable drawings.

10.2 WORKMANSHIP

Surface to receive damp proof course shall be cleaned and carefully swept to remove all dust, laitance etc. and shall be approved by the Engineer-in-Charge. Damp proof course shown shall be cement concrete of proportion and thickness as indicated in the schedule. Approved water proofing compound @ 2% by weight of cement or as directed by the manufacturer shall be mixed in cement mortar for this concrete. The damp proof course shall be laid to the full width of the peripherals walls including shaft walls and the edges shall be straight, even and truly vertical. Wooden forms shall be used to obtain good edges. A coat of hot bitumen of grade 80/100 @ 1.7Kg/SqM is applied over the laid concrete course after 24 hours.

10.3 MODE OF MEASUREMENT

The work shall be measured in SqM. area actually laid limited to sizes as shown in drawing. The rateshall include cost of all the materials, form work, labour etc.

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11. PRECAST REINFORCED CEMENT CONCRETE JALLI

11.1 GENERAL

The item refers to manufacturing, supplying and fixing in position reinforced cement concrete jalli with thickness, proportion, design and pattern as specified in the description of item of schedule of quantities.

11.2 MATERIALS

The concrete shall consist of a mix as specified in the item and specifications for cement concrete shall be similar to that specified under cement concrete. Reinforcement shall be as specified in the item description or as shown in the drawing or as directed by the Engineer-in-charge.

11.3 MANUFACTURE

Precast jalli of approved design and thickness as specified in description of item shall be cast at site and fixed in position at all floors and levels by the contractor. Steel moulds to manufacture approved size, design and thickness of reinforced jalli as per drawings shall be manufactured and got approved before starting large scale casting. Reinforced jalli shall be cast at site. Reinforcement of specified dia. shall be bent to the exact shape of jalli to run

vertically and horizontally along centre of all walls and suitably kept in position. Use of teak wood/shuttering plywood moulds can be allowed at the discretion of the Engineer-in-charge. Precast Jalli shall be made by filling the moulds of the approved design, pattern with complete batch of 1:2:2 or as specified (using 10 mm. down graded stone aggregate) cement concrete so that the entire work may set in one time. If one batch is sufficient to complete a unit, each succeeding batch should follow the preceding batch as quickly as possible. The specifications for reinforced cement concrete shall conform to I.S. 456-2000 and as specified earlier. The jalli shall be cast according to drawing, design and as approved by the Engineer-in-charge. Necessary holes and keys for pins/ dowelsto house in the jalli shall be left for fixing. Jallies shall be cured in a curing tank for a minimum period of 14 days. All the imperfection in surfaces and edges shall be repaired with neat cement paste to finish with sharp and smooth edges. The jalli so manufactured shall be perfectly at right angles when checked with straight edge. Jallies which are not approved due to defective pattern, shape, finish etc. shall be removed forthwith from the site of work.

11.4 FIXING

The jalli shall be fixed in position in cement mortar 1:2 in preformed opening true to line, level and plumb with 6 mm. M.S. pins, all as per drawing or as directed by the Engineer-in-charge. Jalli with damaged edges of surfaces shall not be fixed. The joints shall be cured for a minimum period of 7 days. After grouting the sides with cement mortar etc., the jalli shall be rechecked for its levels and alignment. Finally the jambs, sills and soffits shall be plastered embedding the jalli uniformly on sides. The jalli shall be cleaned off all the mortar splashes, dirt etc.

11.5 MODE OF MEASUREMENT

The jalli shall be measured in square metre and shall be measured between the limiting dimensions of unplastered sides, base and top. Any portion of jalli embedded in the supporting wall shall not be measured for payment. Dimensions shall be measured correct upto two places of decimal of a metre and the area worked out upto two places of a decimal of square metre. No deduction shall be made for the openings in the jalli. The thickness shall not be less than that specified.

11.6 RATES

Rate to include the cost of the following

i) Providing the precast jalli of approved design conforming to specifications detailed above including concrete, moulds etc. (Reinforcement provided shall be paid separately under relevant item(s))

ii) All materials, equipment, labour for handling, transporting, hoisting and fixing the jalli in position including scaffolding, forming grooves if necessary, touching up all sides wherever necessary as per drawing and specifications.

12. STRUCTURAL STEEL

12.1 SCOPE OF WORK

The work covered by this specification consists of furnishing and erecting of structural steel completein strict accordance with this specification and the applicable drawings.

12.2 MATERIALS

All structural steel shall be of standard sections as marked on the drawings conforming to IS 1173, IS 4923-1997, IS 1161-1998 and shall be free of scale, blisters, laminations, cracked edges and defects of any sort. If the structural steel is not supplied by the Department and the Contractor is required to bring such steel, the Contractor shall furnish duplicate copies of all mill orders and/ or also the test report received from the mills, to satisfy the Engineer-in-Charge.

All structural steel and electrodes shall comply in all respects with relevant codes for structural steel.

12.3 WORKMANSHIP

All workmanship shall be of first class quality in every respect to the greatest accuracy being observed to ensure that all parts will fit together properly on erection.

All ends shall be cut true to planes. They must fit the abutting surfaces closely.All stiffeners shall be fit tightly at both ends.

All butt ends of compression members shall be in close contact through the area of the joints.

All holes in plates and section between 12 mm. and 20 mm. thick shall be punched to such diameter that 3 mm. of metal is left all around the hole to be cleaned out to correct size by reamer.

The base connection shall be provided as shown on drawings and the greatest accuracy of workmanship shall be ensured to provide the best connections.

Figured dimensions on the drawings shall be taken.

12.4 ERECTION AND MARKING

Erection and fabrication shall be according to I.S. 800-2007. During erection, the work shall be securely braced and fastened temporarily to provide safety for all erection stresses etc. No permanent welding shall be done until proper alignment has been obtained.

Any part which do not fit accurately or which are not in accordance with the drawings and specifications shall be liable to rejection and if rejected, shall be at once be made good.

Engineer-in-Charge shall have full liberty at all reasonable times to enter the contractors premises for thepurpose of inspecting the work and no work shall be taken down, painted or dispatched until it has beeninspected and passed. The contractor shall supply free of charge all labour and tools required for testing of work.

12.5 DELIVERY AT SITE

The contractor shall deliver the component parts of the steel work in an undamaged state at the site of the works and the Engineer-in-Charge shall be entitled to refuse acceptance of any portion which hasbeen bent or other wise damaged before actual delivery on work.

12.6 SHOP DRAWINGS

The shop drawings of structural steel based on contract drawings shall be submitted to the Engineer-in- Charge. The necessary information for fabrication, erection, painting of structure etc. must be furnished immediately after acceptance of the tender.

12.7 PAINTING

Painting should be strictly according to I.S. 1477-1971 (Part I-Pretreatment) and I.S. 1477-1971 (Part II-painting). Painting should be carried out on dry surfaces free from dust, scale etc. The paint shall be approved by the Engineer-in-Charge.

One coat of shop paint as specified shall be applied on steel, except where it is to be encased in concrete or where surfaces are to be field welded.

12.8 WELDING

Welding shall be in accordance with I.S. 816-1969, I.S. 819-1957, I.S. 1024-1979, I.S. 1261-1959, I.S. 1323-1982 and I.S. 9595-1980 as appropriate. For welding of any particular type of joint, welders shallgive evidence of having satisfactory completed appropriate tests as described in any of I.S. 817-1966, I.S. 1393-1961, I.S. 7307 (Part-I)-1974, I.S. 7310 (Part-I)-1974 and I.S. 7318 (Part-I)-1974 as relevant.

12.8.1 Welding Consumables : Covered electrodes shall conform to I.S. 814 (Part-I)-1974 and I.S.814 (Part-II)-1974 or I.S. 1395-1982 as appropriate.
Filler rods and wires for gas welding shall conform to I.S. 1278-1972.

The bare wire electrodes for submerged arc welding shall conform to I.S. 7280-1974. The combination ofarc and flash shall satisfy the requirements of I.S. 3613-1974. The filler rods and bare electrodes for gasshielded metal, arc welding shall conform to I.S. 6419-1996 and I.S. 6560-1996 as appropriate.

12.8.2 Types of Welding: Arc welding (direct or alternating current) or Oxyacetylene welding may be used. Field welding may be used. Field welding shall be by D.C.

12.8.3 Size of Electrode Runs: The maximum gauge of the electrodes for welding any work and the size of run shall be based on the following tables.

Table 12.1: Maximum Gauge of the Electrodes

Average thickness of plate or section	Maximum gauge or diameter of electrodes tobe used.
Less than 3/16"	10 S.W.G.
3/16" and above but less than 5/16"	8 S.W.G.
5/16" and above but less than 3/8"	6 S.W.G.
3/8" and above but less than 5/8"	4 S.W.G.
5/8" and above but less than 1"	5/16"dia.
1" and above thick section	3/8" dia.

Note : On any straight weld the first run shall not ordinarily be deposited with a larger gauge electrode than No. 8 S.W.G. For subsequent runs the electrode shall not be increased by more than two electrodesize between consecutive runs.

12.8.4 Welding Contractors: The contractor shall ensure that each welding operator employed on fabrication or erection is an efficient and dependable welder, who has passed qualifying tests on the types of welds which will be called upon to make. Sample test shall have to be given by the contractorto the entire satisfaction of the Engineer-in-charge.

12.8.5 Welding Procedure

a) Welding should be done with the structural steel in flat position in a down hand manner wherever possible. Adequate steps shall be taken to maintain the correct arc length, rate of travel, current and polarity for the type of electrode and nature of work. Welding plant capacity shall be adequate to carry out the welding procedure laid down. Adequate means of measuring the current shall be available either

as a part of the welding plant or by the provision of a portable ammeter. In checking the welding current, a tolerance of 10% or 30 amperes from the specified value whichever is less shall be permitted.

b) The welding procedure shall be such as to ensure that the weld metal can be fully and satisfactory deposited through the length and thickness of all joints so that distortion and shrinkage stresses are reduced to the minimum and thickness of welds meet the requirements of quality specified.

12.9 WORKMANSHIP

12.9.1 Preparation of Fusion Faces: Fusion faces shall be cut by stearing machine or gas cutting and later dressed by filling or grinding so that they shall be free from irregularities such as would interfere with the deposition of the specified size of weld to cause the defects. Fusion faces and the surrounding surfaces shall be free from heavy slag, oil paint or any substance which might affect thequality of the weld or impede the progress of welding. The welding face shall be free of rust and shall have metal shine surfaces.

The parts to be welded shall be brought into as close contact as possible and the gap due to faulty workmanship or incorrect fit up shall not exceed 1/16". If separation of 1/16" or more occurs locally, the size of the fillet weld shall be increased at such position by an amount of equal to the width of the gap.

The parts to be welded shall be maintained to their correct position during welding. They shall be securely held in position by means of tack welds, service bolts, clamps or rings before commencing welding so as to prevent and relative movement due to distortion, wind or any other cause.

12.9.2 Step Back Method Should be Used to Avoid Distortion: The minimum leg length of a fillet weld as deposited should not be less than the specified size and the throat thickness as deposited should be not less than that tabulated below

Table 12.2: Throat Thickness of Fillet

Angle between fusion faces	60^0-90^0	91^0-100^0	101^0-106^0	107^0-113^0	114^0-120^0

Throat thickness in cms.	0.70	0.65	0.60	0.55	0.50

In no case should a concave weld be deposited without the specific approval of the Engineer-in-Charge unless the leg length is increased above the specified length so that the resultant throat thickness is as great as would have been obtained by the deposition of a flat.

All welds shall be deposited in a pre-arranged order and sequence taking due account of the effects of distortion and shrinkage stresses.

After making each run of welding, all slag shall be removed and final run shall be protected by clean boiled linseed oil till approved.

The weld metal, as deposited, shall be free from crack, slag, excessive porosity, cavities and other faults. The weld metal shall be properly fused with the parent metal without overlapping or serious undercuttingat the toes of the weld.

The surfaces of the weld shall have a uniform and consistent contour and regular appearance.

In welds containing crack, porosity or cavities in which the weld metal tends to overlap on the parent metal without proper fusion, the defective portions of the welds shall be out cut and re-welded. Where seriousunder cutting occurs, additional weld metal shall be deposited to make good reduction. Testing of welded joints shall be done as per relevant IS codes 3600, 3613, 4260, 7205, 7215, 7307, 7310, 7318.

12.10 MODE OF MEASUREMENT

Various members including gusset plates shall be measured correct to two places of decimals and thenet weight worked out from the standard steel tables approved by Indian Standard Institution. All

structural steel shall be measured on weight basis as mentioned in the schedule of quantities. The length or areas of made/measured in the weight for rolling margin. If weight of section(s) found to be more thanthe standard weights, the measurement / payment shall be restricted to the standard weights. However, if weight of bar(s) found to be less than the standard weights (but within the permissible limit), the measurements / payment for the same shall be as per standard weights. For small works in exceptionalcase, if non-standard sections are used the actual weight of used structural section shall be measured and paid.

No separate measurements shall be taken for welding, riveting, bolting, field connections etc. The rateshall include cost of all labour, materials, scaffolding, transport and also cost of welding, riveting and bolting, field connections if any all to complete the job as per specifications. However, anchor fasteners & foundation bolts with nuts shall be measured and paid under relevant item.

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13. BRICK WORK

13.1 SCOPE OF WORK

The work covered under this specification pertains to masonry work using various types of bricks and its workmanship in building walls of various thickness, in compliance with the relevant specifications and applicable drawings.

13.2 MATERIALS

Bricks used in the masonry shall be of the following type

13.2.1 The Common Burnt Clay Brick : Brick shall be well burnt clay bricks of designated class and shall satisfy the strength criteria and shall be got approved by the Engineer-in-Charge before incorporation inthe work. The bricks shall be hand moulded or machine moulded and shall be free from nodules of free lime, visible cracks, flaws, warpage and organic matter.

In general, the nominal size of bricks (F.P.S.) shall be 22.9 x 11.4 x 7 cm. (9"x4.5"x2.75"). Permissible tolerance on dimensions shall not be more than (±) 8%. The contractor shall get approved the sample and source of bricks from Engineer-in-Charge before procurement on large scale and shall maintain thesame for the entire work. The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour.

- Bricks for Mumbai / Pune and surrounding areas, unless otherwise specified, shall be as per relevant IS of class designation 35 of size 22.5 x 11.1 x 7 cm. Permissible tolerance on dimensions shall not be more than (±) 8%.
- Unless otherwise specified, bricks for Eastern Zone works (Kolkata / Bhubneshwar / Shillong etc.) shall be of class designation 75 of size 25 x 12.5 x 7.5 cm. Permissible tolerance on dimensions shall be as per relevant IS.

In case the size of bricks used in the work is found lesser than the specified one but within the permissible tolerance i.e. {-} 8% , the following shall apply:

i) Extra cement consumed due to more number of joints and due to additional thickness of plaster than the specified in the tender to match with adjoining columns and beams, shall be borne by the contractor without any extra cost to the department.

ii) If the plastering to be done is more than the specified thickness to maintain the plaster surface to perfect line, level and plumb with adjoining columns, beams, walls etc., the contractor shall be responsible to provide more thickness of plaster at his own cost and nothing extra will be paid on this account.

In case the size of bricks used in the work is found more than the permissible, the contractor shall chip out the exposed edges of bricks upto the required level of wall to receive specified thickness of plaster.

Bricks shall generally conform to I.S. 1077-1992. In any case minimum crushing strength shall not be less than 35 kg/cm^2 and water absorption shall not be more than 25% by weight. The Engineer-in-Charge shall have the right to reject bricks obtained from any field where the soil has an appreciable quantity of sulphates and chlorides. The specifications for cement, sand and water shall be same as described herein before under cement concrete. Bricks shall be thoroughly soaked in water before using till the bubbles ceases to come up. No half or quarter brick shall be used except as closer. The closer shall be cut to required size and used near the end of the walls. The walls shall be raised truly to plumb. The type of bond to be adopted shall be decided by the Engineer-in-Charge, but vertical joints shall be laid staggered.

13.2.2 Fly Ash Lime Bricks (FALG Bricks) : The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with or without frog on one of its flat side.

Fly Ash: Fly ash shall conform to IS 3812.

Note: This item will be operated only for load bearing structure upto 2 storeys and for non-load bearingwalls 23 cms thick for multi-storied building's.

Bottom ash used as replacement of sand shall not have more than 12% loss on ignition when tested.

Sand: Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime: Lime shall conform to class „C" hydrated lime of IS 712.

Additives: Any suitable additive considered not detrimental to the durability of bricks may be used.

13.2.3 Mechanized Autoclave Fly Ash Lime Brick: These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with frog, and of 100/80 mm in length, 40 mm widthand 10 to 20 mm deep on one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 andlime shall conform to class „C" hydrated lime of IS 712.

13.2.4 Clay Fly Ash Bricks: The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may notbe provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

13.3 WORKMANSHIP

Four courses of brick work with four joints should not exceed by more than 40 mm., the same bricks piledone over the other without mortar.

Brick work shall not be raised more than 10 courses a day unless otherwise approved by the Engineer-in- Charge. The brick work shall be kept wet for at least 7 days. Brick work shall be uniformly raised alround and no part shall be raised more than 1.0 metre above another at any time.

All joints shall be thoroughly flushed with mortar of mix as specified in the schedule of quantities, at every courses. Care shall be taken to see that the bricks are bedded effectively and all joints completely filled to the full depth.

The joints of brick work to be plastered shall be raked out to a depth not less than 10 mm. as the work proceeds. The surface of brick work shall be cleaned down and watered properly before the mortar sets.

The adhesion between the brick masonry surface and the concrete surface of columns, beams, chajjas, lintels etc. should be proper by ensuring that the concrete surface coming in contact with brick masonry is hacked/ chipped/ keyed, cleaned and cement slurry is applied so that a proper bond is achieved between the two dissimilar materials. It is the responsibility of the contractors to ensure that there will not be any cracks/ fissures anywhere in the brick masonry.

In case the cracks appear subsequently in those areas, they should be made good by cement grouting or epoxy putty grouting/ poly sulphide compound grouting or as per standard modern specifications/ methods with the prior approval of the Engineer-in-Charge, at the cost of the contractor.
All the courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Specified mortar of good and approved quality shall be used. Lime shall not be used where reinforcement is provided in brick work. The mortar should completely cover the bed and sides of the bricks. Proper care should be taken to obtain uniform mortar joint throughout the construction. the walls should be raised uniformly in proper,approved bond. In construction of the wall, first of all two end corners are carefully laid to line and level and then in between portion is built, with a cord stretching along the headers or stretchers held in positionat the ends. This helps in keeping the alignment of the courses and maintaining them in level.Similarly all other courses are built. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances :

a) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5mm.

c) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

d) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 meter rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

No brick work shall be carried on during frosty weather except with the written permission of the Engineer- in-Charge, who will give special directions as to the manner in which the work is to be performed. All brick work laid during the day, shall, in seasons liable to frost, be properly covered up at night as directed by the Engineer-in-charge.

Should any brick work be damaged by frost, the brick work shall, at the discretion of the Engineer-in-Charge, be pulled down and made good, at the cost of the contractor.

Concrete surfaces of columns, beams, lintels, chajjas etc. coming in contact with masonry work shall beproperly chipped, washed and given a thick coat of cement slurry before start of work. The rate quoted shall include wire brushing and cleaning brickwork covered with fungus or deleterious materials.

Brick work shall be well watered/ cured throughout the day for at least a week from the date of buildingand the work shall be protected from sun and rain.

13.5 HALF BRICK WORK

Materials and workmanship for a half brick or brick on edge partition wall shall be as specified above. The wall shall be stiffened by R.C.C. stiffeners of size 115 mm. wide x 80 mm. thickness to the full length of wall and shall be provided with 2 Nos. 8 mm. diameter HYSD. bars or as specified in the schedule as bottomreinforcement (only the. reinforcement will be paid separately under relevant item). These bars shall be

securely anchored at their end where the partition end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. Overlaps in reinforcement, ifany, shall not be less than 30 cm.

In addition to cost of all materials the rates for brick work shall include the cost of the following

i) Providing and fixing necessary single or double scaffolding and removing the same after thework is completed.
ii) Form work for stiffeners concrete as required.
iii) Watering, curing, lifting of materials to any height.
iv) Raking out of joints to receive plaster.
v) Forming slab sittings, cutting or leaving holes for lugs of windows, doors, sills, switch boxes etc.
vi) Making good all holes, chases, etc. to any depth due to conduit pipes, holdfasts, bolts, switch & plug boxes etc.
vii) Bedding and pointing precast lintels, sills etc. in or on walls.

For the purpose of measurements, the thickness of one brick wall and over shall be taken in terms of multiples of half brick.

13.6 SAMPLING AND TESTS

Samples of bricks shall be subjected to the following mandatory tests
a) Dimensional tolerance b) Water absorption c) Efflorescence d) Compressive strength

Note :
1. Cost of above tests shall be borne by the contractor and the quoted rate shall be inclusive of such testing.
2. Sampling and frequency of test shall be as mentioned under mandatory tests.

13.7 MODE OF MEASUREMENT

13.7.1 Brick Work (230mm.thick or more) measured in Cubic Metres

- The contract rate shall be for a unit of one cubic metre of brick masonry as actually done.
- All openings in brick work for doors, windows and ventilators shall be deducted to get the net quantity of actual brick work done.
- Openings or chases required for P.H. or electrical inserts less than 0.1 sqm. and bearing of precast concrete members shall not be deducted.
- No extra payment shall be made for any extra work involved in making the above openings or placements.

13.7.2 Half Brick Wall: Half brick thick masonry walls shall be measured in sqm. All openings in brick work for doors and windows and ventilators shall be deducted to get the net quantity of actual work done. Openings or

chases required for P.H. or Electric inserts less than 0.1 sqm. and bearing of precast concrete members shall not be deducted. No extra payment shall be made for extra work involved in making the above openings or placements.

14. STONE MASONRY

14.1 SCOPE OF WORK

The work covered under this specification consists of supplying and erecting stone masonry walls with available best quality of stone in strict compliance with this specifications and applicable drawings.

14.2 RANDOM RUBBLE MASONRY

14.2.1 Material: The rubble shall be of the best quality trap/granite/basalt/quartzite stones obtained from the approved quarry. The sample of the stone, to be used shall be got approved from the Engineer-in- Charge. All stones shall, generally, be freshly quarried and shall be sound, dense, hard, free from segregation, cracks, weathered portions and other structural defects or imperfections, tending to off set soundness and strength. The percentage of water absorption shall generally not exceed 5% by weight.

For laterite this percentage shall not exceed 12%. All stones shall be wetted before use. Stones shall beneatly worked to requisite sections and forms and shall have fully dressed beds and joints. At least 50% of the stones shall be 0.015 cum in content when reckoned individually. The length of stones for stone masonry shall not exceed three times the height and the breadth or base shall not be greater than three fourth the thickness of wall, or not less than 15 cm. Stones having sharp edges or round surfaces shall not be used. The height of stone may be upto 30 cm. Stones shall be laid on the natural beds and shall run sufficiently inside the wall thickness. No hollow space shall be left out and inter spaces of stones being filled with mortar and stone chips, driven hard & not with mortar only.

All mortar to be used shall be of the type and proportion mentioned in the item. Cement, sand and water to be used shall conform to their relevant specifications as described under cement concrete. The masonry shall be laid to plumb, lines levels, curves, shapes as shown in drawings. All required holes for passage of water or pipes are to be embedded during construction as specified.

All stones shall be wetted before laying in masonry. Concrete surfaces of columns, beams, lintels, chajjas etc. coming in contact with masonry shall be properly chipped, washed and wetted before start of masonry work. The concrete surface coming in contact of masonry shall be given a thick coat of cement slurry as the masonry work progresses in height. Clean chips and sprawls carefully selected to fit in the space shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints or mortar. However, proper shaping and dressing of stones shall be done prior to their laying in masonry and hammering shall not be resorted to often after the stones are laid in position. The Bond stones/Through stone shall be properly laid into the work (one in every square meter area of masonry wall) and shall extend from front to back to thin walls having width of 600mm and shall overlap by at least 150mm in walls having thickness more than 600mm when laid from both sides. Engineer-in-Charge may permit cement concrete 1:2:4, in-situ / pre-cast, to act as bond stone, as required. Bond stone shall be marked by the contractor with white lead paint. When the work has to be started on the old or the one completed a long while ago or in the previous working seasons, care shall be taken to roughen and clean old surface satisfactorily without disturbing the masonry before laying the new. It shall be wetted before laying the bedding mortar.

When practicable, the whole masonry in any structure shall be carried out upto a uniform level throughout. But when breaks are unavoidable in carrying the work continuously in uniform level, sufficiently long steps shall be left. All junction of walls shall be formed at the time when walls are being built. Cross walls should be carefully bonded into the main walls. All masonry built in cement mortar shall be kept continuously wet for 14 days from the date of laying. Should the mortar perish i.e. becomes dry, white or powder through neglect of watering and if the masonry shows hollow joints or non adherence of mortar to the stones or if the work does not conform to drawings and specifications, the work shall be pulled down and rebuilt by the contractor at his own cost and risk. All masonry shall be thoroughly cleaned and washed down on completion and all stains, adhering mortar removed from the surface and raking of joints carried out as the scaffolding is being lowered and removed. Holes left in masonry for supporting scaffolding shall be filled and made good before pointing/ plastering.

.14.3 RUBBLE (KHANDKI FACING) STONE MASONRY- COURSED

The specifications for Random rubble masonry as described above under 14.2 shall generally apply to these for quality of stones, workmanship etc. except for the following:

The face of the stones shall be hammer dressed on all beds and joints so as to give them square/rectangular block shape in order to set on proper bases and render uniform joints. The stonesmay have bushing projected not more than 40 mm on an exposed face and 10mm on a face to be plastered. The external faces shall be laid in alternate courses of headers and stretchers. The height ofeach course shall not be less than 150mm nor more than 300mm.The quoins stone shall be of the same

height as the course and shall be at least 450mm long and shall be laid stretchers and headers alternatively. Bond stones shall be provided and marked as specified above under 14.2.

The other specifications, mode of measurements etc. shall be same as per specifications for R.R. Masonry mentioned above.

14.4 MODE OF MEASUREMENT

All stone masonry shall be measured in cubic metres as actually done. All openings for windows, doors,lintels etc. shall be deducted to get the net quantity of actual work done. Openings or chases required for P.H. and electrical inserts less than 0.1 sqm. and bearings of precast concrete members shall not be deducted. The rate shall also include cost of corner stones, bond stones, scaffolding, labour, curing etc.

14.4.1 Measurement: The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

14.4.2 Rate: The rate includes the cost of materials and labour

14.5 DRY STONE CLADDING

14.5.1 Material: Stone shall be of the type as specified in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified.

Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of ± 2 mm

Before starting the work, the contractor shall get the samples of stone approved by Engineer-In-Charge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Careshall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used in work.

14.5.2 Stacking and Storing: Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

14.5.3 Scaffolding: Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

14.5.4 Fixing: The size & shape of the cramps shall be as per drawing and as per directions of Engineer- in-charge.

The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge.

The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically alongthe stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints.

Stone shall be secured with clamps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

14.5.5 Jointing: Joints horizontal and vertical shall be filled with weather sealant of make as approved by Engineer-in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant,masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

14.5.6 Protection: Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction involved in all operations described above includingcost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps drilling holes / making recesses in stones which shall be paid for separately.

14.5.7 Measurement: The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shallnot be deducted.

14.5.8 Rate: The rate includes the cost of materials and labour involved in all operations described above including cost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps, anchor fasteners, bolts & nuts, drilling holes / making recesses in stones, which shall be paid for separately.

14.6 STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification for structural frame work for dry stone cladding are same specifications as for steel work inbuilt up sections (welded or bolted).

14.6.1 Fixing of Frame: The properly designed structural frame for withstanding the weight of stone slab are fixed/supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole withcement concrete including provision of necessary centring/ shuttering for holding of concrete. The framecan also be supported on RCC surface with the help of approved expansion hold fastener by drilling theholes in RCC surface. Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

14.6.2 Measurement: The mode of measurement shall be the same, as specified for steel work in built up section except that the weight of welding material shall not be added in weight of members for payment and nothing extra shall be paid for making holes for temporary fastening of members during erection before welding, which also includes cost of cement concrete block, centring and shuttering and making holes in walls,but excluding the cost of expansion fastener, steel clamps which shall be paid for separately.

14.6.3 Rate: The rate shall include the cost of all labour and material involved in all the operation described above.

14.7 ADJUSTABLE STAINLESS STEEL CRAMPS

- The cramps shall be stainless steel of make approved by the Engineer-in-charge.
- The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 gms.
- Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.
- Necessary recessed are required to be done in stone slab which is required to be supported by clamps.
- The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.
- The rate includes cost of materials and other operations mentioned as above.

14.8 STRUCTURAL ALUMINIUM GRID SYSTEM FOR DRY STONE CLADDING

Prefabricated Aluminium extrusions grid system of mullion and transom, of alloy 6063 T6 in anodized finish fixed with SS-316 grade anchor bolts, Hilti clamps of SS-316 and fasteners as per approved design & shop drawing may be provided if specified, for dry stone cladding. The system shall be designed to accommodate surface temperature upto 80 degree Celsius and expansion-contraction resulting from temp. differential of 25 degree Celsius alongwith wind load, dead load and thermal loads.

14.8.1 Measurement: The mode of measurement shall be the same, as specified for aluminium work inbuilt up section on weight basis of aluminium sections used and no separate payment shall be made for anchor fasteners, bolts and nuts, washers etc.

14.8.2 Rate: The rate shall include the cost of all labour and materials involved in all the operations described above.

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15. PRECAST CEMENT CONCRETE SOLID BLOCK MASONRY

15.1 SCOPE OF WORK

The work covered under this specification pertains to procurement of best quality locally available or locally manufactured precast cement concrete solid block and workmanship in building walls of various thickness in strict compliance with the specifications and applicable drawings.

15.2 MATERIAL

Precast cement concrete solid blocks shall be of best quality locally available/ manufactured at site and should be approved by the Engineer-in-Charge before incorporation in the work. Use of recycled aggregates may be permitted with the approval of Engineer-in-Charge. The ingredient and the cement concrete used shall conform to relevant I.S. as stipulated in specification for cement concrete works herein before.

Minimum crushing strength of the solid blocks shall be of M-5 grade. The type of the bond to be adopted will be decided by the Engineer-in-Charge but vertical joints shall be staggered. The size of the blocks shall be 290 x 190 x 100 mm. and 290 x 140 x 100 mm or sizes as available locally and the proportion used in making the blocks shall be minimum 1:11 (1 cement : 11 fine and coarse aggregates) to satisfy the strength requirement . The blocks shall be cured well at least for 14 days before incorporation in to the work. The cement mortar for concrete blocks masonry shall be 1:4 and joints shall not be more than 10 mm. thick.

15.3 WORKMANSHIP AND MODE OF MEASUREMENT

The workmanship and mode of measurement shall be same as stipulated in the specification for brick work. Concrete block masonry 140 mm. thick shall be measured in sqm. upto to two places of decimal. The rate quoted shall include cost of all materials, labour including form work in casting the blocks, curing, transporting, handling, hoisting the blocks to proper level, curing masonry etc. complete.

16. AUTOCLAVED AERATED CONCRETE BLOCK MASONRY WORK

16.1 Terminology

For the purpose of, Autoclave Aerated Concrete Block masonry work, the following definitions shall apply

Autoclaved -Steam curing of concrete Products, sand lime bricks, asbestos cement products, hydrous calcium silicate insulation Products, or cement in an autoclave at maximum ambient temperatures generally between 170^0C to 215^0C.

Block - A concrete masonry unit, any one of the external dimensions of which is greater than the corresponding dimension of a brick as specified in IS: 3952-1978 and of such size and mass as to permit it to be handled by one man. Furthermore, to avoid confusion with slabs and Panels, the height of the block shall not exceed either its length or six times its width.

Block Density - The density calculated by dividing the mass of a block by the overall volume, including holes or cavities and end recesses.

Drying Shrinkage - The difference between the length of specimen which has been immersed in water and then subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen.

Gross Area-The total area occupied by a block on its loading face, including areas of the cavities and end recesses.

Height -The vertical dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying.

Length - The horizontal dimension of the exposed face of a block excluding any tongue or other device designed to provide mechanical keying.

Width -The external dimension of a block at the bedding plane, measured at right angles to the length and height of the block.

16.2 Dimensions & Tolerances:

Autoclave Aerated Concrete Block shall be made in sizes and shapes to fit different concrete needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, partition block and concrete floor units.

Autoclave Aerated Concrete Block shall be referred to by its normal dimension the term 'normal' means that the dimension includes the thickness of the mortar joints. The actual dimension shall be 10mm short of the normal dimension (or 6mm short in special areas finer joints as specified).

The normal dimension of the concrete block shall be as follows: -

Length :400, 500 or 600 mm
Height : 200, 250 or 300 mm
Width : 100, 150, 200 or 250 mm

In addition, Autoclave Aerated Concrete Block shall be manufactured in half length of 200, 250 or 300 mm correspond to the full lengths.

The nominal dimensions of the units are so designed that taking account of the thickness of

mortar joints, they will produce wall length sand heights which will conform to the principles of modular co-ordination.

Block of sizes other than those specified above, may also be used if so specified in the case of special Autoclave Aerated Concrete Block such as jallie or screen wall and ornamental block the specified size may not necessarily apply.

The maximum variation in the length of the Autoclave Aerated Concrete Block shall not be more than plus/minus 5mm and maximum variation in the height and width of Autoclave Aerated Concrete Block, not more than plus/minus 3mm.

The faces of Autoclave Aerated Concrete Block shall be flat & Rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angle to the face of the Blocks.

The Autoclave Aerated Concrete Block with special faces shall be manufactured and supplied if so specified.

16.3 The autoclaved Autoclave Aerated Concrete Block shall be classified in two grades according to their compressive strength as indicated in table:

S. No.	Density in oven dry condition (Kg/m^2)	Compressive Strength (Min)		Thermal Condition in Air dry condition (W/m.k)
		Grade-I (N/mm^2)	Grade-II (N/mm^2)	
1	451 to 550	2.00	1.50	0.21
2	551 to 650	4.00	3.00	0.24
3	651 to 750	5.00	4.00	0.30
4	751 to 850	6.00	5.00	0.37
5	851 to 1000	7.00	6.00	0.42

16.4 Materials

Cement complying with any of the Indian Standard may be used as per the direction of the manufacturer.

Use of Fly ash conforming to IS 3812 may be permitted to a limit of 20% in cement conforming to IS 269.

The lime shall satisfy the requirement for class C lime specified as IS 712.

The aggregate used for the manufacture of Autoclave Aerated Concrete Block shall conform to the following requirements

Sand-Conforming to IS 383 except for the grading which may be made to suit the product and silica content shall not be less than 80%.

Fly ash – Conforming to IS 3812 with loss on ignition not more than 6%.

Water used in the manufacture of Autoclave Aerated Concrete Block shall be free from matter harmful to concrete or reinforcement or matter likely to cause efflorescence in the block and shall meet the requirements of IS 456.

Additives and Admixtures may be added either as additives to the cement during manufacturing or as additive or admixtures to the concrete mix. Additive or admixtures used in

the manufacture of concrete block may be Accelerating, water reducing and air -entraining admixtures conforming to IS 9103.

Water proofing agent conforming to IS 2645.

Colouring pigments

16.5 Physical requirements

All Autoclave Aerated Concrete Block shall be sound, free of cracks or other defects which interfere with the proper placing of block units, impair the strength or performance of the construction. Where block units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections except that if not more than 5% of a consignment contains slight cracks or small chippings not larger than 25mm, this shall not be deemed grounds for rejection.

16.6 Tests

(i) Block Density-The block density shall be determined in the manner described in IS 6441 (Pt-1)

(ii) Compressive Strength- The compressive strength of block shall be determined in accordance with IS 6441 (part-5).

(iii) Thermal Conductivity- The thermal conductivity of block shall be determined in accordance with IS 3346.

(iv) Drying Shrinkages-The drying shrinkage of block shall be determined in the manner described in IS 6441 (Part-2).

16.7 Sampling

Lot - In any consignment, all the blocks of the same size and from the same batch of manufacture shall be grouped together into a minimum number of groups of 10000 blocks or less. Each such group shall constitute a lot.

16.8 Manufacturer's Certificate

The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.

16.9 Measurements: Autoclave Aerated Concrete Block Masonry shall be measured in cubic metres unless otherwise specified.

17 CEMENT CONCRETE FLOORING (IPS)

17.0 SCOPE OF WORK

The work covered under this specification consists of providing and laying at all levels and floors, flooring of different types, strictly in accordance with these specifications and relevant drawings.

17.1 CEMENT CONCRETE FLOORING (INDIAN PATENT STONE)

17.1.1 Materials: The specifications for materials, grading, mixing and the quantity of water to be added shall generally conform to their relevant specifications described under plain and reinforced concrete. The maximum size of coarse aggregate shall be 10 mm. The fine aggregate shall consist of properly graded sand. Concrete shall be mixed

preferably by machine, and hand mixing shall be avoided as far as practicable.

17.1.2 Preparation of Base: The base concrete surface shall be thoroughly chipped to remove laitance, caked mortar, loose sand, dirt etc. cleaned with wire brush and washed clean and watered until no more water is absorbed. Where the base concrete has hardened so much that roughening the surface by wire brushes is not possible, the same shall be roughened by chipping or hacking at close intervals. The surface shall be soaked with water for at least 12 hours and surface water removed and dried before laying the topping. Before laying the concrete, cement slurry at 2.00 kg./ sqm. of surface shall be applied for better bond. Concrete flooring shall then be laid in alternate bays in pattern and joints, wide/ flush as per drawing. The edge of each panel into which the floor is divided shall be supported by woodenor metal strips duly oiled to prevent sticking. The panels shall be of uniform size and, unless otherwise specified, no dimension of panel shall exceed 2 m. and the area of a panel shall not be more than 2.00 sqm. However, the exact size of panel shall be decided by the Engineer-in-Charge to suit the size of the room. The joints in the floor finish shall extend through the borders and skirting/dado. The border shall have mitred joints at the corners of the room. Where glass/ aluminium dividing strips are proposed to be provided, the same shall be fixed over thiyyas of cement mortar 1:2 to form panel of size as specified.

The depth and thickness of dividing strips shall be as specified in the item. In the case of flush joints, alternate panels only may be cast on same day. At least 48 hours shall elapse before the concreting of adjacent bay is commenced.

17.1.3 Mixing: The topping concrete shall be of mix of one part of cement, two parts of sand and 4 partsof well graded stone chips of 10 mm. maximum size. The ingredients shall be thoroughly mixed with just sufficient water to the required plasticity, having water cement ratio not more than 0.4.

17.1.4 Laying: The free water on the surface of the base shall be removed and a coat of cement slurry to the consistency of thick cream shall be brushed on the surface. On this fresh grouted base, the prepared cement concrete shall be laid immediately after mixing. The concrete shall be spread evenly and laid immediately after mixing. The concrete shall be spread and leveled carefully. The concrete shall be completed and brought to the specified levels by means of a heavy straight edge resting on the side forms and down ahead with a sawing motion in combination with a series of lifts and drops alternatively with small lateral shifts, either mechanically or manually as directed by the Engineer-in-Charge.

While concreting the adjacent bays, care shall be taken to ensure that the edges of the previously laid bays are not broken by carelessness or hand tamping. Immediately after laying the concrete, the surface shall be inspected for high or low spots and any needed correction made up by adding or removing the concrete and whole surface is again leveled. When the layer is made even, the surface shall be completed by ramming or beating and then screed to a uniform line and level. Before the initial set commences, the surface shall be trowelled to smooth and even surface free from defects and blemishesand tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly or empty gunny bags spread over the surface of the concrete to absorb excess water coming on top due to floating.

17.1.5 Finishing the Surface: After the concrete has been fully compacted, it shall be finished by trowelling or floating. Finishing operations shall start shortly after the compaction of concrete and shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled intermittently at intervals for several times so as to produce a uniform and hard surface. The satisfactory resistance of floor to wear depends largely upon the care with which trowelling is carried out. The object of trowelling is to produce as hard and close knit a surface as possible. The time interval allowed between successive trowelling is very important. Immediately after laying only just sufficient trowelling shall be done to give a level surface. Excessive trowelling in the earlier stages shall be avoided as this tends to work a layer rich in cement to the surface, some time. After the first trowelling, the duration depending upon the temperature, atmospheric conditions and the rate of setting of cement used, the surface shall be re- trowelled many times at intervals to close any pores in the surface, and to bring to surface and scrap off any excess water in concrete or laitance (it shall not be trowelled back into the topping). The final trowelling shall be done well before the concrete has become too hard but at such a time that considerable pressure is required to make any impression on the surface. Trowelling of rich mix of dry cement and fineaggregate on to the surface shall not be permitted. Trowel marks should not be seen on the finishedsurface.

Where broom finish is specified, after the concrete has been thoroughly compacted, and when most of the surface water has disappeared, the surface shall be given broom finish with an approved type of brassor M.S. fiber. The broom shall be pulled gently over the surface from edge to edge in such a manner that corrugation shall be uniform in width and depth, the depth shall be not more than 1.5 mm. Brooming shall be done when the concrete is in such a condition that the surface will not be torn or unduly roughened by the operation. Coarse or long bristles which cause irregularities or deep corrugation shall be trimmed out. Brooms which are worn or otherwise unsatisfactory shall be discarded.

After the concrete in the bays has set, the joints of the panels should be filled with cement cream and neatly floated smooth or jointed. Care should be taken that just the minimum quantity of cream for joint is used and excess spilling over the already finished surface shall be removed when the cream is still green.
In case of wide joints, the same shall be filled with pigmented cement concrete (1:2:4) using approved pigment and the joint shall be finished in perfectly straight line.

17.1.6 Steel Trowel Finish: Areas where PVC Flooring/ Self leveling Epoxy Flooring are proposed to be used are required to have base concrete finished smooth by steel trowel.

17.1.7 Curing: The completed flooring shall be protected from sun, wind and rain for the first two daysand movement of persons over the floor is prohibited during this period. The finished surface shall becovered and cured continuously form the next day after finishing, at least for a period of 7 days. Bunding with murrum for curing is prohibited as it will leave permanent stain on the finished floor.

Curing shall be done by spreading sand and kept damp throughout the curing period of seven days minimum. The surface shall be protected from any damage to it whatsoever. The surface shall then be allowed to dry slowly. All corners, junctions of floor with plastered wall surface shall be rounded off when required at no extra cost.

17.1.8 Mode of Measurement: The rate for flooring and skirting shall be in square metre of the area covered.

The length and width of the flooring shall be measured net between the faces of skirting or dado or plastered faces of walls which is the proudest.

All openings in flooring exceeding 0.1 sqm. in area where flooring is not done shall be deducted and net areas only shall be measured and paid for. Flooring under dado, skirting or plaster shall not be measured for payment.

Nothing extra shall be paid for laying the floor at different levels in the same room.

The dimensions shall be measured upto two places of decimals of a metre and area worked out upto two places of decimal of a square metre.

18.0 Cement Concrete Flooring with metallic hardener topping; IRONITE (OR HARDONATE) FLOORING

18.1 GENERAL

To withstand heavy wear and tear, concrete flooring with metallic concrete hardening compound suchas Ironite/ hardonate shall be laid as wearing layer as detailed below

18.2 METALLIC CONCRETE HARDENING COMPOUND

The metallic compound shall be Ironite/ Hardonate of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease and soluble alkaline compound.

18.3 CEMENT CONCRETE UNDER LAYER

Cement concrete flooring of specified thickness and mix shall be laid as specified and generally conforming to specifications laid down for cement concrete flooring. The top surface shall be roughenedwith brushes while the concrete is still green and the form shall be kept projecting up 12 mm. over the concrete surfaces, to receive the metallic hardening compound topping.

18.4 METALLIC CONCRETE HARDENER TOPPING

This shall consist of 12mm. thick layer of mix 1:2 (1 part of cement mixed with hardener: 2 parts of stone aggregate of 6 mm. nominal size by volume). The metallic concrete hardener compound being mixed with

cement in the ratio of 1:4 (1 metallic concrete hardener: 4 cement used by weight) or as specified by the manufacturer. Concrete hardener shall be dry mixed thoroughly with cement on a clean dry pucca platform. This dry mixture shall then mixed with stone aggregate 6mm. nominal size or as otherwise specified in the ratio of 1:2 (1 cement mixed with hardener: 2 stone aggregate) by volume, and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete, watercement ratio not exceeding 0.40 .

The mixture so obtained shall be laid in 12mm. thickness, on cement concrete floor within 1 to 4 hours of its laying. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressedinto the bottom concrete so as to have good bond with it. The concrete shall be compacted well mechanically. Manual compaction will not be permitted unless approved by the Engineer-in-charge. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

18.5 CURING, PRECAUTIONS, MEASUREMENTS ETC.

Specifications for curing, precautions, quantity measurements etc. shall be same as specified for cement concrete flooring.

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19. TREMIX VACUUM DE-WATERED CONCRETE FLOORING (MONOLITHIC INDUSTRIAL FLOORING)

19.1 GENERAL

The Tremix Vacuum de-watering method is monolithic Industrial flooring. The advantage of this method is that a plastic and easily workable concrete can be placed with light equipment, and after that great part of the surplus water is extracted from the concrete desirable improvement in quality of concrete is achieved. Through vacuum dewatering process shrinkage is reduced significantly (>50%) as compared to normal concrete and so joint-less bay of larger size is possible.

19.2 Base: Generally base of flooring at ground floor shall be same as described for IPS flooring or other type of flooring i.e. sub-base PCC above rubble/brick soling of specified thickness over well compacted plinth filling. A separation layer of plastic sheet (125micron expanded polythene foam sheet), if specified, is

placed over for protection against humidity and water which also act as a sliding layer to prevent floor concrete from sticking to sub base in order to avoid cracking.

19.3 Installations: The position of trenches and pipes for services such as water and drainage, heating, electric supply and telephones etc. must be fixed before floor concreting starts.

19.4 Floor concrete: Floor concrete shall be of M20 grade or as specified.

19.5 Floor Thickness: Floor concrete thickness generally shall be 200mm or as specified.

19.6 Joints: Expansion/contraction/dummy(working) joints shall be as per drawing and/or as directed by Engineer-in Charge.

19.7 Reinforcement: Reinforcement shall be provided as per drawing. Reinforcement at the interface of expansion joint shall also be provided as shown in drawing. Measurement and payment of reinforcementsteel shall be as per relevant item of work.

19.8 Placement method: Vacuum dewatered concrete should be made according to standard DIN 1045. Normally flooring shall be done forming bays of size not exceeding 6.0mx4.5m. Concrete of specified strength and workability is spread in specified thickness along the stretch of two parallel slotted
M.S. channels acting as formwork placed approx.3.0 to 4.0m apart and well compacted using Tremix surface vibrator of suitable length. After compaction surplus excess water is sucked out placing filler padconsisting of two layers on wet concrete. The bottom layer of filler pad in contact with concrete is fine nylon cloth to act as filter whereas the upper layer consist of a special type of plastic net which acts as a waterduct. The suction mat (filler pad) is attached to suction pump through suction hose(vacuum de-wateringsystem).Vacuuming time is approx. 1 to 2 minutes per centimeter thickness of concrete. The aim is to reduce initial w/c ratio by 10 to 15% and this also makes concrete denser through static compaction. Care should be taken to ensure that optimum water required for

hydration reaction must be there in concrete during vacuum treatment of concrete. The surface then shall be troweled with the help of power troweling floater to get neat finish .If specified in item chemical hardener @ specified quantity per unit area is spread while power troweling in progress, to get hard top wearing surface. The same process is repeated in alternate stretches of concrete bay of specified size. Provisions of Dummy or working joints shall dependon daily normal concrete production. Construction/ Contraction joints upto 1/4th of floor thickness and of width(4mm to 6mm) are cut using mechanical saw afterwards and filled with suitable sealants.

19.9 Mode of measurement: The measurement shall be on area basis of flooring in which length andbread are measured upto two decimal place of a meter. The rate to include cost of all materials, labour, equipments involved in operations described above but excluding the cost of reinforcement steel and sealants which shall be paid separately.

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20. SELF LEVELING EPOXY FLOORING

20.1 General: Self leveling Epoxy flooring is a seamless, aesthetic, hard wearing and highly durableflooring system suitable for both commercial as well as industrial flooring.

Floors in factories, workshops, warehouses, garages, abattoirs, hospitals etc. are constantly exposed toheavy mechanical wear (e.g. friction, impact etc.) and chemical damage from thinned, inorganic and organic acids, alkalis, petroleum products, waste, oil etc. The final surface on such floors needs to haveconsiderable mechanical and chemical strength as well as being easy to clean. Industrial floors made from concrete, even those made with surface hardener and mechanical grinding do not usually meet the above requirements (e.g. they do not resist chemical effects from acids, get dusty etc). Self-leveling Epoxy

flooring of specified thickness (2 to 3mm) over such substrate / floor surface meets all the requirementssuch as high abrasion/ impact resistance, chemical resistance, ease to clean and also can be renderedwith aesthetic finish as specified in case of institutional/commercial building.

20.2 Materials

20.2.1 Epoxy: Epoxy shall be of two components(packs)system consisting of (a)Resin and (b)Hardener of approved manufacturers brought to site in sealed containers and mixed in pre-determined proportion as specified or as per manufacturer's specification.

20.2.2 Epoxy Primer: Epoxy primer shall be of same approved Epoxy manufacturer for better compatibility.

20.2.3 Screed/Quartz Sand: Screed/Quartz sand shall be of size 0.4mm down(Q35) or as specified.

20.3 Application

20.3.1 Surface/Substrate Preparation: The surface on which epoxy is to be applied, must be dry (<4% moisture) and stable, free of dust, loose particles, grease, etc. and protected from underneath moisture attack. The substrate must be properly prepared, e.g. by grinding, sand blasting etc., in order to open the pores to allow penetration of the primer and ensure better anchoring and bonding of the epoxy coating. Subsequently, the surface should be carefully cleaned with a high suction vacuum cleaner.

20.3.2 Application

i) On the prepared surface Epoxy primer of approved make is uniformly applied to ensure better anchoring and bonding of epoxy coating at the rate as per manufacturer's specification.

ii) Once the primer is dry, any imperfections in the surface (cracks, holes) should be filled with fine quartz mixed with epoxy primer.

iii) Application of self-leveling epoxy flooring, should take place after priming, but within 24 hours. The two packs epoxy system (Resin + Hardener) shall be mixed in predetermined proportion as specified or as per manufacturer's specification. Hardener is poured into resin in small quantity and stirred well for uniform dispersion of hardener

and the process is repeated to get uniform mix of specified proportion. Subsequently, quartz sand with particle-size 0-0,4 mm (or Q35) is gradually added into the mixture under continuous stirring, in proportion 1:2 by weight (epoxy resin +hardener: sand), until a uniform epoxy mortar is formed. Epoxy mortar is applied by being spread with a notched trowel at a thickness of 2 to 3 mm or as specified to get a smooth final surface. To remove any air trapped in the self-leveling layer, the surface should be gone over with a special spiked roller. This inhibits the formation of bubbles. The epoxy flooring should be protected from moisture for a period of 6 hours after application.

To get a slip-resistant final surface the still fresh coating is then sprinkled with quartz sand of required grade to get desired degree of slip-resistant. After the surface is hardened, loose grains are removed with high suction vacuum cleaner. A coat of epoxy is applied afterwards as a sealing coat.

iv) If the item specifies, a finishing coat with polyurethane of approved colour and shade of approved manufacturer shall be applied on the epoxy floor.

20.4 Rate: Rate shall include cost of all materials, wastages, labours, tools etc. involved in all operations described above.

20.5 Mode of Measurement: Mode of measurement shall be same as flooring item on area basis inSqM. upto two decimal of places.

21. RAISED ACCESS FLOORING (FALSE FLOORING)

21.1 General: A raised access floor is used to provide a means of creating a void below floor level which is capable of ensuring building services are available at their required destination. These services will typically include electrical power, data cables, telecom, air-conditioning, fire detection, security, water and drainage etc. as per functional requirements. The use of raised access floor also allow quick and easy access to these services for maintenance reasons.

21.2 Key Components and Material: The key components of a raised access flooring system are

21.2.1 Floor Panel: This is the horizontal load bearing component of a raised floor. It is normally 600mm*600mm square (industry standard module size) fabricated out of press hollow CRCA sheet infilled with cementitious fillers either bare finished top surface to receive a carpet tile or with a factory bonded finish such as anti static vinyl, high pressure plain/decorative laminates etc. to suit the functional application as specified in item. If specified, the Floor panels can also be made of steel-clad particleboard with top surface finish as mentioned above.

21.2.2 Pedestal: Pedestals are gridded metal framework of adjustable height supports to floor panels.This is the complete vertical, adjustable supporting structure to the raised floor panels. The pedestals are normally bonded to the sub floor using a epoxy resin based adhesive with mechanical fixings also providedif required. The pedestal assembly provides vertical adjustment of 1½" to allow the raised floor to be installed flat and level despite undulations in the sub floor. The pedestal head provides panel location and also when required a means of fixing the panel to the pedestal head.

The height of the legs/pedestals is dictated by the volume of cables and other services provided beneath. The height of raised access floor from finished floor level shall generally be not less than150mm.For height of raised floor more than 600mm. additional care shall be taken for grid/framework design.

21.2.3 Stringer: This is a horizontal component that connects pedestals together. It connects to the pedestal head and is used to provide additional lateral support at greater floor height and/or increase the structural performance of the raised floor system. Stringers can be „snap on" or „bolt on" stringers as per site requirement. Perimeter stringers shall be provided if required, as an additional support to cut panelsalong perimeters.

Note:

i) The raised access floor system shall be designed and tested for the uniform distributed load(U.D.L) and Point Load as specified in item. Generally, the commonly fabricated False flooring systems by leading manufacturer are for capacity as (a)1080kg/m^2UDL and 360kg point load, (b)1350kg/m^2UDL and 450kg point load & (c)1680kg/m^2 and 560kg point load.

ii) The complete false flooring system shall be of specialized manufacturer and shall be got approved by Engineer-in Charge before procurement.

21.3 Laying/Installations: The complete raised access floor system (of specified capacity) as described above shall be installed by the specialized/skilled workers under the guidance of approved manufacturerand as per approved design. The sub floor beneath shall be structurally sound and surface shall be flat and in clean condition.

The Tolerance in level of top finish surface of raised floor shall not be more than ±1.5mm. The installed flooring system shall be tested for load capacity as per standard practice of testing.

21.4 Rate & Mode of Measurement: The rate shall include cost of all materials including wastages, labours, equipments, installation, testing etc. involved in the work. The mode of measurement shall be on the area basis in Sqm upto two decimal places. There shall be no deductions for sleeves/ cut-outs(upto 0.2Sq.m) in false flooring. Also, nothing extra shall be paid for making any additional arrangement for such sleeves/cut-outs.

GENERAL NOTE FOR ALL STONE/TILING WORKS

Where the size of flooring stone / tiles and height of risers, skirting or dado does not admit full size of other finished size tiles, the tile(s) are to be cut / sawn to the required size and nothing extra shallbe paid for the same.

22. KOTAH STONE WORK IN FLOORING/ SKIRTING/ FACIA / SHELVES / RISER / TREADS

22.1 MATERIALS

The stone shall be hard, sound, durable, homogeneous in texture and resistant to wear. These shall be without any soft veins, cracks or flaws and shall have uniform colour. They shall have natural surface free from broken flakes on top. Hand cut/ machine cut for exposed edges and machine polished. Kotah stoneshall be of the best quality and of the specified thickness, size and the shade, which shall be got approved by the Engineer-in-charge.

The slabs / tiles shall be rectangular or square in shape or as per pattern shown in drawing and as directed by the Engineer-in-charge. The sizes given in schedule of quantities are tentative and can vary only slightlyas per the availability in the market. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40mm as specified in the item. Tolerance of (±) 2 mm shall be allowed for the thickness. In respect of length & width, tolerance in length & width shall be permissible upto (±) 5 mm for hand cut slabs & (±) 2 mm formachine cut slabs.

Uniformity of size and colour / shade shall generally be maintained for the stones used in any one room.The exposed surface shall be machine polished to a smooth, even and true plane and the edges hand cut and dressed true and squares. The evenness of the surface of slabs and edges of the slab shall not be marred by careless dressing or handling and no patching up shall be allowed for the slab. The edges shall be quite straight. The under face may be left as required or rough dressed. Before taking up the work, samples of stone slabs to be used and their dressing and polishing shall be got approved by the Engineer- in-charge and kept in his office as approved sample and the stone slabs to be used shall conform to thesame.

22.2 BEDDING/ BACKING COAT

In case of flooring / skirting / dado, the mortar bedding / backing shall be of cement mortar of thicknessand mix specified in the schedule of work.

22.3 CEMENT MORTAR

Cement mortar bedding shall be as specified under relevant specification for flooring work.

22.4 CONSTRUCTION DETAILS

Cement mortar as specified for bedding shall be uniformly mixed. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall betaken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the stones. Before spreading the mortar, the sub-floor or base shall be cleaned of all dirt, setmortar scum or laitance and of loose materials by hacking and brought to original levels and then well wetted without forming pool

of water on surfaces.

22.5 FIXING THE STONE SLAB/ TILE

Before laying, the stone shall be thoroughly wetted with clean water, neat cement grout (2.75 kg/ sqm.)of honey like consistency shall be spread on the mortar bed over as much areas as could be covered with the slabs within half an hour. The specified type of stone shall be laid on the neat cement float and

shall be evenly and firmly bedded to the required level and slope in the mortar bed. Each stone shall begently tapped with wooden mallet till it is firmly and properly bedded.

There shall be no hollows left. If there is a hollow sound on gently tapping off the slab, such slab shall beremoved and reset properly. The joints shall be grouted with matching cement slurry. Approved pigment shall be used in cement slurry to match with shade of stone. Pigment required to match the shade of stone shall be supplied by the contractor at no extra cost. The stone adjoining the wall shall go about 12mm. under the plaster, skirting or dado for the wall. All stone slabs, tiles shall be so laid as to have continuous lines from various rooms to the corridors. No change of lines shall be permitted at junction between rooms and corridors. Only one-piece machine cut, Kotah stone shall be used for treads and risers, unless otherwise specified in the tender schedule.

22.6 CURING

The work shall be kept well wetted with damp sand or water for seven days.

22.7 POLISHING AND CLEANING

22.7.1 The stone polishing process in general consists of following steps

22.7.1.1 **Grinding:** This method is a very aggressive approach to refinishing stone. It uses a metal- bonded and diamond grit heavy weighted floor buffer to remove deep scratches and lippage (Lippage is a condition where one edge of a stone is higher than adjacent edges, giving the finished surface an uneven appearance). The objective of grinding is to flatten the floor and make it dust free.

22.7.1.2 **Honing:** Honing process follows the grinding process. This process is less aggressive approach than grinding. Although similar to grinding, the materials and grits used are not as coarse as they are used for the grinding process. If the stone surface to be polished is having minor to moderate scratches and etch marks, the process of floor finishing may start with honing and skip the grinding phase. This method shares the same objective as grinding, ending with a flat floor.

22.7.1.3 **Polishing:** After the honing phase, a higher grit and sometimes combinations of higher grit compounds are used to bring out a shine in stone during this process.

22.7.2 **Method:** When the bedding and joints have completely set and attained required strength, the surface shall be machine polished to give smooth, even and true plane to the flooring. All flooring shall be thoroughly cleaned and handed over free from any mortar stains etc. The floor shall then be kept wet for a minimum period of 7 days.

The polishing shall be carried out using polishing machine fitted with high performance resin bonded diamond tools/pads starting with coarser grit pad then medium grit pad, fine grit pad and very fine grit pad in that sequence to get the required polished surface.

The surface shall be ground evenly with machine fitted with coarse grade diamond grit pad (grit size. 100). Water shall be used profusely with grinding. After grinding, the surface shall be thoroughly washed, remove all grindings, mud cleaned and mopped, and the joints opened out during grinding shall be grouted once again wherever necessary with matching cement. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with grit pad (grit size200) and shall be grouted again the opened out joints with matching cement. The process is repeated using medium grit(size400) and then with fine grit diamond pad (Grit 800) for normal shine polish finish .For mirror polished finish(i.e. high gloss finish) the process of polishing is carried out using very fine grit pad/ tool (grit size 1500). After the final polish, oxalic acid crystals powder(or other approved floor

polishing chemical) shall be dusted over the surface (@ 32.5 gm. per m^2, sprinkled water and rubbed hard with Namdah block (pad of woolen rags). The following day the floor shall be wiped with a moist rag and dried with a soft

cloth and finished clean. If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

For small areas or where circumstances so required, hand polishing using smaller size grit pads of medium to fine grit grades may be permitted in lieu of machine polishing after laying, entirely at the discretion of the Engineer-in-charge.

In all other respects, the process shall be similar as for machine polishing. The finished floor shall not sound hollow when tapped with a wooden mallet.

22.8 SKIRTING AND DADO/ FACIA

The quality and type of stone shall be same as mentioned for flooring except of their height and thickness or backing coat which shall be as mentioned in item schedule. The backing shall conform to the specifications for cement mortar specified for item. Contractor should take into consideration the fact that touching up of the plaster at the junction of skirting / dado is invariably done after the skirting/ dado/ facia work is completed and quote rates accordingly. Nothing extra for the same shall be entertained.

The skirting tiles shall be true in plane, line, level and plumb or in slope. The vertical lines of skirting tilesshould be in line with that of flooring tile lines. The colour of the skirting tile and floor tile shall match. The undone portion of plaster work left above the skirting work shall be finished round or as directed by the Engineer-in-charge in the matching plaster. The item of plastering shall be inclusive of this plaster finishing above the skirting tiles, required to be done after laying of skirting tiles. No additional payment will be admissible for this extra operation.

Polishing may be done by hand, but a smooth surface and fine polishing shall be obtained as specified.Joints shall be finished in neat matching cement slurry. The junction of plaster and the upper edges of the dado/ skirting shall be finished smoothly as directed by the Engineer-in-charge without any extra cost.

22.9 MODE OF MEASUREMENTS

The length and / or width of the flooring / skirting / dado shall be measured net between the faces of skirting or dado or plaster faces of walls which is the proudest, and height of skirting / dado shall be measured from the finished level of floor. All openings exceeding 0.1 sqm. in area where tiling is not done shall be deducted and net areas only shall be measured and paid for. Flooring under dado, skirting or plaster shall not be measured for payment. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room.

All dimensions shall be measured correct upto 2 places of decimal of a meter and area so worked out shall be correct upto two places of decimal of a sqm. for flooring, skirting, dado etc.

Note: Wastage in tile cutting to get the required dimension of rooms etc. as specified in drawing or as directed by the Engineer-in-charge shall have to be taken into consideration by contractor while quoting the rate for work to be measured as above. No extra claim on this account will be entertained.

22.10 TANDUR STONE / CUDDAPPA STONE / POLISHED SHAHABAD STONE / BLUE WADI STONE FLOORING / SKIRTING / DADO

The specifications for these items shall be similar to those for Kotah stone as above.

23. MARBLE STONE FLOORING, TREADS, RISERS, SILLS, CLADDING, DADO ETC

23.1 MARBLE STONE SLABS

The colour and quality of marble slabs shall be of the kind of marble specified in item/drawings/as directed by the Engineer-in-charge. The marble from which the slabs are made, shall be of selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. Before starting the work, the contractor shall get the samples of marble slabs approved by the Engineer-in-charge. All slabs which goes into work shall strictly conform to the samples, failing which the entire materials are likely to be rejected.

The slabs shall be machine polished and machine cut to the dimensions specified in items of schedules of quantities/drawings and as directed by the Engineer-in-charge.

23.2 DRESSING OF SLABS

Every stone shall be cut to the required size and shape, fine dressed on all sides to the full depth so that a straight edge laid along the side of the stone is full in contact with it. The top surface shall also be fine dressed to remove all waviness. The top surface of slabs shall be machine polished and exposed edges machine cut, or as specified in the item and as directed by the Engineer-in-charge. All visible angles and edges of the slabs shall be true, square or as required, and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be 25 mm. or as specified in the description of item. The minimum size of stone to be used for various items shall be as mentioned in the schedule of quantities/drawings of this tender. Marble stones of approved smaller sizes other than mentioned in the schedule of quantities, if required for bands, borders, flooring etc. shall be provided and laid as directed by the Engineer-in-charge.

Any opening of required size and shape at any desired place in flooring, bands, borders etc. shall be made in such a way that marble bounded by number of marble stones/slabs. No broken or defaced stone shall be permitted in the work.

23.3 BEDDING/BACKING MORTAR

The bedding/backing shall be of cement mortar/lime mortar of mix and thickness as specified in the description of the item.

23.3.1 Mixing: The mixing of mortar shall be done in mechanical mixer or hand mixing as specified/as directed by the Engineer-in-Charge.

23.3.1.1 **Mixing in Mechanical Mixer:** Cement and sand in the specified proportion shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste.

Only the quantity of mortar, which can be used within 30 minutes of its mixing shall be prepared at a time. Mixer shall be cleaned with water each time, before suspending the work.

23.3.1.2 **Hand Mixing:** If approved by Engineer-in-Charge, hand mixing shall be allowed. The measured quantity of sand shall be levelled on clean masonry platform and cement bags emptied ontop. In hand mixing, the quantity of cement shall be increased by 5% over the approved constant, with no extra cost to the Department. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture gives an uniform colour. The quantity or dry mix which can be used within 30 minutes shall then be mixed on masonry through with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

23.3.1.3 General : Mortar shall be used as soon as possible after mixing and before it has begun to set, and in any case within 30 minutes after the water is added to the dry mixture. Mortar unused for more than 30 minutes shall be rejected and removed from the site of work immediately.

23.4 LAYING - FLOORING

Before laying the cement mortar bedding/backing, the concrete/brick, floor/wall surfaces shall be thoroughly hacked, cleaned of all mortar scales, concrete lumps etc., brushed, washed with water to remove mud, dirt etc. from the surface and shall be thoroughly wetted. Until and unless the surface is approved by the Engineer-in-Charge, the flooring shall not be started. A bedding of cement mortar of 20 mm. average thickness with the minimum thickness at any place under the slab not less than 13mm. shall be laid evenly and to the required slopes as directed. The marble slabs shall be thoroughly washed and cleaned and then be laid on the bedding/ backing with cement floating at the rate of 4.39 kg./sqm. All slabs shall be truly and evenly set in a thick cement slurry or paste like consistency applied to the sides and bottom and over the prepared base. The slabs shall then be tamped down with a wooden mallet until they are exactly in true plane and line with adjacent slabs. All slabs shall be extended upto the unplastered surface of masonry walls/RCC columns/RCC walls. The slabs shall be close jointed in matching cement slurry and the cement slurry coming out through the thin joints shall be immediately wiped clean. The grains of marble stone shall be matched as shown in drawing or as directed by the Engineer-in-Charge. All slabs shall be so laid as to have continuous lines from various rooms to the corridors. No change of lines shall be permitted at junction between rooms and corridor, if the same flooring is specified in both the places.

23.5 MARBLE SILLS, TREADS ETC.

Marble stone for sills shall be of approved quality. Dressing of stone slab, mortar mix. for bedding/backing, laying etc. shall be similar to as described above as far as applicable. Marble slabs of specified thickness and width shall only be provided. The length of the each slab required for the sill shall be of the pattern which shall coincide with the lines of the mullions of windows where it is laid or as directed by the Engineer-in-Charge. Normally it shall not be less than 1.0 m. length.

23.6 MARBLE STONE DADO & CLADDING

Only machine cut and machine polished marble stone shall be used. Brass cramps and brass pins of approved quality, size and make shall be provided. The brass pins shall be provided at the meeting of two marble slabs both ways horizontally and vertically. The brass cramps shall be provided at theplaces approved by the Engineer-in-Charge. Marble to be used shall be of approved size, colour, type of veins and laid as specified in schedule of quantities or to the pattern shown in drawings or as directed by the Engineer-in-Charge. Laying of marble stone shall be similar as stated above as far as applicable. Allexposed edges shall be moulded as specified / shown in drawing and polished to match with the adjoining surfaces.

23.7 POLISHING AND FINISHING

Slight unevenness at the meeting edges of slabs shall be removed by fine chiseling and finished in the same manner as specified under kotah stone polishing works

23.8 MEASUREMENT

Marble stone flooring, sills, treads, risers, dado cladding etc. shall be measured in square metre correct to two places of decimal. The length and breadth shall be measured between the finished faces correct to two places of decimal of metre. No deduction shall be made nor extra paid for any opening of area upto 0.05 sqm. Nothing extra shall be paid for working at different levels.

Note: Wastage in marble slab cutting to get the required dimensions, as specified in drawing or asdirected by the Engineer-in-Charge shall be deemed to be considered by the contractor while

quoting the rate for work. The work shall be measured as above and no extra claim will be entertained on this account.

23.9 RATE

The rate shall include the cost of all materials, transport tools, plants, scaffolding and labour involved in all operations described above.

23.10 MIRROR POLISHED GRANITE STONE FLOORING, TREADS, RISERS, SILLS, CLADDING,

DADO

Specification for mirror polished granite stone in flooring, dado, cladding, treads, risers, sills etc. shall besimilar to marble specification except polishing as pre-mirror polished granite is used in work. In case ofexposed edge, edge polishing/edge moldings shall be done at site by skilled stone polisher as specified/shown in drawing and polished to match with the adjoining surface.

FLAMED FINISH GRANITE STONE FLOORING: - The process is often referred to as a "flamed" or "thermal" finish and can be best described as creating a textured look. To achieve the style, an intense flame is held at the stone's wet surface. While firing it, the surface becomes so hot it bursts and a layer flakes away to reveal a rough, even texture. It is especially used at a location of high importance to have a great finish for designs requiring a modern aesthetic.

Note: Agency has to procure stone slab of specified thickness and sizes only. However, a tolerance in thickness of all types of natural stones upto ± 2mm may be accepted considering market availability by Engineer-in-Charge.

23.11 MODE OF MEASUREMENT AND RATE

Same as described for marble work.

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24. PRESSED CERAMIC TILE FLOORING/SKIRTING/DADO (INCLUDING VITRIFIEDTILES)

24.1 PRESSED CERAMIC TILES

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat and true to shape and free from blisters, cracks, crazing, spots, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630 (various parts). Definition, Classificationand Characteristics of pressed ceramic tiles shall be as per IS 13712. Sampling and basis for acceptance shall be in accordance with IS 13630 (Part-15). Shapes, Sizes & Requirements of tiles shall be as under

24.1.1 Wall Tiles: Wall tiles for Skirting/Dado/Facia etc. shall conform to IS 15622, having water absorption E >10% (Group B-III).

24.1.2. Floor Tiles: Floor tiles shall be as specified below:

24.1.2.1 Ceramic tiles: Tiles conforming to IS 15622, having water absorption 3%<E ≤ 6% (Group B-II).

24.1.2.2 Vitrified tiles: Tiles conforming to IS 15622, having water absorption E ≤ 0.08% (Group B-I).

24.2 PREPARATION OF SURFACE AND LAYING OF TILES FOR FLOORING

24.2.1 Preparation of Surface: Base concrete or the RCC slab on which the tiles are to be laid shall becleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:6 (1 cement : 6 sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thicknessunder any portion of the tiles shall not be less than 10 mm.

Mortar shall be spread, tamped and corrected to proper slope and levels. Over this mortar bedding neatgrey cement slurry of honey like consistency shall be spread @ 3.3 kg of cement/sqm. over an area uptoone square metre and combed using suitable combing trowel, to receive tiles. Tiles shall be soaked in water, washed clean and shall be fixed on the prepared mortar bed one after another following the arrowmark on back of the tiles. Each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit therequired pattern, unless specified use of specific spacers. After tiles have been laid, surplus cement slurry shall be cleaned off.

The surface of the flooring during laying shall be frequently checked with a straight edge of about 2m long, so as to obtain a true surface with the required slope. In bath, toilet, W.C., kitchen and balcony/verandahflooring, suitable tile drop or as shown in drawing shall be given in addition to required slope to avoid spread of water.

Where full size tiles cannot be fixed, these shall be cut/sawn to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

24.2.2 Pointing and Finishing: The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment as required to match the colour of tiles. Where tiles spacer lugs are provided, the half the depth of joint shall be filled with cement grout and the remaining top half of the jointshall be filled with approved tile grouting compound or as specified without the lugs remaining exposed. After necessary curing, the finished surface shall be washed and cleaned. The finished floor shall not sound hollow when tapped with a wooden mallet.

24.2.3 Measurements: Length and breadth shall be measured correct to a cm between Skirting / Dadoand the area calculated in square metre correct to two places of decimal. No deduction shall be made nor extra paid for voids/opening of areas less than 0.10 square metre.

24.2.4 Rate: The rate for flooring shall include the cost of all materials and labour involved in all the operations described above unless otherwise specified in the item. Nothing extra shall be paid for cutting of the tiles to required size to suit the site condition and/or to complete the work as per the drawings.

24.3 PREPARATION OF SURFACE AND CLADDING OF TILES FOR SKIRTING/DADO ETC.

24.3.1 Preparation of Surfaces: The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before commencing the work.

24.3.2 Cladding: 12 mm thick plaster of cement mortar 1:4 (1 cement : 4 sand) mix or as specified shall be applied and roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement paste applied fully at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd/cut size of tile shall be adjusted at bottom to take care of slope of the flooring.

Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed, these shall becut/sawn to the required size and their edges rubbed smooth. Skirting/dado shall not project from the finished "surface of wall" by more than the tile thickness; undulations if any shall be adjusted in wall.

24.3.3 Finishing & Curing: The joints shall be cleaned off the grey cement grout with wire/coir brush ortrowel to a depth of 2 to 3 mm and all dust and loose mortar removed. Joints shall then be filled with white cement added with pigments as required to match the colour of tiles. After necessary curing, the surfaceshall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

24.3.4 Measurements: Length shall be measured correct to a cm. Height shall be measured correct to acm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in squaremetre, correct to two places of decimal. Length and height shall be measured along the finished face of the

skirting or dado including curves where specials such as coves, internal and external angles and beads are used.

Where cornices are used, the area of dado shall be measured excluding the cornices. Nothing extra shall be paid for cutting of the tiles to required size to suit the site condition and/or to complete the work as perthe drawings.

24.3.5 Rates: The rate shall include the cost of all material, labour, cement mortar backing coat, part cutting of tiles, bevelling of tiles at corner joints (if specified in the item) and all the operations described above, unless otherwise specified. The specials such as designer borders, coves, internal and external angles and beading shall be measured and paid for separately.

24.4 FIXING OF TILE FLOORING USING QUICK SET TILE ADHESIVE

When tile flooring is to be laid over the existing flooring without dismantling old flooring, it can be laid with adhesive. Process shall be as under:

24.4.1 Surface Preparation: The old flooring shall be thoroughly checked for hollowness if any. Hollow sounding tiles shall be dismantled and the gap shall be filled with CC 1:2:4 correct to the existing floor level. Final surface of the floor shall be cleaned off all dirt, dust, mortar splashes, greasy materials etc. and level checked. Undulations, if any, shall be rectified with tile adhesive.

24.4.2 Fixing of Tiles: High polymer modified quick set approved tile adhesive (conforming to IS 15477)shall be thoroughly mixed as per Manufacturer's specifications. It shall be prepared in such limited quantities so that it can be used within 1.5 to 2 hours. It shall be spread over the prepared surface to getuniform top level for an area not more than one sqm at one time, keeping 3 mm average thickness of theadhesive. The adhesive so spreaded shall be combed using suitable combing trowel. Tiles shall be pressed firmly into the position with slight twisting action checking it simultaneously to ensure good contact gently being tapped with wooden mallet till it is properly backed with adjoining tile following the arrow mark on back of the tiles. The tiles shall be fixed within 20 minutes of application of adhesive. The surplus adhesive from the joints and surface of the tiles shall be immediately clean.

The adhesives is classified into 5 types:

Type 1 Adhesive: - This adhesive is suitable mainly for tiles with apparent porosity greater than 3 percent. It is suitable for most of the clay and ceramic (non-vitrified) tiles of small dimension (size not more than 300 mm x 300 mm) and the majority of cement-based backgrounds (substrates) like cement plaster, cement concrete, cement screed, etc, and for interior dry area applications only.

Type 2 Adhesive: - This adhesive is suitable mainly for tiles with an apparent porosity less than or equal to 3 percent. It is suitable for vitrified/fully vitrified tiles, glass mosaic tiles, all stones, dense and large dimension (More than 300 mm × 300 mm size) tiles and stones (slabs), and where background and location is more demanding like wet areas, submerged areas, etc. This type of adhesive is recommended for both interior floor and wall applications, and for exterior floor applications.

Type 3 Adhesive:- This adhesive is suitable mainly for tiles and stone tiles on exterior wall substrates like plaster or concrete. It is suitable for tiles like ceramic, clay tiles, basalt tiles vitrified, glass mosaic tiles and porcelain tiles and all-natural stone tiles.

Type 4 Adhesive:- This adhesive is suitable mainly for tiles and stone tiles which are included in Type 1, Type 2 and Type 3 but intended for installation on dry wall board substrates. It is suitable for all types of tiles and stones except metal tiles or engineered stones to be installed on dry wall board substrates like gypsum boards, plywood, wood, calcium silicate boards, medium density fibre boards, fiber cement boards, cement boards, bison panel, etc.

Type 5 Adhesive:- This adhesive is suitable for all types of tiles including engineered stones (manufactured stones) which are intended for installation on glass or metallic substrates like, grid iron, mild steel, stainless steel, aluminum or copper, etc. It is suitable for metal tiles, glass tiles, engineered stones or for all types of tiles and stones to be installed on different cement-based substrates like cement screeds, plaster, concrete, drywall boards like gypsum boards, plywood, wood, metals composite boards, modified backer boards and the metallic substrates.

The surface of the flooring shall be frequently checked during laying with straight edge of about 2m long so as to attain a true surface with required slope. Where spacer lugs tiles are provided these shall be filled with grout without lugs remaining exposed.

Where full size tile cannot be fixed, these shall be cut/sawn to the required size, and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall/concrete surface shall abutt the vertical surface.

24.4.3 Finishing / Measurements / Rates: Specifications as per Pressed Ceramic Tile Flooring / Skirting / Dado / Facia etc., as above shall apply mutatis-mutandis. Quoted rates shall include rectification of existing floor undulations, levelling concrete, additional thickness of tile adhesive etc. Nothing extra shall be payable for the excess consumption of tile adhesive, if any, over theoretical requirement.

24.5 ACID OR ALKALI RESISTANT TILES

24.5.1 Manufacture and Finish: The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100^0C and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to shape, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall be conforming to IS 4457-2007. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity shall be as per IS 4457.

24.5.2 Dimensions and Tolerances: Ceramic unglazed vitreous acid-resistant tiles shall be as specified in the Schedule of items. The thickness shall be as per approved manufacturer"s specifications or as specified in the Schedule of items conforming to relevant standards. The depth of the grooves on the underside of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be +2 percent.

24.5.3 Shape: The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed tobetween the purchaser and the manufacturer. Tiles shall be checked for squareness and warp as per IS4457-2007.

24.5.4 Performance Requirements: The tiles when tested in accordance with method given in IS 4457,shall conform to be requirement specified in the code.

24.5.5 Loss in Abrasion: The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

24.5.6 Marking: Tiles shall be legibly marked on the back with the name of the manufacturer or his trademark, manufacturer"s batch number and year of manufacture. Each tile may also be marked with the ISIcertification mark.

24.5.7 Preparation of Surface and Laying: Preparation of surface and laying shall be as mentioned in preceding previous 22.2.1 and 22.2.2 except the bedding used to be acid and or alkali resistant epoxy mortar(5to8mm) over a bed of bitumastic compound(8to10mm) over two coats of acid resistant bitumastic primer as specified and approved by Engineer-in-Charge. Thickness of backing of mortar for dado/skirting to be 12 mm or specified on item.

24.5.8 Pointing and Finishing: As per Para 22.2.2 except that mortar/grout used for pointing to be acidand or alkali resistant as specified.

24.5.9 Measurements/Rates: Same as per Pressed Ceramic Tile Flooring / Skirting / Dado / Fascia etc.,as mentioned above. Quoted rates shall include rectification of existing floor undulations, leveling concrete, additional thickness of tile adhesive etc. Nothing extra shall be payable for the excess consumption of tile adhesive, if any, over theoretical requirement. The rate shall include the cost of all materials and labor involved in all the operations described above. Nothing extra shall be paid for cutting of the tiles to required size to suit the site condition and/or to complete the work as per the drawings.

Note: The above Specification for surface preparation, bedding and laying holds good for flooring using

natural acid resistant stone of **Red Mandana** of specified size and thickness.

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25 PVC SHEET / TILES FLOORING

25.1 P.V.C

Flooring material gives a resilient and non-porous surface which can be easily cleaned with a wet cloth as dust and grime do not penetrate the surface. Since a burning cigarette will damage the neat surface of the PVC sheet, special care should be taken to prevent burning cigarette stumps to come in contact with thePVC flooring materials. It shall be laid on a base that is finished even and smooth such as concrete, metal or timber boarding. Unevenness or undulations in the base will show badly on the surface and are liable to damage the P.V.C sheet / tiles.

25.2 MATERIALS

The PVC flooring material shall conform IS : 3462. It may be in the form of tiles, sheets or rolls as specified. It shall consist a thoroughly blended composition of thermoplastic binder, filler and pigments.

The thermoplastic binder shall consist substantially of one or both of a) Vinyl chloride polymer and b) Vinyl chloride copolymer The polymetric material shall be compounded with suitable plasticizers and stabilizers.

PVC flooring material shall be of approved manufacturer and shall be any of the following types meetingthe required specification:

(i) Acoustic / Flexible compact (reinforced with glass fiber grid layer with RD quartz crystal chips) PVC vinyl flooring sheets/tile with high abrasion and scratch resistant properties having anti bacterial and anti fungi quality.

(ii) Homogeneous (single-layer composition which increase s scratch-resistance) PVC sheet/tile

(iii) Hetrogeneous multi-layer PVC vinyl flooring sheet/tile,

(iv) Antistatic & Conductive PVC sheet/tile: These are specialty PVC floorings used at operation theatres, clinics, computer/server rooms, electronic manufacturing facilities, supermarkets, schools public offices, and commercial offices where static electricity needs to be avoided. Anti-Static sheet material is designed to reduce the buildup of static electricity that is created when objects and people come in contact with the material. Flat clear anti-static sheet material is formulated to have a surface that is more resistant to static electricity, this means that a 5000-volt charge would be dissipated to effectively zero in less than ¼ of asecond when in contact with anti-static PVC.

All of the above products of approved manufacturer shall be tested and certified as per relevant standard codes as directed by the EIC.

25.2.1 Thickness: The preferred thickness of PVC tiles for normal floor covering shall be 1.5, 2.0, 2.5, 3.0 or 4.0 mm. Thickness of PVC sheets shall be measured with micrometer or Ratchet type or a dial gaugegraduated to 0.02 mm. The micrometer shall have flat bearing surfaces of at least 6.5 mm diameter at both contact points.

For sheets and rolls the thickness of the specimen shall be measured at twenty scattered points.

For polystyrene wall tiles, the cavity depth of the test specimen shall be measured at five pointstaken at random on the rear surface of each tile with a suitable depth gauge.

25.2.2 Size: The width of flooring sheets and rolling in continuous length shall be 1000, 1500 and 2000 mm. When supplied in rolls the length of the rolls shall not be less than 10 metre. The measurement shall be carried out with a travelling microscope or suitable scale graduated to 0.02 mm. Each tile shall be measured for length and width at the three quarter point in each direction.

25.2.3 Tolerance: Tolerance limits shall be as given in the Table 23.1

Table 23.1: Tolerance Limits

(a)	In Thickness	± 0.15 mm
(b)	In Width as under	

(i)	300 mm square tiles	± 0.2mm
(ii)	600 mm square tiles	± 0.4mm
(iii)	900 mm square tiles	± 0.6mm
(iv)	Sheets and rolls	± 0.1 per cent

25.2.4 **Adhesive:** Rubber based adhesives are suitable for fixing PVC flooring over concrete, wooden and metal sub-floors. PVA based adhesives shall be used for concrete and wooden sub floors. PVA based adhesives are not suitable for metallic surfaces and also for locations where there is constant spillage ofwater.

25.3 PREPARATION OF SUB-FLOORS

Before laying PVC sheets / tiles, it is essential to ensure that the base is thoroughly dry and damp proof as evaporation of moisture can not take place once the PVC flooring is laid. Moisture slowly damages the adhesive resulting in PVC sheet / tiles being separated from the base and curled up. In case of new work

a period of 4 to 8 weeks shall be allowed for drying the sub-floor under normal conditions. Concrete sub-floors on the ground floor shall be laid in two layers. The top of the lower layer of concrete shall be painted with two coats of A-90 grade (conforming to IS: 1580) applied at the rate of 1.5 kg/sqm. The top surface of the lower layer shall be finished smooth while laying the concrete so that the bitumen can be applied uniformly. The bitumen shall be applied after the concrete has set and is sufficiently hard. Bitumen felt conforming to IS : 1322 shall be sandwiched in the sub-floor laid in two layers.

In new concrete floor, the smooth finish required shall be produced by using cement slurry spread on fresh concrete floor and finished smooth. If the concrete floor is old and surface not even, the surface should be made smooth by first cleaning it free of all foreign material and then a layer of cement mortar 1:2 of average thickness of 6 mm shall be applied on the surface finishing the surface smooth. The finished surface shall be cured for 7 days and then allowed to dry thoroughly. Alternatively, if specified, small undulations may be rectified with plaster of Paris.

Where it is expected that the dampness may find its way from the surrounding walls, the same shall alsobe effectively damp-proofed upto atleast 150 mm above the level of the sub-floor and the damp proof treatment below the floor shall be extended over the walls.

25.4 LAYING AND FIXING

Prior to laying, the flooring tiles / rolls / sheets shall be brought to the temperature of the area in which it is to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours.

Where air-conditioning is installed, the flooring shall not be laid on the sub-floor until the conditioning units have been in operation for at least seven days. During this period the temperature shall neither fall below 20^{O}C nor exceed 30^{0}C. These conditions shall be maintained during laying and for 48 hours, thereafter.

Before commencing the laying operations, the sub-floor shall be examined for evenness and dryness. The sub-floor shall then be cleaned with a dry cloth. The PVC flooring shall not be laid on a sub-floor unlessthe sub-floor is perfectly dry. Dryness of the sub-floor shall be tested conforming to relevant IS codes and manufacturers recommendations as directed by the Engineer-in-Charge.

The layout of the PVC flooring on the sub-floor to be covered should be marked with guidelines. The PVC flooring shall be first laid for trial, without using the adhesive, according to the required layout.

The adhesive shall be applied by using a notched trowel to the sub-floor and to the back side of the PVCsheet tile flooring. When set sufficiently for laying, the adhesive will be sticky to touch, but will not mark the fingers. In general, the adhesive will require about half an hour for setting. It should not be left after setting for too long a period as the adhesive properties will be lost owing to dust films and other causes.

Care should be taken while laying the flooring under high humidity conditions so that condensation doesnot take

place of the adhesive. It is preferable to avoid laying under high humidity conditions.

The area of adhesive to be spread at one time on the sub-floor depends entirely upon local circumstances. In case of a small room, adhesive may be spread over the entire area but relatively small areas of tiles/sheets flooring should be treated in a larger room.

When the adhesive is just tack free the PVC flooring sheet shall be carefully taken and placed in positionfrom one end onwards slowly so that the air will be completely squeezed out between the sheet and thebackground surface. After laying the sheet in position, it shall be pressed with suitable roller weighing about 5 kg to develop proper contract with the sub-floor. The next sheet with its back side applied with the adhesive shall be `[laid edge to edge] with the sheet already laid and fixed in exactly the same manner as the first sheet was fixed. The sheets shall be laid edge to edge so that there is minimum gap between joints.

The alignment should be checked after laying of each row of sheet is completed. If the alignment is notperfect, the sheets may be trimmed by using a straight edge.

The tiles shall be fixed in exactly the same manner as for the sheets. It is preferable to start laying of thetiles from the centre of the area. Care should be taken that the tiles are laid close to each other with minimum gap between joints. The tiles should always be lowered in position and pressed firmly on to the adhesive. Care should be taken not to slide them as this may result in adhesive being squeeze up between the joints. PVC tiles after laying shall be rolled with a light wooden roller weighing about 5 kg to ensure full contact with the under layer. Any undulations noticed on the PVC surface shall be rectified by removingand relaying the tiles after thorough cleaning of the underside of the affected tiles. The adhesives applied earlier in such places shall be thoroughly removed by using proper solvents and the surface shall be cleaned to remove the traces of solvents used. Work should be constantly checked against guidelines in order to ensure that all the four edges of adjacent tiles meet accurately.

Any adhesive which may squeeze up between sheets or tiles should be wiped off immediately with a wetcloth before the adhesive hardens. If, by chance, adhesive dries up and hardens on the surface of the sheet or tile, it should be removed with a suitable solvent. A solution of one part of commercial butyleacetate and three parts of turpentine oil is a suitable solvent for the purpose.

A minimum period of 24 hours shall be given after laying the flooring for developing proper bond of the adhesive. During this period, the flooring shall not be put to service. It is preferable to lay the PVC flooring after completion of plastering, painting and other decorative finish works so as to avoid any accidental damage to the flooring.

When the flooring has been securely, fixed, it shall be cleaned with a wet cloth soaked in warm soap solution (two spoons of soap in 5 litres of warm water).

When the edges of the PVC sheets or tiles are exposed, as for example, in doorways and on stair treads, it is important to provide protection against damage of flooring materials. Metallic edge strips may be usedand should be securely fastened to the sub floor to protect edges of the flooring.

25.5 PRECAUTION FOR MAINTENANCE

PVC flooring subject to normal usage may be kept clean by mopping with soap solution using a clean damp cloth. Water shall not be poured on the PVC flooring for cleaning purpose as the water may tend to seep through the joints and cause the adhesive to fail. To maintain a good wearing surface a good appearance, the flooring may be periodically polished. When polish is applied frequently, a thick layer builds up which collects dirt and dust and is tacky to walk on.

If the traffic is light, the floor shall be given frequent brushing regular polishing by an application of new polish every 4 to 6 weeks. Under moderate traffic conditions the floor shall be given an occasional washwith a wet mop but no detergents shall be used so that the polish is not removed.

Application of polish may be done every one to three weeks. PVC flooring should not be over waxed. When this condition develops, the coatings should be cleared off with white spirit or paraffin and a light even coat of polish applied. When the PVC flooring has been polished, it will remain bright for a considerable period if dry mop is

applied each day. It is this daily `dry polish` that maintains the glossy surface. After exceptionally heavy traffic PVC flooring should be swept with a hair broom, rubbed with a mop or cloth frequently rinsed in clean water and finally rubbed dry.

25.6 MEASUREMENTS

Length and breadth shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm. Nothing extra shall be paid for providing PVC flooring in borders and margins, irrespective of their width.

25.7 RATE

The rate shall include the cost of all materials and labour involved in all the operations described above,except those described under "Precaution for Maintenance". The rate does not include the cost of sub floor or damp proof treatment if any. It also does not include the cost of metallic edge strip to protect edge of flooring, wherever provided, it shall be paid separately.

25.8 PVC ASBESTOS FLOOR TILES

Material, Dimensions and Tolerance, colour and finish, physical requirements and test shall be as per IS:3461 and the rest shall be as per specification for "PVC Sheet / Tile Flooring" as described above.
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26. CHEQUERED CEMENT TILE FLOORING

26.1 Chequered Cement Tiles

The tiles shall be of nominal sizes such as 20 × 20 cm, 25 × 25 cm and 30 × 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in- Charge. The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm.The overall thickness of the tiles shall not be less than 30 mm. The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered tiles shall be cement tiles, or as specified in the description of the item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm. The tiles shall conform to the specifications for plain cement concrete or in respect of method of manufacture and the mix of the backing and wearing layers.

26.2 CHEQUERED TILES IN STAIR TREADS: - The length of the tiles including nosing shall be as specified. The nosing edge of the tile shall be rounded. The minimum thickness of the tile shall be 30 mm or as specified in item. The front portion of the tile for a minimum length of 75 mm from and including the nosing shall have grooves running parallel to the nosing and at centres not exceeding 25 mm. Beyond that the tiles shall have the normal chequer pattern. The nosing shall also have the same wearing layer as the top.

26.3 Laying, curing and Finishing shall be as specified in flooring work except that the polishing of the tiles. Cement concrete tiles normally do not require polishing but where polishing is required the same shall be done as per specifications.

26.4 Measurement and Rate: Length shall be measured correct to a cm. Height shall be measured correct to acm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in squaremetre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used, the area of dado shall be measured excluding the cornices. Nothing extra shall be paid for cutting of the tiles to required size to suit the site condition and/or to complete the work as per the drawings. The rate shall include the cost of all materials and labour involved in all the operations described above.

Nothing extra shall be payable for cutting the tiles to suit the size of treads and also for nosing.

27. WOODEN FLOORING

27.1 SEASONING AND PRESERVATION

All timber used for timber floors shall be thoroughly seasoned in accordance with IS : 1141. After seasoning, the timber shall be treated with preservative in accordance with IS : 401. Seasoning and preservative treatment shall not be paid for separately and the rate quoted for the item shall be inclusive of the same.

27.2 SUPPORTING JOISTS

Main beams and joists of the class of wood sections specified in the description of the item for beams and joists, or as instructed by the Engineer-in-charge shall be fixed in position to dead levels. The width of the joints shall not be less than 50 mm. The arrangement and spacing of beams, joists etc. shall be as perdesign furnished.

27.3 BOARDS

It shall be of the class of timber and thickness specified in the description of the item. The timber shall be as specified in the succeeding chapter for wood work. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall be maintained throughout exceptwhere the width of the room is not an exact multiple of the boards. In the latter case, the difference shallbe equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planing shall be paid for extra. Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the square butt type and shalloccur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

27.4 IRON SCREWS

Iron screws shall be of the slotted counter sunk head type, of length not less than the thickness of planksplus 25 mm subject to a minimum of 40 mm,an of designation of No.9 conforming to IS :451.

27.5 FIXING

The joists on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully joined and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zigzag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strips shall be paid for extra. The flooring shall be truly level and plane. The joints shall be truly parallel and orperpendicular to the walls, unless otherwise specified. The floor shall be planed in both directions and made perfectly even, true and smooth.

NOTE : No wood of any kind shall be placed within 60 cm of any fire place or flue. Provision shall be made for ventilating the space below the floor in case of ground floor and between and top of ceiling in the case of upper floors. Such arrangements shall be paid for separately.

27.6 FINISHING

The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer-in-charge. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid separately unless specifically included in description of the flooring item.

27.7 MEASUREMENTS

Length and breadth of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in SqM correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 SqM. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 SqM.

27.8 RATE

The rate shall include the cost of labour and materials involved in all the operations described above, with the exceptions noted in the relevant sub paras.

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28 WOOD WORK IN FRAMES, SHUTTERS AND PANELLING

28.1 WOOD WORK

All timber mentioned in the item in schedule of quantities shall be from the heart of a sound tree of nature growth mostly free from sap wood. It shall be uniform in texture, straight in fiber and shall be well and properly seasoned. It will be free from decay ,fungal growth, boxes heart, pitch pockets or streaks on the exposed edges, splits and cracks, and all other defects or any other damages of harmful nature which will affect the strength, durability, appearance and its usefulness for the purpose for which it is required. Only properly seasoned timber shall be used.

28.2 TEAK WOOD

28.2.1 **Superior Class Teak Wood such as Balarsha, Malabar and Dandeli :** Individual hard and soundknot shall not be more than 12 mm in diameter and the aggregate area of all the knots shall not exceed one half per cent of the area of the piece. It shall be close grained.

28.2.2 **First Class Teak Wood:** Individual hard and sound knot shall not be more than 25mm in diameter and aggregate area of all knots shall not exceed one percent of the area of the piece. Sapwood shall notbe allowed.

28.2.3 **Second Class Teak Wood:** Individual hard and sound knot shall not be more than 40 mm in diameter and aggregate area of all knots shall not exceed one and half percent of the area of the piece. Wood shall be generally free from sapwood, but traces of sapwood may be allowed.

28.3 HARD WOOD (SALWOOD, BABUL ETC.)

Sal is about 30 per cent heavier than teak, 50 per cent harder, and about 20 to 30 per cent stronger. In shock resistance it is about 45 per cent above teak. Its heart wood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period, while its sapwood is very perishableand should not be used. Well dried sal is not a really easy wood to saw and work. It is a rough constructional wood than a carpentry timber. No individual hard and sound knot shall exceed 25mm in diameter and the aggregate area of all the knots shall not exceed 1% of the area of the piece. Sapwood is very perishable and should not be used.

It can be used for a variety of purposes, such as for beams, rafters, flooring, piles, bridging, tool handles,picker arms and tent pegs, etc.

28.4 SEASONING OF TIMBER

Control on moisture content of timber is necessary to ensure its proper utility in various climatic conditions. The process of drying timber under controlled conditions is called seasoning of timber. Timber shall be either air seasoned or kiln seasoned and in both cases moisture content of the seasoned timber shall meet the specified

percentage relevant to the climatic zones. Kiln seasoning of timber, where specified, shall be done as per IS 1141 in a plant approved by Engineer-in-Charge.

28.5 PRESERVATION OF TIMBER

Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers and marine organisms. Preservative treatment, where specified, shall be done using Oil type, Organic solvent type or Water-soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned. All surfaces exposed after treatment, except due to planing, shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401-2001 in a plant approved by the Engineer-in- Charge and samples shall be tested for presence of preservatives as per IS2753-1991.

The samples of species to be used shall be deposited by the contractor with the Engineer-in-Charge before commencement of the work. The contractor shall produce cash vouchers and certificate from standard kiln seasoning plant operator about the timber section to be used on the work having been kiln seasoned by them, failing which it would not be so accepted as kiln seasoned. Seasoning of timber shallbe judged from its moisture content as laid down in I.S. 287. The seasoning of timber shall conform to I.S.1141-1993. Scantling of all types of timber shall be straight. Warped scantling shall not be used. Before use in works, the scantling shall be kept in covered and well-ventilated place and shall be got approved.

The workmanship shall be of best quality. All wrought timber is to be sawn, planed, drilled or otherwise machine worked to the correct sizes and shall be as indicated in drawing or as specified. All joinery workshall fit truly and without wedging or filling. Wood work in frames shall be wrought. All frame joints shall be put together with white lead and pinned with hard wood pins securing with corrosion resistant star shaped metal pins as approved by the Engineer-in-charge. If after fixing in position, any shrinking or substandard materials or bad workmanship is detected, the contractor shall, forthwith remove them and replace the same at his own cost, all as directed by the Engineer-in-charge.

Individual members shall be of continuous length. The finished size and sections shall be as per drawing or as specified. The heads and posts of frames shall be through tennoned into the mortises to the full widths as shown in the drawing. All necessary mortising, tennoning, grooving, matching, tonguing, housing rebate and other necessary works for correct jointing shall be carried out, in the best workmanship like manner. Joints not specifically indicated shall be recognized form of approved joints for each position. The door frames shall be provided with 6 nos. approved iron hold fasts, fabricated out of 30 x 3 mm. section, 300 mm. long (150 mm. long for cross partitions) M.S. flats with spliced end in casethey are abutting brick masonry works. These M.S. hold fasts shall be embedded in plain cement concrete 1:3:6 block of size 300 x 75 mm. depth (100 x 75 mm. for cross partitions) and for full width ofbrick masonry. For frames abutting concrete surfaces, 6 nos., 100 mm. long coach screws with sunk heads inimum 10 mm. from face of frames, shall be provided. Each screw shall be secured in concretewith lead wool sufficiently stuffed in the pre-drilled holes to receive the screws. Top member of door frames for opening exceeding 1.25 m. in width, shall be secured with a coach screw 100 mm. long in centre of member. All other T.W. scantlings shall be fixed to structural openings with wood screws of suitable size & rawl plug so as to get in effective hold of at least 40 mm. Suitable teak wood plugs shall be provided to conceal the screw heads. The door frame shall rest on concrete sub- base in ground floor or structural floor slab in case of upper floors, the extra length of sides of frames thus embedded below finished floors shall not be measured for payment. All parts of wood work resting on or set in masonry or concrete shall be well painted with two coats of bituminous paint or solignum as directed by the Engineer-in-charge, prior to installations. All nails, screws, hold fasts, plates, plugs, pins required for wood work joinery and fixing work, shall be provided by the contractor, at his own cost. All materials shall be approved by Engineer-in-charge before using in works.

Painting of door frames and shutters (paneled, flush door, block board, plywood) shall be carried out asper specifications for painting for wood work.

All the embedded timber shall be given two coats of hot tar or solignum before erection. This is incidental to the item and shall not be measured for payment.

28.6 TEAK WOOD PANEL DOOR SHUTTERS

Teak wood door shutter shall generally conform to standard laid in I.S. 1003 (Part1)-2003 or the latest revision for requirements of materials, construction workmanship and shall be of specified thickness and of specified class teak wood of approved design with stiles, top, bottom and lock rail generally as per drawing. Wherever shown, each teak panel shall be in a single width piece, but when two or more pieces have to be used and are permitted, all of them shall be of equal width and shall be jointed with a tongue and groove joint with chamfered edges glued together and reinforced with metal dowels. Adhesive used for bonding stiles, rails, panels etc. shall be BWP type synthetic resin confirming to IS 848

The shutters shall be single-leaf or double leaved paneled door shutter as specified and shown in the drawings. In case of double leaved shutters, the meeting of the stiles shall be rebated by one third the thickness of the shutter. The rebating shall be either splayed or square type as shown in drawing.

28.6.1 Teak Wood Timber Paneled Shutters: Timber panels shall be preferably made of timber of larger width. The minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be designed such that no single panel exceeds 0.5 square metre in area.

28.6.2 Teakwood Plywood Panel Shutters: The specifications for teak wood panelled shutter shall generally apply to Plywood panel shutters for frame, stiles etc.

Plywood boards used for panelling of shutters shall be Marine Ply grade (IS:710) or BWR grade (IS:303)as specified . Each panels shall be a single piece of thickness, 9 mm for two or more panel construction

and 12 mm thickness for single panel construction unless otherwise specified. Adhesive used for bonding stiles, rails, panels etc. shall be BWP type synthetic resin confirming to IS 848

28.6.3Teakwood Particle Board Panel Shutter: Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocellulose i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall beflat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087. Adhesives used for bonding shall be BWP type synthetic resin conforming to IS 848.

Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for boards uptoand including 25 mm thick and ± 2.5 per cent for boards above 25 mm thickness. Each board shall be ofuniform thickness.

28.6.4 Pre-laminated Particle Board Panel Shutter: Prelaminated particle boards are available in two grades namely Grade I and II as per IS 12823. Each grade is further classified in four types; namely Type - I, II, III, IV. For pre-laminated particle board panel shutters, particle board prelaminated particle board Grade-1 (FPT-I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and prelaminated conforming to IS 12823 Grade-I, type II or I shall be used. Tolerance in thickness shall be ± 5%.

28.6.5 Teak Wood Glazed Shutters: The specifications for teak wood panelled shutter shall generally apply to glazed shutters for frame, stiles etc. The sash and beading required for glazing shall be of the best teak wood and shall be fixed as per the design shown in relevant drawing. Any mouldings, carvings shown shall be worked out from the teak wood member of bigger size.

28.6.6 Glazing: Glazing shall be generally with 4 mm. thick plain float glass/bajra glass unless otherwise mentioned in the schedule of quantities. The detailed specifications for glazing given hereafter shall be followed generally.

28.6.7 Finish: Adhesive used for bonding stiles, rails etc. shall be BWP type synthetic resin confirming to IS 848. Panels of shutters shall be flat and well sanded to a smooth and level surface.

28.6.8 Beading: Beadings in panelled shutter shall be provided where specified in architectural drawings or directed by the Engineer-in-Charge. Each length of beading shall be single piece. Joints at the corners shall be mitred and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

28.6.9 Machine/Factory Made Shutters: Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without anypriming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

29. FLUSH DOOR SHUTTERS

Solid core flush door shutters shall be of 5 ply construction and approved make generally conforming to the I.S. specification 2202-1991 (specification for wooden flush door shutter- solid core type). The finished thickness of the shutter shall be as mentioned in the schedule of items.

29.1 FACE VENEERS

Commercial face veneers used in flush door shutter shall conform to the requirements laid down in I.S. 303 -1989 specifications for ply wood for general purposes (revised) interior grade.

Decorative face veneers used in flush door shutters shall be of grade - I and shall conform to the requirements of decorative veneer specified for grade - I decorative ply wood in I.S. 1328 - 1982 specifications for veneered decorative ply wood interior grade. Thickness of veneers shall not exceed 1 mm.

29.2 ADHESIVES

Phenol formaldehyde synthetic resin (liquid type adhesives) conforming to I.S. 848 specifications for synthetic resins shall be used for bonding.

29.3 LIPPING

Lipping, where specified, shall be provided internally on all edges of the shutters. Internal lipping alroundshall be done with single piece battens of best quality hardwood or teakwood as specified of depth not less than 25 mm and width equal to the thickness of core. For double leaved shutters, depth of the lipping atmeeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping. Thickness of external lipping, wherever specified in the item, shall not be more than 10mm and not less than 6mm.

29.4 REBATING

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm..

29.5 WORKMANSHIP AND FINISH

All the faces of the door shutter shall be at right angles. The shutter shall be free from twist and warp in its plane. Both faces of the door shutters shall be sanded to a smooth even texture. The workmanship and finish of the face panels shall be in conformity with those specified in I.S. 303 - 1989 specification for plywood for general purpose (revised) for commercial type and I.S. 1659 - 1990 specification for block boards for decorative type.

29.6 TESTS

Tests shall be conducted as per mandatory test requirement, by the Department at contractors cost and acceptance criteria shall be as per I.S. 2202. The flush door shutters manufactured shall be inspected for its quality and workmanship and tested at the factory before dispatching. All facilities shall be extended for such inspection and testing. The sampling and testing shall be as per the IS requirements and all costs towards test including sample for destructive tests shall be borne by the contractor.

29.7 TOLERANCE

Tolerance on nominal width and height shall be (±) 3 mm. Tolerance on nominal thickness shall be (±)1.5mm.

The thickness of the individual shutter shall be uniform throughout.

29.8 MISCELLANEOUS

Wherever mentioned in the Schedule of quantities, vision panels, venetians, plastic laminates, pushplates etc. shall be provided in the flush doors.

The vision panels shall be of size mentioned in the drawing and shall be provided with teak wood lipping all around the glass. The glass shall be float glass of thickness 4 mm or as specified.
Teak wood venetians or louvers shall generally conform to relevant specifications of timber. Necessary grooves and rebate in frames shall be provided as per drawing.

Approved plastic laminate of required design, required shade and colour and specified thickness shall be provided and fixed on flush door to the required size on any side of the shutter as shown in drawing. It shall be fixed with Fevicol or any other approved adhesive. Fixing shall be done in such a way that there shall not be any air gap, warpage or undulations on the surface. Finished surface of plastic laminate shall be cleaned with wax polish.

The shutters shall be painted on commercial facing side with two coats of synthetic/flat oil paint of approved shade and make over an approved coat of primer. The decorative veneer side of the shutter shall be wax or french polished with two or more coats so as to render a satisfactory surface.

The flush doors shall be single leaf or double leaf type as mentioned in the schedule of quantities. In case of double leaf shutters, the meeting of the stiles shall be rebated 20 mm. and shall be either splayed or square type and the T.W. lipping around the meeting shall not be less than 35 mm. deep. The meeting stiles shall be in single piece.

Sufficient care shall be taken to prevent any damage and loss of shape during handling, transporting, stacking, fixing etc. The door shutters shall be handled with utmost care to prevent any surface damage, warping etc.

29.9 FIXING

For side hung shutters of height upto 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Fittings shall be fixed as per schedule of fittings as specified.

29.10 MODE OF MEASUREMENT

The work covered under the respective items in schedule and the above specifications shall be measured as follows

The cubic contents for wood work shall be measured for the finished size, limiting to those shown in the drawings or ordered by the Engineer-in-charge. The cross sectional dimensions shall be measured equivalent to nearest enclosing rectangle (least rectangle/square) for wrought and planed sizes. The cubical content shall be worked out correct upto three places of decimals of a cubic metre. The frames embedded below finished floor shall not be measured.

The square meter areas for shutters shall be measured for the exposed surfaces of shutter between frames from inside or outside whichever is more. The linear dimensions shall be measured upto two places of decimals of a metre. The area for payment shall be worked out correct upto two places of decimals of a square metre. The rate for shutters shall include:

(i) Cost of supply assembly and erecting in position.

(ii) Cost of polishing, painting, supplying wood preservative, screws, nails, hold fasts etc.

(iii) Cost of labour for making adjustments in frames, if required, shutters and also for fixing required fittings and fixtures.

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30. PRESSED STEEL DOOR FRAME

30.1 SCOPE OF WORK

This specification lays down the requirements regarding material, dimensions and construction of steel door frames for internal and external use.

30.2 MATERIAL

Steel door frames shall be manufactured from commercial mild steel sheets of 1.25 mm. or as specified. Thickness shall conform to I.S. 513 (cold rolled sheets) or I.S. 1079 (hot rolled sheet). Steel door framescan also be manufactured from Plain grade Galvanised Sheets of 1.25mm or specified thickness with zinc coating of class VIII (120 g/m^2) as per IS 277 - 2003 or stainless steel sheets of 1.00mm or specified thickness (Grade 430 or 304S1) as per IS:6911.

30.2.1 Standard sizes, Tolerances and Designations: Steel door frames (M.S, G.I and S.S) shall conform to IS 4351-2003.

30.2.1.1 Sizes: The overall sizes and types of door frames shall be as shown in drawings. 5 mm. clearance on all the four sides shall be allowed for the purpose of fitting the frame into modular openings.

30.2.1.2 Tolerances: The sizes indicated in drawings for door frames shall not vary by more than (±) 2mm.

30.3 PROFILE

Steel door frames with or without fanlight shall be made in the profile as per I.S. 4351 (latest version) asper drawings. Any of the five profiles mentioned in I.S. 4351 or sizes specified in the schedule of work may be supplied to suit doors of either hand, opening inwards or outwards, as specified or directed.

30.4 CONSTRUCTION

Each door frame shall consist of hinge jamb, lock jamb, head and, if required, angle threshold. The whole shall be rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit.

30.5 BASE TIES AND ANGLE THRESHOLDS

Base ties shall be of pressed mild steel angle of size 20x20x1.25 mm. thick adjustable to suit floor thickness of 25, 30, 35 or 40 mm. and removable, or alternatively, thresholds of mild steel angle of section 50 x 25 mm., minimum, shall be provided for external door frames.

30.6 FITTINGS

30.6.1 Fixing Lugs: There shall be three adjustable lugs with split end tail to each jamb without fanlight,and four for jamb with fanlight. The head of the fixing lug shall be of 120 mm. long and shall be made from flat steel strip 25 mm. wide and not less than 1.60 mm. thick. The tail of the lugs for use with door frame profile shall be 200 mm. long and shall be made of steel stripnot less than 40 mm. wide and not less than 1.0 mm. thick.

30.6.2 Mortar Guards: Mortar guards of thickness of main frame sheet shall be provided in accordance to provisions of IS 4351 and as instructed by Engineer-in-charge shall be provided. These shall be welded to the frame at the head of the frame for double shutter doors to make provision for bolts. These shall also be provided to the frame behind the hinges, mortice locks and latches, slots, aldrop and sliding /tower bolts.

Note: The term „double-shutter doors" indicates „Pairs of side-hung doors", that is, two side-hung doors mounted in one frame thus forming a two-leaf door rebated together at the lock strike.

30.6.3 Lock Strike Plate: There shall be an adjustable lock-strike plate of steel, complete with mortar guard, to make provision for locks or latches complying with the relevant Indian Standards. Lock-strike plates may be of brass when so specified in the tender; otherwise they shall be of galvanised mild steel and fixed at 75 cm. to 90 cm. from finished floor level.

Shock Absorbers: For side-hung door, there shall not be less than three buffers of rubber or other suitable material inserted in holes in the rebate and one shall be located on the centre line of the lock-strike plateand the other two at least 45 cm. above and below the centre line of the lock-strike plate. For double- shutter doors, there shall be two buffers of rubber or similar suitable material inserted in holes in the rebate in the lock jamb only at the head and spaced 15 cm. at either side of the centre line of the door.

30.7 MODE OF MEASUREMENTS

The length shall be measured in running metres correct to a cm. out to out of the frames. Threshold angle/base tie will not be measured for payment, cost of which shall be included in pressed steel frame.

31. GYPBOARD/CALCIUM SILICATE PARTITION

31.1 MATERIALS

(i) Gypsum Board conforming to IS 2095 (Pt.-I)
(ii) Non asbestos multi-purpose cement board conforming to IS 14862
(iii) Tapered edge calcium silicate board

Tapered Edge Calcium Silicate Board are manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminum or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

31.2 INSTALLATION

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and as directed by Engineer-in-Charge.

31.3 JOINTING & FINISHING

Joints of the boards are finished with specially formulated Jointing compound and fibre tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hardlaminates. Services should be incorporated before commencement of board fixing.

31.4 FITTING AND FIXTURES

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement.

31.5 TOLERANCE

Tolerance in dimensions shall be ± 5 mm.

31.6 MEASUREMENTS

Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shallbe calculated in square meter correct to two places of decimal. No deduction will be made of openings ofareas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved informing such openings.For openings exceeding 0.40 sqm. in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such openings.

31.7 RATE

The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc. described.

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32. FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES AND SHUTTERS

32.1 SCOPE

The specification for Glass Fibre Reinforced Plastic (GRP) Panel Type Door frame and Shutters shall generally

conforming to IS 14856 and other associated IS Codes as regards to types, sizes, material, construction, workmanship, finish, performance requirements and sampling etc. for use in residential and industrial buildings, except the large size door shutters for industrial and special buildings like workshops, garages, godowns, etc.

32.2 REFERENCES

The above cited IS 14856 shall be referred with its associated codes.

32.3 TERMINOLOGY

Aggregate Defects: Presence of impurities such as pin holes, impurities and traces of mending more than5 each or 5 in aggregate for defects at localized place.

Blistering: Air or solvent entrapped during moulding.

Colour Blots: Colour blots occurring on account of uneven distribution of colouring material.

Crazing: Fine hair cracks on the surface.

Defective Impregnation: Imperfect impregnation of glass fibre with unsaturated polyester resin.

Gelcoat: A gelcoat of UV stabilized, fire retardant, isophthalic quality mixed with 15 percent by weight, aerosil powder (500 micron ground silica) suitably formulated to high viscosity given to exposed exteriorsections of the moulded door shutter to provide a smooth glossy finish, enhance aesthetics and improveweathering and water resistant properties of the moulded door shutter. The thickness of the coat shall bebetween 0.35 to 0.40 mm.

Impurities: Foreign matter present, other than specified.

Laminate: A reinforced resin sheet or moulding.

Pin Holes: Pores of size less than 1mm appearing on the surface. **Small Pores:** Pores of size more than 1mm appearing on the surface.**Wrinkle:** A slight ridge or furrow on surface.
Base Block: A wooden or suitable material provided within the door/shutter frame to facilitate fixing offittings and other accessories.

RTM Process: Resin Transfer Moulding includes all forms of resin injections, resin infusion vacuuminfusion and vacuum press moulding. Moulding is done in a closed mould under differential pressure.

Hand Lay Up: Hand Lay up process consist of laying gelcoat with appropriate layers of Chop Strand Mat(CSM) and resin in open moulds.

32.4 HANDING

Handing and direction of closing of shutters shall be designated in accordance with IS 4043.

32.5 MATERIAL

Glass Fibre Chopped Strand Mat (CSM): The glass fibre chopped strand mat used shall be as per IS 11551.

Glass Fibre Rovings: The glass fibre rovings shall be as per IS 11320.
Isophthalic Resin: Isophthaiic resin shall be of fire retardant grade as per IS 6746.

Curing Agents

1 Catalyst used shall be Methyl Ethyl Ketone Peroxide (MEKP), benzyl peroxide, acetyl aceto peroxide, etc.

2 Accelerator used shall be cobalt napthalate, cobalt octonate, N.N. dinethyl anilene, etc.

Fillers and Additives

1 Permissible fillers are fiench chalk powder (Talc) and calcium carbonate.

2 Aluminium trihydrite, antimony trioxide, minimum 5 percent, by weight of isophthalic resin, shall be used for fire retardancy.

3 The fillers and additives content shall not exceed 10 percent by weight of isophthalic resin.

Auxiliary Chemical: Polyvinyl alcohol (PVA) or other semipenetrant release agents and wax shall beused as a mould release agent.

Pigments: Pigments compitable with isophthalic resin and gelcoat shall be used to obtain the shade offinish as mutually agreed between the manufacturer and the purchaser.

Base Blocks: Base blocks for fixing fixtures in shutter with screws shall be of seasoned and treated hardwood or any other suitable material.

Polyurethane Foam: Slabs of minimum density of 32 kg/cum and of thickness 4 mm less than the shutter thickness with (±) 0.5 mm tolerance shall be used.

32.6 CONSTRUCTION / FABRICATION

32.6.1 **Frame:** Door Frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treatedhard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either handlay up or resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./m2 and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856 .The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts ofIsopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat toobtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat.

32.6.1.1 Tolerance: Tolerance of size of frame to be + 2 mm and on size of rebate to be + 1 mm.

32.6.1.2 Finish: The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

32.6.1.3 Fixing of Frames: The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixedat 200 mm from the floor. The third anchor bolt shall be fixed in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

32.6.1.4 Measurements: The outer length of the vertical and horizontal members of UPVC door frame shall be measured in running metres including embedded length in floor corrected upto a cm.

32.6.1.5 Rate: The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware,which may be required, shall be paid for separately.

32.6.2 FRP Shutter: The FRP shutter shall have hollow rails and stiles monolithically cast with panels.

i) The shutters shall be contact moulded by either hand lay up or Resin Transfer Moulding (RTM) process in two pieces as per IS 14856-2000. The process shall consist of laying gelcoat of 0.35 mm to 0.40 mm thickness laid over with three layers of GRP mat (one layer of 300 CSM mat and two layers of 450 CSM)for each of the web (panel) portion and four layers of GRP mat for the flange (rails and stiles) portion (one layer of 300 CSM mat and three layers of 450 CSM mat). While closing the two pieces, additional layer of

450 CSM mat shall be provided in the web portion. The CSM mat shall be bonded with isophthalic resin in the ratio not less than 1:2 (one part of mat to two parts of isophthalic resin and fillers and additives) by weight. The edges

shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient rovings shall be laid in the corners to have smooth curve while laying the CSM mat. If the shutter is moulded usingthe RTM process, then moulding shall be done either by laying gelcoat followed by laying of the GRP mat. Core material shall be placed in location in the hollow sections. The GRP mat shall be bonded by injecting under pressure isophthalic resin in a ratio not less than 1:2 (one part of mat to two parts of isophthalic resin). Alternatively, if the shutter is moulded without using gelcoat then the process is to lay the FRP mat in the mould with the core material blocks in location in the hollow section. The GRP mat shall then be bonded by injecting under pressure, isophthalic resin in a ratio not less than 1:2 (one part of mat to twoparts of isophthalic resin).

ii) Blocks of any seasoned hardwood of bulk density not less than 450 kg/m^3 at 12 percent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle sliding door bolt, mortice lock, etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter.

iii) Blocks shall be provided at predetermined places in the shutter so as to fix hinges, mortice locks, tower bolts, aldrops, door closures, etc.

iv) The finished surface shall be buffed and polished as per IS14856:2000 with wax.

32.6.2.4 Dimensions, Sizes and Tolerances (Shutter)

Dimensions of Components and Tolerances: The finished dimensions and tolerances of the different components of door shutter shall be as given below:

Table 28.1: Dimensions and Tolerances of Components of Door Shutters

SN	Description	Width (in mm)	Thickness (in mm)
i	Vertical stile, top and freeze rail	90 (±) 3	30 (±) or 35 (±) I
ii	Lock rail	120 (±) 3	30 (±) or 35 (±) I
iii	Bottom rail	150 (±) 3	30 (±) or 35 (±) I

Minimum thickness of GRP laminate of **hollow rails and stiles** shall be 3 mm.
Minimum thickness of GRP laminate used for **panel in the shutter** shall be 5 mm.

Sizes and Types: Sizes and types of the shutters shall be generally as per working drawings issued forthe work or shall conform to the modular sizes as per IS 14856.

32.7 LOCATIONS OF FITTINGS AND ACCESSORIES

i) The lock rail of door shutters shall be so placed that its centre line is at a height 850 + 5 mm from the bottom of the shutter.

ii) Each door shutter shall be fixed to the frame with three hinges of the type specified, unless otherwise specified. These location shall be, one at the centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication, by depressing the profile has been made.

iii) Other fixtures shall also be provided at the locations where blocks have already been provided

32.8 FINISH

i) The surface of the moulded shutters shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects.

ii) Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable.

iii) Panels, rails and stiles of the door shutters shall be flat and shall have smooth and level surface.

iv) Shutter shall be finished in colour & design as specified in the agreement item.

32.9 TESTS

32.9.1 Tests on Material: Following tests shall be conducted on FRP laminate (without removing gel coat) cut from door shutter. The method of carrying out the test shall be as per the reference code mentioned against each test. Acceptable criteria shall be as mentioned against each test.

Table 28.2: Tests on GRP Laminate

Sl No.	Tests (as per IS requirement)	Acceptable Value
i)	Fibre glass content Annex B	25 percent (Min)
ii)	Barcol hardness Annex C	30 BHU (Min)
iii)	Tensile strength Annex D (MPa)	100 (Min)
iv)	Bending strength Annex E (MPa)	120 (Min)
v)	Elastic modulus Annex F in bend (MPa)	1 500 (Min)
vi)	Water absorption Annex G	0.5 percent (Max)
vii)	Fire retardancy Annex H	100 mm length of the specimen shall not bum within 60 seconds

32.9.2 Requirements on Shutters: The following tests in accordance with IS 4020 (Parts 1 to 16) shall be conducted on the door shutters.

32.9.2.1 Dimensions and Squareness Test: Door shutters, when tested in accordance with 1S 4020 (Part 2), the dimensions of nominal width and height shall be within a limit of (±) 5mm. The door shutter shall not deviate by more than 1mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. Thenominal thickness of the shutter shall be within a limit of (±) 1.5mm.

32.9.2.2 General Flatness Test Door shutters, when tested in accordance with IS 4020 (Part 3), the twist, cupping and warping shall not exceed 6 mm.

32.9.2.3 Local Planeness Test: Door shutters, when tested in accordance with 1S 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

32.9.2.4 Impact Indentation Test: Door shutters, when tested in accordance with IS 4020 (Part 5), shallhave no defects such as cracking, tearing or delamination and the depth of indentation shall not be morethan 0.2 mm.

32.9.2.5 Edge Loading Test: Door shutters, when tested in accordance with IS4020 (Part 7), the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

32.9.2.6 Shock Resistance Test: 1. Door shutters, when tested in accordance with 2.1 of IS 4020 (Part8), there shall be no visible damage in any part of the door after twenty-five blows on each end.

2. Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 8), the normally hung shutter, with hangings, fixings and fastenings should withstand without any significant permanent deformation and without deterioration the five impacts on both sides of the shutter.

32.9.2.7 Buckling Test: Door shutters, when tested in accordance with IS 4020 (Part 9), shall not showany deterioration and any residual deformation more than 5 mm after 15 min of unloading and the initial deflection also shall not be more than 50 mm.

32.9.2.8 Slamming Test: Anyone of the following tests shall be used.

1. Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have anyvisible damage in any part of the door at the end of 50 successive impacts.

2. Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have anyvisible damage in any part of the door at the end of I00 successive impacts.

32.9.2.9 Misuse Test: Door shutters, when tested in accordance with IS4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

32.10 SAMPLING AND CRITERIA FOR CONFORMITY

The sampling and criteria for conformity shall be in accordance with IS 4020 (Part 1).

32.11 MARKING

All door shutters conforming to this specification shall be marked with the following information:

a) Name of manufacturer or trade-mark, if any.
b) Lot number/date of manufacture for identification.
c) ISI Certification mark if any.

32.12 MODE OF MEASUREMENT

Square metre area for shutters shall be measured for the exposed surfaces of shutter between frame work from inside or outside, whichever is more. The linear dimensions shall be measured upto two places of decimals of a metre. The area for payment shall be worked out correct upto two places of decimal of a square metre.

32.13 RATE TO INCLUDE

The rate quoted by the contractor shall include supplying and fixing the shutters including supplying andfixing all fittings and fixtures as per item and / or drawing. Unless otherwise specified, frame work for theshutters shall be measured and paid separately under relevant item.

33. PVC FOAM SHUTTER

33.1 MATERIAL

PVC Free Foam Sheet is chemically foamed, rigid, light weight extruded sheet with fine & homogenous closed cell structure having a smooth matt surface finish on both sides. PVC Integral Free Foam sheetscan be cut, sawn, sheared, punched, drilled, nailed, riveted, screwed, etc. like wood and at the same time being plastic it is 100% moisture and termite proof. Range of PVC plastic foam sheets includes -PVC Free Foam sheet ,PVC Integral Free Foam Sheet, PVC low density free foam sheet, PVC Rigid sheet ,etc.

PVC Integral Free Foam Sheet is chemically foamed, extruded rigid, light weight sheet with fine & homogeneous closed cell structure & smooth, glossy, hard surface finish(scratch resistant) on both sides.PVC Integral Free Foam integral sheets are available in thickness varying 8mm to 30mm and usedfor false ceilings, shutters, kitchen / toilet doors, wall partitions, etc.

Table 29.1: Properties of PVC Integral Foam Sheet

Properties	Unit	Value
Physical		
Density	Kg/m^3	525-575
Hardness	Shore D	≥55
Water Absorption	%	≤1.0
Mechanical		
Tensile Strength	Mpa	≥11
Elongation at break	%	≥10
Thermal		
Vicat Softening Point	0_C	75
Thermal Conductivity	W/m-K	0.1
Flammability - Meets the requirement of Class 1Y as per BS 476 Part 7		

PVC Foam Flush door shutter shall be made out of Integral Foam sheet of 25mm. or specified thickness of approved manufacturer (Excel sheet of M/s Jain Irrigation or Equivalent approved).The Shutter sheet shall meet the technical specifications as mentioned above when tested as per relevant standard method of testing.

33.2 SIZES AND TYPES

Sizes and types of the shutters shall be generally as per working drawings issued for the work or shall conform to the modular sizes as per IS 14856.

33.3 FIXING

Fixing shall be similar to fixing of wooden flush door shutter. Fixing of all fittings and fixtures as specifiedfor the shutter shall be included under the scope of shutter item.

33.4 REQUIREMENTS ON SHUTTERS

Same as mentioned for FRP Shutter above.

33.5 MODE OF MEASUREMENT

Square metre area for shutters shall be measured for the exposed surfaces of shutter between frame work from inside or outside, whichever is more. The linear dimensions shall be measured upto two places of decimals of a metre. The area for payment shall be worked out correct upto two places of decimal of a square metre.

33.6 RATE

The rate quoted by the contractor shall include supplying and fixing the shutters including supplying andfixing all fittings and fixtures as per item and / or drawing. Unless otherwise specified, frame work for theshutters shall be measured and paid separately under relevant item.

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34. FACTORY MADE FIBRE GLASS REINFORCED PLASTIC CHAJJA

34.1 GENERAL

F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chajja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge.

34.2 MATERIAL

(1) Glass Fibre (chopped strand mat) shall be as per IS 11551
(2) Unsaturated Polyester Resin shall be as per IS 6746
(3) Surface Burning Characteristics of Building Material - ASTM E 84-77a
(4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
(5) Curing Agents - Cobalt Napthanate and MEKP
(6) Test of products - IS 14425
(7) Glass Fiber Roving - IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modulus of elasticity, good textile processing and excellent fiber reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivityand high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture andcorrosion resistance.

34.3 TOLERANCE

Tolerance of + 10 mm in overall size of FRP chajja is permissible.

34.4 FINISH

The F.R.P. laminate to be finished with polyurathene based or equivalent paint as final coat or gloss or mat followed by clear lacquer coat to get the shine of required shade.

34.5 MEASUREMENT AND RATE

The width and length to be measured in centimetres and area to be calculated as square metre correct upto two places of decimal. The rate includes cost of all the materials, labour scaffolding, fittings & fixingupto all heights etc. involved in operations described above, but excludes the paint.

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35 FITTINGS AND FIXTURES

35.1 SCOPE OF WORK

The work covered under these specifications consist of supplying different types of fittings and fixtures required for doors, windows, ventilators etc. The supply shall be in accordance with the specification, drawings / approved

samples. Samples of various fittings and fixtures proposed to be incorporated in thework shall be submitted by the contractor for approval of the Engineer-in-charge before order for bulk supply is placed.

35.2 GENERAL

All fittings and fixtures shall conform to relevant IS code and made of brass, anodized aluminium, iron oxidised (M.S.) or as specified. These shall be well made reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be counter sunk to suit the heads of the specified screws. All hinges pins shall be of steel for brass hinges and aluminium alloy NR-6 or steel pins for aluminium hinges with nylon washers or as specified. All riveted heads pertaining to hinge pins shall be well formed. Screws supplied for fittings shall be of the same metal and finish as the fittings. However brass cadmium plated/chromium plated screws shall be supplied with aluminium fittings. Samples of each fixture/ fitting shall be furnished by the contractor for approval of the Engineer-in-Charge. Order for procurement of fittings and fixtures in bulk shall be placed only after approval by the Engineer-in-Charge.

The fittings and fixtures to be incorporated in the work shall be strictly according to the approved sample.Fittings shall be fixed in proper position as shown in the drawing and as directed by the Engineer-in- Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with a screwdriver and not hammered in. Recess shall be cut to the exact size and depth for the counter sinking of hinges. The fittings and fixtures shall be fixed in a workman like manner and any damages done either to fittings and fixtures or to the shutter frames etc. should be rectified by the contractor at his own cost..

Mild steel fittings shall be bright satin finish black stone anodized or copper oxidised (black finish), nickel chromium plated or as specified.

Brass fittings shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

Aluminium fittings shall be anodized to natural matt finish or dyed anodic coating less than grade AC 10 of IS: 1868

Stainless steel fittings shall be non-magnetic, rust & moisture proof, strong & sturdy. Pin of hinges shallalso be of stainless steel.

35.3 BUTT HINGES

Brass and aluminium hinges shall be manufactured from the extruded sections and shall be free from cracks and other defects. M.S. butt hinges shall be cranked and manufactured from M.S. sheets. All butt hinges shall conform to relevant I.S viz. IS 12817(Stainless Steel), IS 1341 (M.S.) & IS : 205 (Cast brass & aluminium). The size of butt hinges shall be denoted by length of the hinge and other dimensions i.e. breadth of hinge and thickness of its flap should be as specified.

Hinge pin shall be made of mild steel, brass or stainless steel as specified and shall fit inside the knuckles firmly and riveted head shall be well formed so as not to allow any play or shake, and shall allow easy movement of the hinge.

The number of knuckles in a hinge shall be as per IS 1341. The size of knuckles shall be straight and atright angle to the flap.

The screw holes shall be clean and counter sunk. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of the wood screws. The number of screw holes shall be as per IS 1341.

35.4 PARLIAMENTARY HINGES

These shall be manufactured from extruded section for brass and aluminium and from M.S. sheets for iron oxidized and shall conform to IS 362. These shall be free from cracks and other defects. The size of the parliamentary hinges shall be designated by the width between open flanges, while the length and thickness shall be as specified .

35.5 PIANO HINGES

These shall be generally conformed to I.S. 3818 and shall be made of either brass oxidised, aluminium anodized, iron oxidised (M.S.) or as specified. Piano hinges shall be fixed in the entire length of the cupboard shutters in a single piece. No joints shall be allowed. Its size will be the width of the two flaps when open.

35.6 SPRING HINGE

These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453. Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to aswing door in the normal manner.

(a) When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.

(b) The door shall require a force of 2.0 ± 0.5 kg for 100 mm hinges and 3.0 ± 0.5 kg for 125 mmand 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 90º. Thesize of spring hinge shall be taken as the length of the plate

35.7 TOWER BOLTS

These shall generally conform to IS 204 (Part I & II). They shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action.

The tower bolts shall be of the following types :

(i) MS semi barrel tower bolt with ms sheet pressed barrel and G.I. bolt or with MS barrel and MS Sheet bolt.

(ii) Oxidised brass barrel tower bolt with brass sheet barrel and rolled or drawn brass bolt.

(iii) Anodised aluminium tower bolt with barrel and bolt of extruded sections of aluminium alloy. In case of M.S. tower bolt plates and straps after assembly shall be firmly anodize or spot welded properly.

The knobs of brass tower bolts shall be cast and the bolt fixed into the knob firmly as per I.S. specifications. The tower bolt shall be finished to correct shape and pattern so as to have a smooth action. Wherever specified, aluminium barrel tower bolts shall be manufactured from extruded sections of barrel & bolts.

Knobs shall be properly screwed to the bolt and riveted at the back. The size of the tower bolt shall betaken as the length of barrel without top socket.

35.8 DOOR LATCH

This shall be of MS, cast brass or as specified shall have smooth sliding action. MS Latch shall be copper oxidised (black finish) or as specified. Brass Latch shall be finished bright, chromium plated or oxidised or as specified. The size of door latch shall be taken as the length of the latch.

35.9 INDICATING BOLT (Vacant/engaged)

These shall be of cast brass finished bright chromium plated, or oxidized or as specified. The shape andpattern shall be approved by the Engineer-in-Charge

35.10 ALDROPS

These shall be oxidised brass or anodized aluminium, iron oxidised or as specified and shall be capable of smooth sliding action and shall be as per relevant I.S. Brass sliding door bolt (aldrop) shall be made from rolled brass generally confirming to IS : 2681. M.S. sliding door bolt shall generally conform to I.S.281. The hasp shall be of cast brass and screwed to the bolt in a workman like manner. Alternatively the hasp and the bolt may be in one piece. Bolts shall be finished to shape and threaded with worth standard and provided with round brass washers and nuts of square or hexagonal shape. All components shall be smooth and polished. The leading dimensions of aldrop shall be as the length of the bolt and specified diameter.

35.11 DOOR HANDLES- BOW/PLATE HANDLES

These should generally conform to IS : 208. Unless otherwise specified door handles shall be of 100 mm size & windows handles of 75 mm size. These shall be of cast Brass or cast/sheet Aluminium alloy or mild steel handles as specified and of specified size, shape and pattern as approved by the Engineer-in- charge. All edges and corners shall be finished smooth and correct to shape and dimensions. Brass handles shall be finished bright, chromium plated or oxidised as specified. Anodised aluminium or iron oxidised (m.s.) handles shall be of specified size, shape and pattern. The size of the handle is taken as the inside grip of the handle. In case of iron oxidised handles, the same shall be manufactured from m.s. sheet pressed into oval section as per I.S.

35.12 MORTISE LOCK & LATCH

This should generally conform to I.S. 2209. Handles shall conform to IS 4992.

Mortise lock with latches and a pair of level handles shall be 6 levers, with zinc alloy pressure die cast/brass or as specified body of approved quality, and shall be right or left handed as specified. The pair of handles shall be either brass chromium plated or anodized aluminium of approved shape and pattern or as specified. It shall be of the best Indian make of approved quality. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leafdoor a rebated face. Level handles with springs shall be mounted on plates and shall be of approved quality,anodized aluminium or as specified.

35.13 UNIVERSAL HYDRAULIC DOOR CLOSER

This shall be generally conform to IS : 3564. These shall be made of cast iron/aluminium alloy/zinc alloyand of shape and pattern as approved by the Engineer-in-Charge.

The door closers may be polished or painted and finished with lacquer to desired colour as specified. Aluminium alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall bepickled, scrubbed and rinsed to remove greese, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphating treatment in accordance with IS 3618.

The operation of the Hydraulic door closer shall be very smooth. Speed of the Hydraulic door closer shall be adjustable and latch closing also shall be adjustable type. Suspension and lubrication of door closer shall be in perfect line and level.

Performance Requirements : After being fitted in its position when the door is opened through 90°, the same should swing back to angle of 20° ± 5° with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final positionthe door smoothly negotiates with the latch.

35.14 MORTICE NIGHT LATCH

This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

This should generally conform to IS: 3847. It shall be cast or sheet brass, cast or sheet aluminium alloy or mild steel as specified and of approved make. These shall be bright finished or copper oxidised (black) finish as specified. Normal size of the latch shall be denoted by the length of the face over the body in millimetres.

35.15 CUPBOARD OR WARDROBE LOCK

This should generally conform to IS 729. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. Thisshall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidised or as specified. The size of the lock shall be denoted by the length of the face across the body in mm.

These locks shall be fitted with four, five or six levers as specified. False (dummy) levers shall not be used.

35.16 FLOOR DOOR STOPPER

The floor door stopper shall conform to IS: 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. Thesize of door stopper shall be determined by the length of its plate. The body of the door stopper shall becast in one piece. All parts of the door stopper shall be of good workmanship and finish and free from surface and casting defects. Aluminium stopper shall have anodic coating of not less than grade AC-10 of IS 1868.

35.17 KICKING PLATES

This shall be of brass (finished bright or chromium plated or oxidised) bronze, stainless steel,aluminium or as specified. Aluminium kicking plates shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5 mm in case ofstainless steel. Shape of the plate shall be as specified. This shall have bevelled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of theplate. The shape and pattern shall be according to the drawings and as approved by the Engineer-in- Charge.

Note : The contractor shall provide for all the incidentals required for fixing these fixtures and fittings such as cadmium plated screws etc. Fittings and fixtures shall be fixed securely in a workman like manner all as directed by the Engineer-in-charge. Any of the fixtures damaged during the fixing shall be removed and new one fixed in their place and the surface of joinery made good where affected, at his own expense. Mortise plates shall be used over holes where the bolts enter in the wood work. Metal sockets shall be provided to all bolts where the shoot enter brick, stone, concrete etc. The incidental Fixtures like mortise plates, metal sockets, screws etc. shall not be paid for separately.

35.18 MODE OF MEASUREMENT AND RATE

Unless otherwise specified, all fittings including all necessary accessories shall be measured in numbersand the rate shall include the cost of all materials including taxes, octroi, excise duty, if any, loading, unloading, transporting, cost of screws, bolts and other accessories and fixing the same complete.

36. GLASS AND GLAZING

36.1 SCOPE OF WORK

The work covered by this specification include supplying and fixing the glass panes to teak wood orsteel doors and windows, strictly in accordance with these specifications and drawings.

36.2 MATERIALS

36.2.1 **Glass :** The glass shall be clear float glass of specified thickness and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable defects.The float glass shall conform to the IS 14900 The glass shall be of approved manufacturer as specified.Toughened float glass/heat reflective glass of specified shade and approved manufacturer shall be usedwherever specified. The glass shall be free from bubbles, flaws specks, waves, air holes, distortion, scratches, cracks or other defects. The glasses in bulk quantities shall be brought to site in manufactureroriginal packings and their guarantee shall be produced if called for by the Engineer-in-charge. The glass shall be of required thickness as mentioned in the items of schedule of quantities and/or drawing or as directed by the Engineer-in-charge. The contractor shall submit the sample of the glass which he proposes to use on the work and only such approved quality of glass shall be used in the works. The glass broughtto site shall be protected against damages. Wherever frosted (obscure) glass is mentioned in the item ofschedule of quantities and / or shown in drawings, the glass shall be of sand blown pattern and shall also be got approved from the Engineer-in-charge.

36.2.2 **Tempered Glass:** There are two types glass tempering process (a) Heat strengthening & (b)Toughening

36.2.2.1 **Toughened Glass:** Glass Toughening is achieved by means of heating glass up to 650ºC in a toughening furnace, followed by a quick cooling process at exit. During the cooling process the externallayers reach a lower temperature than the internal layers, thus creating compression on the external faceand tension on the internal. In the event of breakage of toughened glass, the glass fracture into small fragments and there will be shower of small fragments of glass which may cause injury to the inhabitants.

36.2.2.2 **Heat Strengthened Glass:** In heat strengthening process in glass, permanent surface compressive stress is induced by controlled heating and cooling process in order to give its increased resistance to mechanical and thermal stresses and prescribed fracture characteristics. The process involves heating the glass, near about to malting point (i.e 650^0 C) and cooling. In heat strengthening process, the cooling is done slowly to gain 3 to 4 times impact strength of glass panel. In the event of breakage heat strengthened glass fractures in a manner similar to annealed glass. Since the glass panels are fixed to the frame work using structural sealant on the perimeter on the glass, glass panes holds on, till replacement.

36.2.3 **Reflective Glass :** This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy . However, most of reflective glazing blocks day light more than solar heat.

Types of Coatings: There are two types of reflective glass, Pyroltic (Hard) coated and vacuum (soft) coated.

36.2.3.1 **Pyroltic** : It is a coating applied during glass manufacture. The coating is fused into the glass at 1200°C.

36.2.3.2 **Vacuum Coated Glass**: It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than pyroltic products.

36.2.3.3 **Testing:** The reflective glass shall be tested for the followings:

(i) Physical/Field Test: In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.

(ii) Lab. Test: In the lab, the reflective glass shall be tested for the parameter specified as per manufacturer"s specifications.

36.2.4 **Laminated Glass:** In laminated glass two or more glass sheets are bonded together using a polymer layer in between in the event of breakage, the glass fragments remain bonded to the film/ resin interlayer. Laminated glass is generally can be used for skylight to avoid the fall of glass pieces in the event of breakage.

Lamination process can be done in two ways

1. Film Lamination (PVB - Polyvinyl Butyral): In this process two or more sheets are separated by one or more plastic interlayer"s and subject to heat, and pressure to ensure perfect adhesion.
2. Resin Lamination: In this process liquid resin is poured into cavity between two sheets of glass which are held together until resin cures.

33.2.5 Integrated Glass Unit: Integrated Glass units are basically multiple layered glass panes that have very dry air or inert gas between the glass panes. The glass panes are hermetically sealed. Glass panes shall be of specified thickness and type. In double glazed unit (DGU), double glass panels are separated by an air or other gas filled space to reduce heat transfer across a part of the building envelope. The glass panes are separated by a "spacer" and the panes are hermetically sealed.

32.2.5.1 Spacer: Spacer performs the role of keeping the glass panes apart as well acts as a housing for the desiccant.

32.2.5.2 Desiccant: Or, the drying agent performs the most important role in an IGU; that of absorbing the moisture from the hermetically sealed space.

32.2.5.3 Secondary Sealant: This sealant is applied on the outside of the unit. It performs several roles, chief among them of providing structural strength.

32.2.5.4 Primary sealant: First line of defense for the hermetic seal.

36.3 REFLECTIVE COATING POSITION

(a) In single glazed unit reflective surface placement on outer side position (position - 1) should be avoided due to the

effects of weathering and pollutants and subsequent cleaning difficulties. Though this will marginally decrease the heat reflection performance, the same will enhance the colour of the glass avoiding the strong "mirror" like appearance when viewed from the outside

b) In Integrated glazed unit (DGU) with one clear and one reflective glass with air gap hermitically sealed, reflective surface shall be placed at inner side (position - 4).

36.4 BEADING

The beading shall be of teak wood of superior quality timber in case of teak wood doors and windows and/or required sizes mentioned in the items of schedule of quantities and/or shown in drawing. In case of steel / Aluminium doors and windows, the beading shall be anodised aluminium beading of channel section as per sizes mentioned in the item and / or shown in the drawing. The junction of the beadings shall be mitred jointed.

36.5 DIMENSIONS, THICKNESS AND WEIGHT OF THE GLASS

Dimensional (length & breadth) tolerance and thickness tolerance shall be as per Table-I and Table-II of IS-14900:2000. The thickness of float glass shall depend on the size of panel. The tolerance in thicknessshall be as under:

Table 32.1: Tolerance in Thickness

Nominal thickness	Range of thickness	Weight in kg / SqM
3.0 mm	2.7 to 3.3mm	7.5
4.0 mm	3.7 to 4.3 mm	10.0
5 mm	4.7 to 5.3 mm	12.5
6.0 mm	5.7 to 6.3 mm	15.00
8.0 mm	7.4 to 8.6 mm	20.00
10.0mm	9.4 to10.6mm	25.00
12.0mm	11.2 to 12.8mm	30.00

36.6 WORKMANSHIP

The glass shall be cut to the required sizes of panels where it is to be fitted, and it shall be so cut that it fits properly in the frames without rattling. Pre-measurement of each panel prior to the cutting of glass is essential.
The beading shall then be fixed to glass panes and screwed at close intervals not more than 10 cm. from each corner and the intermediate not more than 20 cm. apart. When the glass panes are fixed withaluminium beading having mitred joints, epoxy resin or silicon sealant shall be applied covering the area in contact between the glass panes and sash bars and also between glass panes and the beading. In case of louvers, all the exposed edges of the glass shall be ground properly.

All glass panes shall be fixed within the aluminium framing by use of CP brass or SS screws and the joints sealed with epoxy resin or silicon sealant to make the unit completely waterproof. Glazing or caulking compound around the perimeter of glass shall not be permitted. Fixed glass panes shall be supported bysetting blocks. There shall be no whistling or rattling.

36.7 GENERAL

After the inspection is over and permitted by the Engineer-in-charge, glass panes shall be cleaned off any labels, paints smears and spots and shall be washed from both the sides and all glazing left clear, perfect and free from rattling. The contractor shall provide all the scaffolding, tools and plants for fixing the glass panes at his own cost. In case of steel windows, any hardware if fixed in position, shall be removed temporarily before fixing the glass panes and which shall be re-fixed back in position, all at the contractors cost.

32.7 MODE OF MEASUREMENT

The rate for teak wood door/window shutters and/or steel door/window shall normally cover the cost of glass and glazing also, unless otherwise mentioned. In case the glazing is carried out as a separate item, the measurement shall be taken out to cut size of teak wood/steel door/window frames forming the sides of glass panes

and area calculated to two places of decimal of a square meter.
The rate shall include the cost of supplying and fixing the glass panes, all materials, wastages, labour , transport, scaffolding etc.

37. STEEL DOORS, WINDOWS AND VENTILATORS

37.1 SCOPE OF WORK

The work covered under these specifications consist of supplying steel windows and doors and ventilators, fixing, glazing etc. complete in strict accordance with the specifications and relevant detailed/shop drawings.

37.2 GENERAL

The contractor shall submit 6 copies of shop drawing covering all types of work under this specification before manufacture. The drawing shall show all dimensions, details of construction, installation, relating to adjoining and related work etc.

37.3 MATERIAL

Shutters, frames etc. as dimensioned in the drawing shall be fabricated from I.S. standard sections rolled by M/s. Man Industries or other approved equivalent. No glazing bars shall be provided unlessotherwise shown in drawing. Glazing used will be clear float glass of approved manufacturer of specified thickness. Steel sections shall be free from rolling or other defects. They shall be easily welded and punched and shall be cold straightened and shall conforming to latest I.S. 1038 - 1983. The anticorrosive shop coat of paint shall be given before the materials are brought to site.

37.4 COUPLING BARS FOR COMPOSITE DOORS,WINDOWS AND VENTILATORS

All doors window, ventilators units shall be so constructed that those if required may be coupled together by means of the standard mullion and weathered transom bars and coupling pieces.

All steel hinges shall be projected steel hinges with non magnetic stainless steel pins and washers to permit complete ease in cleaning the glass and shall be welded or riveted to the frame.

37.5 FABRICATION

The frames shall be square and flat and shall be constructed of sections cut to length, mitred and welded at corners. All welding shall be electrical flash butt welding excepting for the welding of steel sheets for the shutters.

Sections shall be formed true to details with clean straight, sharply defined profiles and free from defects that may impair its durability. All works shall be accurately formed to the required dimensions, line and level. All joints shall be continuously reinforced, fitted and continuously welded at the edges. Surface along joints shall be ground to attain a smooth level surface even and flush with adjoining surfaces. All frames shall be properly reinforced for the attachment of hardware. The heads of frames for openings wider than 1.2 m. shall be reinforced to prevent sagging or deflection when installed.

37.6 INSTALLATION

The doors, windows and ventilators brought to site shall be stacked up site down on wooden runner under cover. Fixing shall be done as per latest Indian Standard Specifications. The size of the preparedopenings shall be checked first and these should be cleaned off all obstructions.

The doors/windows/ventilators shall not be forced into the walls but shall fixed into prepared openings in workmen like manner.

All joints between masonry/concrete and the metal shall be fully filled with approved mastic filler/putty in order to ensure water tightness. The joints shall be neatly pointed with matching cement and excess material shall be removed.

All brick jambs and sill holes shall be cut 50 mm. square and 100 mm. deep for fixing hold fasts. All concrete jambs and lintels, holes shall also be carefully drilled and if reinforcing steel is encountered, the length of the hold fasts may be decreased and existing surface made good to the originalcondition.

Any hard ware if fixed in position shall be removed before fixing the frames in the structural openings and moving parts shall be secured with wire or string during erection and while the building work is being completed to prevent damage to the part. Hardware shall be fixed as late as possible preferablyjust before the final coat of paint is applied. It shall be fitted in workmanlike manner so that it may not be marked and mutilated by hammers and screws and pins are not marked and mutilated by hammers and screwdrivers. It shall be tested for correct operations to the satisfaction of the Engineer-in-charge.

37.7 DETAILS OF COMPONENT PARTS

37.7.1 **Doors :** Door shutters shall be hung on projecting hinges of 67 mm size and shall be fitted with mortise lock and two brass or bronze lever handles. In case of double leaf doors, the first closing leaf of double leaf doors shall also be provided with brass or bronze tower bolts concealed in the section at

top and bottom. These shall be so constructed as not to work loose or drop by their own weight and necessary lugs, fittings, screws etc. shall be provided and fitted properly at site.

37.7.2 **Windows :** Window shutters shall be hung on projecting hinges. One leaf of the hinges shall be welded into a slot in the outer frame and the other leaf of the hinges riveted to the opening shutters. Hinges may be of the friction type in which case the window shall not be fitted with peg stay. In case of non-friction projecting hinges, a brass or bronze three holes peg stays 300 mm. long with pegs and brackets, welded or rivetted to the frame shall also be provided. Handles shall be of brass or bronze andand shall be mounted on a mild steel handle plate welded to the shutter in such a way that it should be fixed after the shutter is glazed. The handles shall have a two point nose which shall engage with brass,bronze or aluminium alloy as specified, striking plate, on the fixed frame so that it can hold the shutters in a slightly openable as well in a fast position.

37.7.3 Ventilators

37.7.3.1.1 **Top hung ventilators:** These shall be fixed with plain hinges, riveted to the fixed frames or welded to it after cutting a slot in it. A peg stay 300 mm. long of brass or bronze with three holes, as in case of windows shall be provided.

The locking bracket shall either be fitted to the fixed frame or to the ventilators.

37.7.3.1.2 **Centre Hung Ventilators:** These shall be hung on two pairs of brass of lead/tin/bronze cup pivots, riveted to the inner and outer frame of the ventilators to permit these to swing through an angle of approximately 85 deg. The opening portion of the ventilators shall be so balanced that it remains openat any desired angle under normal weather condition.

A bronze or brass spring catch shall be provided at the top centre of the ventilator. A brass cord pully wheel in a mild steel or malleable iron brackets, shall be fitted with screws or welded at the sill and acord eye shall be fixed to inner frame of ventilators to facilitate opening of ventilators.

37.7.4 **Composite Units:** Composite units consist of a combination of two or more units of doors, windows, ventilators etc. as the case may be. The different units shall be coupled by using coupling sections. The coupling sections shall be made from M.S. sheet 3.15 mm. in thickness and 56 mm. wide as per I.S. 1038-1957 para 5.2 and these shall be fixed with bolts and nuts.

Wherever the ventilators, windows and doors shall have coupling section, mastic cement shall be applied between the junctions to make the joints watertight.

To calculate height or width of composite units, add 2.5 cm. for each mullion or transom coupling bar for each unit.

37.8 FINISHING

All steel surfaces shall be thoroughly cleaned of rust, scale and dirt by pickling and marking. A shop priming coat of superior quality red oxide or equivalent shall then be given before despatch. Alternatively, where so specified, the steel surfaces shall be treated for rust proofing by the hot dip zinc spray or electro galvanising process, having a coating of not less than 60 microns thickness or as specified. Zinc spray articles shall be given one coat of priming coat of superior quality red oxide or equivalent.

Final finishing with two coats of synthetic enamel/flat oil paint of approved make and shade shall be given after the doors, windows and ventilators are erected/fixed in final position. The rate shall be inclusive of final finishing coats including the priming coat.

In case of galvanised doors, windows and sashes, their surfaces shall be treated with copper acetate solution or other approved mordant solution to ensure proper adherence of paint, unless the galvanised surface has weathered adequately at the time of final painting.

Non-ferrous parts and working parts such as handle stays, catches, handle pins, hinge pins etc. shall not be painted.

37.9 GLASS AND GLAZING

Specifications for glazing given in this book under chapter Glass and Glazing, shall also be applicable for steel doors / windows / ventilators.

37.10 MODE OF MEASUREMENT

The mode of measurements for steel doors, windows and ventilators for complete item of supply and fixing in position shall be on area basis calculated in sqm. correct to two places of decimal. The height and width of members shall be measured outer to outer edge of the members correct to 1 mm.

The rate for steel door, window and ventilator shall include cost of all fittings, materials, hold fasts, glazing, painting, labour etc.

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38. ROLLING SHUTTERS

38.1 SCOPE OF WORK & GENERAL

Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters upto 10 sq. metre shall be of push and pull type and shutters with an area of over 10 sq. metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately if not included in item.

38.2 MATERIALS

38.2.1 **Shutter:** Rolling shutters complete with accessories shall be of approved quality and as specified. These shall be suitable for fixing in position as specified i.e. outside or inside; on or below lintel or between jambs of the opening. Rolling shutter shall be hand/gear operated as specified in the item of schedule ofquantities. For hand operated shutters, it shall be push and pull type. For gear operated shutters, it shall be provided with reduction gear operated by mechanical device with chain, crank, shaft and handle. The shutter be built up of inter locking lath section formed from cold rolled steel strips. The shutter shall consist of 80 mm. wide MS laths 1.25 mm thick or gauge as specified of best quality mild steel sheet machine rolled. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. Laths shall be inter-locked together throughout their entire length and jointed together at the end with end locks. These shall be mounted on specially designed pipe shaft. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

38.2.2 **Spring:** The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part I . The spring shall be of best quality and

shall be manufactured from the tested tensile spring steel wire or strip of adequate strength to balance the shutter in all positions. The spring, pipe shaft etc. shall be supported on strong mild steel or malleable cast iron brackets. Both the side guides and bottom rails shall be jointless and of single piece of pressed steel of minimum 16 gauge thickness. The top cover of shaft, spring etc. shall be of thesame materials as that of lath. No extra payment shall be made for the hood, brackets etc. to cover the

shaft etc. The reduction gear arrangement operated by the mechanical device shall be of the best qualityand shall be easy in operation.

38.2.3 **Rollers and Brackets:** The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter upto 6 metre width and height not exceeding 5 metre, steel pipes of 50 mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x
3.15 mm for shutters upto a clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5 m and upto 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pretensioned helical springs to counter balance the weight of theshutter and to keep the shutter in equilibrium in any partly open position.

When the width of the opening is greater than 3.5m the cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearing with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.

In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulleywith two ball bearing shall be provided.

38.2.4 **Guide Channels:** Both the side guides and bottom rails shall be jointless and of single piece of pressed steel of minimum 16 gauge thickness.The width of guide channel shall be 25 mm the minimum depth of guide shall be as follows.

Clear width of shutters		Depth of guide channel
i)	Upto 3.5 m	65 mm
ii)	3.5 m upto 8 m	75 mm
iii)	8 m and above	100 mm

The gap between the two legs of the guide channels shall be sufficient to allow the free movement of theshutter and at the same time close enough to prevent rattling of the shutter due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment tothe wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embeddingin the walls.

The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

38.2.5 **Cover:** The top cover of shaft, spring etc. shall be of the same materials as that of lath .Top cover shall be of mild steel sheets not less than 0.90 mm thick or as specified and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

38.3 FIXING

The arrangement for fixing in different situations in the opening shall be as per IS 6248.Brackets shall befixed on the lintel or under the lintel as specified with rawl. Plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets. The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts

and nuts. The side guide channels and cover frames shall then be fixed tothe walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done

accurately in a workmen like manner that the operation of the shutter is easy and smooth. All grout holesand damages on the wall while fixing of shutters shall be made good by the contractor at no extra cost tothe Department. The contractor shall ensure smooth and easy working of shutters. All the members of the rolling shutter shall be thoroughly cleaned off dust, scales, rust etc. and shall be given approved primingcoat of red oxide paint before fixing the shutter in position and then shall be painted with two coats of flat/synthetic enamel paint of approved quality and shade.

38.4 MODE OF MEASUREMENT

Clear width and clear height of the opening for rolling shutter shall be measured correct to a cm. The clear distance between the two jambs of the opening shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height. The area shall be calculated in square metres correct to two places of decimal

38.5 RATE

The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover,brackets,spring,guide channels etc. Reduction gear operated mechanical device of chain and crank operation,ball bearing etc. ,if not included in item, shall be paid for separately.

38.6 ROLLING GRILLS - SHUTTERS

Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined withsafety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rollinggrill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter-cum-grill shall not exceed 1.0 m and the height of the grill portion in any individual segment shallnot be more than 0.5 m.

Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 38.2 shall be applicable to rolling grills shuters except in respect of the shutter portion,and shall conform to IS 6248.

38.6.1 **Shutters:** Rolling grill shutter and the rolling grill portion of the rolling shutter-cum-grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20 mm wide and 5 mm thick mild steel flat links. Straight bars shall be spaced not exceeding150 mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Engineer-in-charge, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120 mm and the depth of corrugation is 80 to 100 mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the centre of the hole to thenearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All linksshall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughs of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint.

38.6.2 **Measurement & Rate:** The measurement and rate shall be as specified in 38.4 and 38.5 respectively. In case of Rolling Shutter-cum-Grill, extra rate over rolling shutter rate for grill area only shall be paid for if provisioned in item.

39. M. S. GRILLS / RAILINGS

39.1 GENERAL

The contractor shall submit 6 copies of shop drawings covering all types of work under this specifications before manufacture. The drawing shall show all dimensions, details of construction, installation relating to the adjoining work.

39.2 MATERIALS

All structural steel shall conform to I.S. 226 sections for grills and shall be free from loose mill scales, rusts, pittings or any other defects affecting its strength and durability.

39.3 FABRICATION

The grill shall be fabricated to the design and pattern shown in the drawings. All joints shall be made in best workman like manner with slotting and welding as required to the specified size and shape. The edge of the M.S. flats shall be suitably mitred before welding to get the desired shape. The joints shall be filled to remove excess stay after welding. Screws, nuts, washers, bolts, rivets and any other miscellaneous fastenings, devices shall be of steel and shall be provided by the contractor. Manufactured M.S. grills then be fixed in between the posts, balusters, M.S. frame work etc. to correct alingnment. Any undulations, bends etc.found shall be rectified by the contractor at his own cost. Thecomplete assembly of grill/railing so fixed shall be firm and there shall not be any lateral movements.

39.4 SAMPLES

Samples of grill and railings shall be submitted for approval of the Engineer-in-Charge and to be got approved before taking up for mass fabrication.

39.5 INSTALLATION

The approved grills shall be fixed in position where specified and shown in drawings including in masonry walls, teakwood frames, hand railings etc. Any damages to walls, frames etc. caused during fixing the grills shall be made good by grouting with cement mortar/packing/repairing properly at the contractors cost.

39.6 PAINTING

Painting shall be done as per the specifications specified under painting.

39.7 MODE OF MEASUREMENT: (On area basis or on weight basis of steel section used asspecified in item of work)

1. Actual area of M. S. grill manufactured and fixed in position shall only be measured in square metre for payment. All measurements shall be taken to two places of decimal of a metre and area shall be calculated to second place of decimals of a square metre.

2. The weight of material used shall be calculated on the basis of actual weight of steel sections used for fabrication and shall be compared with the standard weights given in the relevant IS that the variation inactual weight should be within tolerances specified. The payment shall be made for the actual weight. The length of each member used for fabrication shall be measured **outer to outer of cut length** correct twoplaces of decimal of a metre. The rate shall include the cost of all materials, labour, transporting, fabricating, installing, scaffolding if necessary, grouting etc. complete.

39.8 FINISHING/ PAINTING/ POLISHING FOR RAILING

Teak wood hand rail shall be French/ melamine polished or painted with synthetic enamel paint/ flat oil paint of approved make and shade over one coat of approved primer as specified in item and as per specification . M.S. grills, balusters etc shall be painted with synthetic enamel paint as specified under painting/ polishing specifications.

39.9 MODE OF MEASUREMENTS (HAND RAILS)

Hand railing shall be measured for payment in running metre. The length shall be measured along the top centre line of the hand rail and shall be measured between ends of balusters, newels, posts as the case

may be upto two places of decimals of a metre. Rate shall include fabrication, leaving suitable pockets,grouting

the same, providing and fixing suitable teak wood plugs, fixing, all labour, materials, transport, painting/polishing, finishing and scaffolding if necessary.

40. STAINLESS STEEL GRILLS/ RAILING

40.1 Material: Stainless steel sections (bars, square bars ,pipes, plates, sheets) shall be of specifiedgrade (S-304, S-316) and shall conform to AISI(American Iron and Steel Institute)-300 series. SS-304 is a chromium nickel austenitic stainless steel with good corrosion resistance properties and good weld-ability. Higher alloy SS-316 with 2 to 3% molybdenum and lesser carbon content has higher corrosion resistant,used where there is definite exposure to chlorinated water such as swimming pool or other harsh exposure condition. All alloy under AISI-300 series are non-magnetic. However, higher alloy grade S-316 should be preferred and used to prevent the magnetic foot-print in near vicinity of magnetic sensitive application such as MRI (Magnetic Resonance imaging).

40.2 Fabrication: Fabrication of grill or hand railing shall be as per sizes and pattern shown in drawing using standard sections as specified. All joints shall be made in best workman like manner with slotting and welding as required to the specified size and shape. The ends/edge of the SS pipes/ flats shall be suitably mitred before welding to get the desired shape. All the stainless steel joints shall be welded using Tungsten inert gas(TIG) method of welding(IS-2811-1987) in which non combustible electrode made of tungsten is used in presence of inert gases mixture of Argon and Helium as shielding gases. Weld flush should be properly grinded and polished to get highly reflective finish.

40.3 Samples: Samples of grill and railings shall be submitted for approval of the Engineer-in-Charge and to be got approved before taking up for mass fabrication.

40.4 Installation: Same as for MS grill and Hand railing.

40.5 Finish: The installed grill or hand railing shall be mirror/ matt finished as specified by proper buffing of surface to the satisfaction of Engineer in-Charge.

40.6 Mode of Measurement (On Weight Basis): The weight of material used shall be calculated on the basis of actual weight of steel sections used for fabrication and shall be compared with the standard weights given in the relevant IS that the variation in actual weight should be within tolerances specified.The payment shall be made for the actual weight. The length of each member used for fabrication shall be measured outer to outer of cut length correct two places of decimal of a metre.

The rate shall include the cost of all materials, labour, transporting, fabricating, installing, scaffolding if necessary, grouting etc. complete.

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41. ALUMINIUM DOORS, WINDOWS, WALL SPANS, GLAZING ETC.

41.1 SCOPE OF WORK

The work covered under these specifications consist of supplying, fabrication and installation of Natural shade/ colour anodized glossy/ matt finished aluminium doors, windows, wall span, composite units, glazing etc. strictly in accordance with these specifications and relevant detailed approved shop drawings.

41.2 GENERAL

The material, fabrication and hardware shall conform to the IS 1948. The contractor shall submit 6 copies of shops drawings covering all type/details of work as generally shown in Architectural drawing and envisaged under these specifications before manufacture. The drawing shall show all dimensions, detailsof construction, installation of fixtures and relation to adjoining and related works. No fabrication work shall be undertaken prior to obtaining approval of the shop drawings from the Engineer-in-Charge.

41.3 MATERIALS

Aluminium alloy extruded sections used in the fabrication of extruded door/ window sections shall conform to IS 733 & IS 737(composite unit). Hollow aluminium alloy sections used shall conform to IS 1285 and shall be

anodised before incorporating in the work. Anodic coating shall conform to IS 1868. The frame work, stiles, mullions, beadings, transoms and handles etc. shall be of aluminium anodised sections as shown in detailed approved drawings. All aluminium sections shall be of JINDAL/HINDALCO or other equivalent make as per drawing. The contractors can also propose nearest alternative sections they manufacture/posses without changing the elevation, structural stability & functional requirement. Department reserves the right to accept the alternative section or otherwise. The sections shall be structurally suitable to withstand all the loads, the members have to sustain. Counter sunk screws, nuts, bolts, washers, rivets and other miscellaneous fastenings devices shall be of approved brass cadmium plated or stainless as specified in the approved drawing.

41.4 FABRICATION

Material, fabrication and dimensions of aluminium doors, windows and ventilators manufactured from extruded aluminium alloy sections of standard sizes and designs complete with fittings, ready for being fixed into the building shall be as per IS 1948

The frames shall be manufactured square and flat, the corners of the frame being fabricated to true right angle. All the fixed, sliding and opening frames shall be constructed of sections which have been cut to length, mitred, welded and mechanically fixed at the corners. Where hollow sections are used with welded joints, argon-arc welding or flash butt welding shall be employed (Gas welding or brazing not to be done). In case welded joints are used, anodising shall be done after fabrication as a whole. All welding shall be on unexposed sides in order to prevent pitting/discolouration of other surface imperfections after fixing etc. Necessary allowance shall be made while manufacturing the aluminium door entrances, wall spans and glazing for receiving plaster. No field fabrication of frames is permitted.

Each door leaf shall be prepared to receive glazed panel of required thickness. Glazing shall be done with approved quality EPDM gasket with snap-in-bevelled anodised matt/glossy finish aluminium metal

glazing stops inside and outside. All doors shall have off- set pivots, double action (180° minimum swing) floor springs with oil check boxes of approved manufacture. All doors shall have 4 lever concealed brass body mortise lock without handles as per manufacturers design, with concealed flush C.P. brass tower bolts provided at suitable locations. All doors shall have push plates of design shown in the approved drawing as described in the schedule of quantities. All entrances shall be without thresholds. All aluminium surfaces in contact with masonry or concrete shall be given a thick coat of bitumastic paint. After fabrication, aluminium sections shall be protected from construction hazards that may damage their appearance or finish. All exposed surfaces of aluminium door entrance shall be protected by masking tape during transshipment and erection. All sections and hardware shall have anodic film and cover of minimum thickness of 0.015 mm.

The dimensions shown in the drawing are overall heights and widths to the outside of frames of aluminium windows. The side hung shutters shall have projected friction type hinges of aluminium alloy. Concealed projected hinges having structural stability and of good quality will also be considered only after the inspection of the sample submitted by the tenderer. The necessary pegstays, handles, window fasteners etc. shall be of aluminium. The handle shall be mounted on a handle plate rivetted to the opening frame. The pegstays shall be 300 mm. long or as required complete with peg and locking bracket and shall have holes for keeping the shutter open in three different positions. No field fabrication of frames is permitted. The complete fabricated assembly shall be anodised in approved satin finish with minimumfilm thickness of 0.015 mm. for the entire surface.

For composite units the door shall be coupled to windows or side- lights by extruded aluminium sectionsmade from aluminium alloy conforming to IS Designation HE9-WP of IS 733.

A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate shall be appliedon the finished sections of the aluminium work by the contractor to protect the surfaces from wet cement, lime, dirts, dust etc. during the construction activities. The size for door, window or ventilator frames shall not vary by more than (±) 1.5 mm.

41.5 **Finish:** Alumiumum doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally be colour anodized/powder coated as specified in item.

41.5.1 **Anodising**: Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide

range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensures uniform coating in uniform colour and shades. The extrusions shall be anodized minimum average thickness of 15 micron(AC-15) or as specified in approved colours as per IS1868-1996. The anodized extrusions shall be tested regularly under strict quality control adhering to Indian Standard IS 5523-1983.

41.5.2 **Powder Coating**: The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer-in-Charge. The polyester powder shall be applied by electrostatic powder spray. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer- in-Charge or his authorized representative. The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate, shall be applied on aluminium doors, windows and ventilators by the supplier to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is completed

41.6 HARDWARE

All cut outs, recesses, mortising or milling and operations required for fixing the hardware shall be accurately made reinforced with packing plate as required to ensure adequate strength of the connection. All the hardware accessories shall be of best approved type and of anodised finish same as for the frames and other sections. Each lock shall be supplied with two stainless steel keys and each key shall be with number stamped thereon according to the number on doors so installed. All hardware shall be free from defects, which may affect the appearance and serviceability. All hardware shall be fixed after obtaining the prior approval of the Engineer-in-Charge. Approved samples of hardware shall be kept in the custody of the Engineer-in-Charge. Working and moving parts of locksets shall be accurately fitted to smooth, close bearings and shall be free from rattle. The floor springs shall be of heavy-duty type and should allow door operation smoothly and shall conform to IS 6315. The contractor shall furnish a guarantee for all finishing and quality of hardware covered under this section and which shall remain free from defects of any kind, either materials and/or workmanship for a period of one year (unless otherwise specified) from the date of completion/handing over of work. The contractor shall repair or replace any and all defective work and damage caused, at any time or times during that period within 3 days from the written notice. This shall be done without any extra cost to the Department and to the complete satisfaction of the Engineer-in-Charge. In case the same are not replaced immediately after the receipt of the notice to do so, the Department shall do so at the cost of contractors. The cost as certified by the Engineer-in-Charge shall be final and binding on the contractors.

41.7 FIXING

Fixing and glazing of doors, windows and ventilators shall conform to IS 1081, unless otherwise specified. The frames shall be accurately fixed in the flooring / brick masonry or R.C.C. works. The fixing of the frame

shall be done with cadmium plated brass counter sunk screws driven on to the teak wood rough ground, or fixed to the wall with hold fasts as directed by the Engineer-in-charge, and as shown in approved drawings. All aluminium works shall be fixed in position as per relevant Indian Standard Specifications and code of practice for fixing and glazing of aluminium work. Joints between metal and masonry shall be fully caulked with mastic / polysulphide compound in order to ensure water tight joints as directed by the Engineer-in-Charge. Joints shall be neatly painted with matching cement and excess materials shall be removed. Fixing of aluminium door entrances, hardware etc. shall be done in best workmanship like manner true to line, level, plane, plumb etc. and all as directed by the Engineer-in-Charge. Breaking of floor for providing floor springs and restoration of the floor finishes to the original specification and finishes and minor additions and alterations to the openings shall be deemed to have been included in the quoted rates.

41.8 GLASS AND GLAZING

41.8.1 **Glass :** The glass unless otherwise specified, shall be clear float glass of specified thickness and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable

defects. The float glass shall conform to the IS 14900.

41.8.2 **Glazing Clips/ Beading :** The glazing clips/beading where specified in drawings for aluminium/steel doors and windows shall be anodised aluminium beading of channel section or as specified & as per sizes mentioned in the item and/or shown in the drawing.

The junction of the beadings shall be mitre jointed. Holes for glazing clips shall be drilled prior to fabrication and shall not be done at any later stage.

The glass shall be cut to the required sizes of panels where it is to be fitted and it shall be so cut that it fits properly in the frames without rattling. Pre-measurement of each panel prior to the cutting of glass isessential.

The clips/beading shall then be fixed to glass panes and screwed at close intervals not more than 10 cm. from each corner and the intermediate not more than 20 cm. apart. When glass panes are fixed with wooden beadings having mitred joints or aluminium beading, a thin layer of glaziers putty shall be applied covering the area in contact between the glass and sash-bars and beadings. In case of louvers all the exposed edges of the glass shall be ground properly.

41.8.3 **Glazing :** The glass panes shall be fixed to the frame as mentioned above with approved quality EPDM gasket with snap-in-bevelled anodised matt finished aluminium metal glazing stops inside and outside. In the fixed side and transom light, the thickness of glass or panel shall be accommodated by the screw down glazing stops. The glass panels shall be fixed firmly and truly parallel to the plane of frames. All damages or breakages during glazing shall be made good at the contractors own cost till the work isproperly taken over by the Engineer-in-Charge.

All wall spans, doors and windows glazing /fixed glazing etc. shall be tested for water tightness. Anyleakage found during testing, it shall be the responsibility of the contractor to rectify the same without any extra cost.

41.9 GENERAL

After the inspection is over and permitted by the Engineer-in-Charge, the glass panes shall be cleanedoff any labels, paint smears and spots and shall be washed from both the side and all glazing left clear,perfect and free from rattling. The contractor shall provide all the scaffolding, tools and plants for fixing the glass panes at his own cost. In case of aluminium/steel doors/windows any hardware if fixed in position shall be removed temporarily before fixing the glass panes and which shall be re-fixed back in position all at the contractors cost.

41.10 MODE OF MEASUREMENT

41.10.1 **Aluminium work:** The measurement of aluminium sections shall be taken only after the frames along with shutters are fixed in its final finished position in line, level and plumb. Length of each extrudedsection used for fabrication shall be measured **outer to outer of cut length** correct two places of decimal of a metre.

The weight of material used shall be calculated on the basis of actual weight of extruded sections used for fabrication and shall be compared with the weights given in the catalogue of the approved manufacturersubject to the condition that the variation in actual weight should not exceed (+ / -) 10% than the approved catalogue weights. The payment shall be made for the actual weight of the extruded section **after anodising**. The final weight shall be calculated in kgs upto two places of decimal.

41.10.2 **Glazing work:** The length and width of opening for glazing inserts shall be measured correct to a centimetre and area for payment shall be calculated in square metre nearest to 0.01 SqM.

41.11 RATE

Unless otherwise specified, fittings and fixtures such as window handles, hinges, peg-stays, friction-stays, concealed window lock, cleat angles, stiffener plates etc. shall not be measured for payment and rate quoted shall include cost of all such fittings, accessories and hardware. However, door closer, floor springs shall be measured separately as specified in the item and paid for.

The rate quoted shall include all taxes, duties etc. tools, plants, labour involved in all the operations described

above, fixing in final position including submitting shop drawings etc. and all incidentals to thejob involved.

41.12 TESTING

Aluminium sections shall be tested for its unit weight, anodic coating etc. as per relevant IS codes.

41.13 GUARANTEE

All materials and workmanship in above work shall be guaranteed for a period of one year (unless otherwise specified) from the date of handing over the work. Unqualified performance guarantee for smooth operation of the windows, doors, wall spans and precautionary measures against leakages etc. shall be furnished by the contractor on stamped paper, if so specified in schedule of quantities. Any defect found during the guarantee period shall be replaced/made good to the original conditions/positions entirely at the cost of the contractor.

42. PANELING MATERIAL: (Other than Glass)

42.1 Pre-laminated Particle Board: A particles board laminated on both surfaces by synthetic resin impregnated base papers under heat and pressure. Pre-laminated particle boards shall be of two grades, namely, Grade I and II corresponding to IS 3087 & 12823 respectively

42.1.1 Dimensions and Tolerances: Dimensions and tolerances shall conform to IS 12049.

42.1.2 Testing: One sample for every 100 sqm. or part thereof shall be taken and testing done as perIS 12823. For quantity less than 100 sqm, the test certificate from manufacturer shall be relied upon. TheEngineer-in-charge may ask for testing even if the quantity is less than 100 sqm.

42.2 Aluminium Sheet: Aluminium Sheets for use as panels shall be 1.25 mm thick aluminium alloysheet conforming to IS 737. Aluminium alloy sheet for use in general paneling work shall be of types (anodized or Powder coated) and thickness as specified and conforming to the requirement of IS 737. Aluminium sheets shall be of approved make and manufacturer. Aluminium panel may be prefabricatedunits manufactured on modular or non-modular dimension.

42.2.1.1 Fixing: The required size of panel, keeping sufficient margin to be inserted inside the section shall be cut to correct size and fixed firmly in the frame with CP brass or aluminium or stainless steel screws of star headed, counter sunk and matching size groove. Joints sealed with epoxy resin or siliconsealant to make the unit water proof.

42.2.2 Measurements: The length and width of opening for panellings shall be measured correct to a centimetre and area for payment shall be calculated in square metre nearest to 0.01 SqM.

42.3 Plywood Boards

42.3.1 Plywood shall be of BWP grade or BWR grade as per IS 303.

42.3.2 Marine plywood confirming to IS 710.

42.3.3 Fire resistant plywood confirming to IS 5509.

42.3.4 Thickness: Plywood boards are available in thickness ranging from 3 to 25 mm. Tolerance in thickness shall be ± 10% for boards upto and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. **Note :** Plywood of 9 mm thick of 5 or 7 ply may be used generally.

42.3.5 Moisture content of the plywood boards when tested in accordance with IS 1734 (Part 1) shall not be less than 5 per cent and not more than 15 per cent.

42.4 Particle Boards: Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocellulose i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

42.4.1 Adhesives: Adhesives used for bonding shall be BWP type synthetic resin conforming to IS 848.

42.4.2 Thickness and Tolerance: Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for boards upto and including 25 mm thick and ± 2.5 per cent for boards above 25 mm thickness. Each board shall be of uniform thickness.

42.5 Veneered Particle Boards: Veneered Particle Boards with core of FPT-1 or graded board Grade-I particle board (IS 3087) with commercial or general purpose veneer (Type-1) or decorative veneers on both faces or with decorative veneer on one face and commercial /general purpose veneers on the other Type-2. Face veneers are bonded using adhesives under the influence of heat and pressure.

42.5.1 Adhesives: The adhesive used for bonding veneers shall be BWP or BWR type conforming to IS 848 for grade I veneered particle board.

42.5.2 Thickness & Tolerance : Veneered particle boards are available in various thickness 6, 10, 12, 20, 25, 30, 35, 40, 45 & 50 mm. Tolerance in thickness shall be ± 5%.

42.5.3 Type of face veneers, thickness of veneered particle boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade veneered particle boards with BWP type synthetic resin adhesive shall be used.

42.6 Non-Asbestos Fibre Boards: Fibre boards shall be of medium density cement board reinforced with wood fibre, produced by fiberizing steamed wood under pressure, blended with adhesive and wax and formed into solid panels under controlled conditions of heat and pressure as per IS 14862.

42.6.1 Adhesives: The adhesive used for bonding shall be BWP type synthetic resin conforming to IS 848.

42.6.2 Thickness: Fibre boards are available in thickness 6, 9, 12, 15, 18, 22, 25, 30, 35 & 40 mm. The tolerance in thickness shall be ± 0.3 mm. Thickness of fibre boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade fibre boards bonded with BWP type synthetic resin adhesive shall be used.

42.7 Veneered Decorative Plywood: Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall conform to IS 1328.

42.7.1 Requirement of Veneered decorative plywood shall be as under:

(a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

(b) The decorative veneered surface shall be free from torn grain, dead knots discolourisation and sapwood.

(c) The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects. All veneers shall be

matched or mismatched to achieve a decorative effect in colour figure and grain.

42.7.2 Adhesive: The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

42.7.3 Thickness: The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

42.8 PRE-LAMINATED MEDIUM DENSITY FIBER BOARD: Pre-laminated medium density fiber boards are available in two grades namely Grade I and II as per IS 14587:1998. Each grade is further classified in four types; namely Type –I, II, III, IV.

42.8.1 Material

A medium density fiber board laminated on both surfaces by synthetic resin impregnated base papers conforming to IS 14587:1998 Grade-I, type II or I shall be used.

Impregnated Base Paper : Printed or plain coloured absorbent base paper having a weight of 60-140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of medium density fiber board.

Impregnated Overlay : An absorbent tissue paper having a weight of 18-40 g/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

42.8.2 Thickness: The thickness of pre-laminated medium density fibre boards shall be 6, 9, 12, 15, 18, 22, 25, 30, 35 and 40 mm.

42.9 Marine Plywood: Marine plywood shall be generally conforming to IS 710. Selection of timber species for manufacture of plywood shall be as prescribed in IS 710 and as far as possible a single species of timber shall be used. The adhesive used for bonding the veneer shall be of the hot press synthetic resin, phenol formaldehyde type (BWP) and shall conform to IS 848. Extender shall not be added to the adhesive by the plywood manufactures. Fillers, if used, shall not exceed 10 percent by mass of solid content of the glue.

42.10 Fire Retardant Plywood: Fire retardant plywood shall generally conform to IS 5509. The plywood to be given fire retardant treatment shall conform to BWR grade of IS 303 to be able to stand pressure impregnation. Plywood for treatment shall be clean, free from oil or dirt patches on the surface and at a moisture content not exceeding 15 percent. In case of veneered decorative plywood care shall be taken that colour of the solution does not spoil to decorative surface. For Eco-mark the plywood shall conform to the requirements of Eco-mark specified in IS 303.

42.10.1 Fire Retardant Treatment: This shall be either pressure impregnation or soaking treatment as per IS 5509.

42.10.2 Choice of Treatment: The choice of treatment may be left to the manufacturer of plywood as per fire resistant requirements prescribed in IS 5509. The purchaser should however, specify whether plywood is to be treated with fire retardants only or with fire retardants and preservatives. The recommended retention of fire retardant chemicals for different hazards like interior or exterior use not subject to leaching by rain and water is of the order of 50 kg/m.

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43. uPVC Casement / Sliding Windows and Doors

43.1 Material: uPVC (un-plasticised polyvinyl chloride) is PVC resin blended with acrylic modifier, titanium dioxide and other chemicals. Then it is processed through machine and mould to produce required uPVC multi-chambered profiles. The factory made uPVC white colour doors and windows shall be comprising of approved uPVC make multi-chambered frames, sash and mullion duly reinforced with appropriate thickness of galvanised iron section of required length, an appropriate dimension of uPVC glazing beads, EPDM gasket according to frame/sash profile and specified hardware and fittings of approved make having dimensions as per nomenclature of items. There are two type of uPVC extruded profile series which are used depending upon the size and design of window/door and wind load consideration and the agency shall also provide wind load calculation sheet duly approved by the Engineer-in-Charge as per IS 875 (Part-3) namely **Small Series** (small depth dimension) having wall thickness of 1.9±0.2 mm and **Big Series** (big depth dimension) having wall thickness of 2.3±0.2 mm of uPVC main profile i.e frame.

Note :

(i) For building it is a must to use big series above 5th floor.

(ii) All uPVC profiles should be got approved by Engineer-in-charge before fixing at site of work.

43.2 Tolerance in profile dimension

For uPVC frame, sash and mullion extruded profile minus 5 % tolerance in dimension. i.e in depth and width of profile shall be accepted. Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

43.3 Terminology

(a) **Frame:** Non movable or fixed portion of the window/door attached to the wall and to which the sash is assembled.

(b) **Sash:** Movable part in a window/door.

(c) **Glazing Bead:** Profile which holds the glass or any other partition materials.

(d) **Transom (or Mullion):** Profile used within the frame, vertically or horizontally in a frame and/ or sash.

43.4 Marking

uPVC profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every one meter along the length of the profile and it should be visible when the window is open as well as shall contain the following minimum information on the main profile such as frame, sash and mullion/transom.

(i) The name of the trade mark or brand name of the manufacturer

(ii) Date of manufacturing and profile code

43.5 Testing (Criteria for conformity)

The uPVC extruded hollow profiles use in window and doors shall conform to the manufacturer's specification or as per **EN 12608** and other standards.

Minimum percentage of **titanium dioxide** content in uPVC profiles shall not be less than **7.00 percent** and **calcium carbonate** content shall not be more than **10.00 percent**.

The uPVC casement / fixed / sliding windows and doors shall be factory fabricated by the approved manufacturer and installation work shall be carried out by them or their authorised vendor duly approved by the Engineer - in -charge.

43.6 Configuration: Indicative size and configuration of window& door (Casement/ sliding) are

specified in the item in the tender document.

43.7 Fabrication

(i) According to the drawing, the required dimension and length of uPVC frame, sash and mullion profiles shall be mitred cut and reinforced with galvanised iron section of required length and thickness.

(ii) All frame and sash profiles of door and window shall be fusion welded at all corners. Mullion and Transom profiles shall also be fusion welded as per window / door design so as to prevent any ingress of water or air in the reinforcement chamber.

(i) Each corner and joints shall be neatly cleaned by removing all excess material. The weld shall be finished by grooving, knifing etc. at exposed welded portion only.

(iv) The minimum overlap of 6 mm shall be provided on frame and mullion to ensure effective seal between the sash and frame.

(v) The window / door shall be designed and provided water drainage/ventilation slots in profile of frame, sash, transom or mullion in order to permit the escape of entrapped water, moisture from the system. A minimum of 2 nos slots shall be provided at least at every 500 mm. The drainage shall be so designed as not to puncture the reinforcement chamber and prevent water running through the reinforcement chamber. The holes and slots shall offset between the inner and outer walls so as to prevent any back flow.

43.8 Reinforcement

(i) The reinforcement material should be non-hygroscopic and should have no adverse effect of the performance of the window/door and it shall confirm to any grade of IS 1079 or IS 513.

(ii) Mild steel section reinforcement made from Roll forming process and shall be hot dip zinc galvanised in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.

(iii) The thickness of reinforcement shall be as such that the uPVC window and doors meet the design wind pressure in accordance with IS 875 (Part-3) and design of the reinforcement should be as per uPVC profile manufacturer recommendation and fix to ensure adequate fastener retention.

(iv) Galvanised mild steel reinforcement section is to be inserted in uPVC frame, sash and mullion profile of required length with in 6 to 15 mm distance from the face of the weld and then shall be screwed at 150mm from the end at every 400 mm (maximum) pitch to uPVC profile so that it does not move or rattle.

(v) Galvanised mild steel reinforcement section thickness shall be changed according to floor level keeping in consideration of wind load factor and minimum thickness should be as below:

- From ground floor upto floor 5th level = 1.60±0.2 mm
- From floor 5th level onwards = 2.20±0.2 mm

43.9 Glazing

(i) After fusion welding and cleaning of the corner of the sash prescribed glass panes shall be placed after fitting EPDM gasket and uPVC beading of approved quality and make.

(ii) Window sash shall be made in such a way that glazing or re-glazing is possible at site without the need to remove the outer frame.

(iii) The plastic spacer shall be used to provide to support the glass in sash/frame.

(iv) The following glass thickness shall be used in uPVC windows and doors but in no case less than 4mm.

- For single glazing - 4 to 6mm

- For double glazing - 20 mm or 24mm

Glazing supports shall be provided on frame or sash in order to distribute the load of the glass and to place the glass in the frame or sash. Spacers that would provide supports to the glass in the frame or sash shall be installed after the glazing support are installed. The supports and spacers shall be so placed as not block the drainage holes/slots.

43.10 Glazing gasket & Weather pile strip/ Wool pile

(i) Material for glazing gaskets shall be of EPDM (Ethylene propylene diene monomer) and shall be used on both side of glass panes in uPVC sash and glazing bead profiles.

(ii) Weather pile strip / Wool pile shall be used in uPVC sliding door and window to reduce air filtration and water penetration.

43.11 Window / Door Hardware and Fittings

Materials for all hardware except for fixing shall have at least the equivalent corrosion resistance of EN 1670- 1988 grade 4 (240 hrs) when subjected to natural salt spray testing in accordance with EN ISO 9227. Testing shall be carried out on complete hardware items and also duly approved by the Engineer - in - charge before use at the site of work.

Hardware like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 199 (Windows and Doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear.

These shall be provided as per nomenclature of item of approved make and duly approved by Engineer-in- Charge before fixing at site of work. Hardware / fittings such as handle, roller, touch lock, multipoint locking, 3D hinges, friction hinges etc. shall be directly screwed not pre-drilled or hammered.

43.11.1 For Casement windows

Approved quality stainless steel friction hinges (SS 304 grade) with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top and one at bottom.

43.11.2 For Casement doors

Minimum three numbers of approved quality 3D hinges with necessary SS screws shall be provided in the casement door shutter up to 0.90 meter in width and 2.10 meter in height, for more than 2.10 metre height minimum four numbers 3D hinges to be used.

43.11.3 For Sliding windows/doors

One pair of zinc alloy body with single nylon roller (weight bearing capacity to be 40 kg) upto 1.50m window height dimension and one pair stainless steel (SS 304 grade) body with adjustable double nylon roller (weight bearing capacity to be 120kg) above 1.50 m window height dimension of approved quality to each shutter of window shall be provided.

One pair of adjustable double nylon roller of approved quality to each shutter of door shall be provided.

In case of wire mesh, stainless steel fly proof wire mesh shall be provided as per nomenclature of item of approved make and manufactures duly approved by the Engineer-in-charge before fixing at site of work. SS wire mesh must be in the first track of the three track frame from the interior field of vision and that SS wire mesh must be fixed with EPDM gasket in a sash profile as the glass sash profile.

43.11.4 Tolerance

The tolerance in dimensions of finished window / door in size shall not be more than ± 5mm from the approved drawing dimension.

43.11.5 Installation

(i) There shall be a maximum gap of 3 to 5mm in between uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level.

(ii) To maintain the exact dimension of door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing of door or window.

(iii) The uPVC frames are to be fixed in prepared opening in the walls. Window / door frame shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100x8mm fasteners of approved make.

(iv) The gap between uPVC window / door and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mmin width to allow expansion/contraction of uPVC profiles. Silicon sealant of matching colour of uPVC profile shall be applied over backer rod.

43.11.6 Precautions taken before installation of uPVC Window &Door

(i) Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where uPVC window / door to be fixed.

(ii) Aperture shall be smooth in line and level as well as in plumb.

(iii) Flooring (where casement door is to be installed should be complete before installation of door).

(iv) The grill where to be installed in sliding / casement window should be provided after the installation of window.

(a) For sliding window – The grill shall be provided on the outer face of window.

(b) For casement window – The grill shall be provided on the inner face of window.

(v) Installation of uPVC door and window should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. Atleast one coat of paint should be done before installation begins.

(vi) The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the window/door fabricated from the profile, when viewed by the normal vision.

43.11.7 Mode of Measurement

The length and width of the window / door shall be measured from outer to outer face of the uPVC frame correct to a centimetre. Area shall be calculated in square meter nearest to 0.01 square metres.

43.11.8 Rate

The rate includes the cost of all labour, material and T&P involved in all the operations described above at all heights of the building.

44. Wire Mesh, Wire Cloth (Wire Gauze)

44.1 Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedged by one or more wires in each edge.

44.2 Mesh : Average width of aperture and the nominal diameter of the wire shall be as under:

Average width of Aperture mm	Nominal dia. of wire mm
1.40	0.63
1.18	0.56
1.00	0.50

44.3 Width of aperture and dia of wire cloth shall be as specified. Unless otherwise stated, wire cloth of 1.40 mm average aperture width woven with 0.63 mm nominal dia galvanized mild steel wire shall be used. Fly-proof wire cloth (aperture 1.40 mm) is generally provided in Kitchen and dining areas while wire cloth of smaller aperture is used in mosquito proof shutters.

45 ALUMINIUM CURTAIN WALL SYSTEM

45.1 GENERAL

1) Aluminium Curtain Wall System shall be designed for the following effects:
   (a) Permanent Deformation, thermal expansion.
   (b) Wind and seismic load
   (c) Air and water infiltration or leakage.
   (d) Lateral deflection per floor height

2) Unless otherwise specified the design of the system shall be prepared by the specialized firm for executing such works and submitted to the EIC / Department for approval after detailed scrutiny and checking design calculations and drawings.

3) The work shall bear five years guarantee. It will be obligatory on the part of the contractor to execute the work systematically and conduct the necessary mock-up unit tests, before taking up the work to the satisfaction of EIC / Department.

45.2 SPECIFICATION FOR MATERIALS USED FOR CURTAIN WALL

Table 45.1: Specification for Materials Used for Curtain Wall

1	**Glazing**	Glazing work shall be as specified in the description of the item and / or as described under the chapter 35 (Glass & Glazing) of this book.
2	**Framing system**	Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.
3	**Sealant**	As specified in the item or silicon sealant
4	**Heat Reflective Toughened Glass**	As per approved Manufacturer‟s specification. (a) Saint Gobain - Reflectosolar as specified. (b) Asahi India glass (Colour and shade as specified in item)

45.2.1 **Aluminium Alloy Extruded Sections:** Extruded sections to be used for fabrication of framing system for curtain walls shall be manufactured and supplied by approved reputed companies. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works. Dimensions and weights of the sections shall be as per approved drawings.

45.2.2 **Components, General specifications, Glazing, Panelling etc. for Curtain Wall System:** Theseshall be generally as per relevant Chapters of this book.

45.3 SCOPE OF WORK

45.3.1 Preliminary Requirements

i) The contractor shall design, test, fabricate, deliver, install and guarantee all construction necessary to provide a complete curtain wall system, all in conformity with the drawings and approval of the Engineer-in-Charge.

ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawings.

iii) The curtain wall system shall also include the following activities

(a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure,windows etc.
(b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
(c) All thermal insulation associated with the system.
(d) All fire protection associated with the system.
(e) All copings and closure and metal cladding to complete the system.
(f) All sealing and flushing including sealing at junctions with other trades to achieve completewater tightness in the system.
(g) Isolation of dissimilar metals and moving parts,
(h) Anticorrosive treatment on all metals used in the system,
(i) Polyester powder coating/anodized aluminium sections,

(iv) The contractor shall also be responsible for providing the following

(a) Engineering proposal, shop drawings, engineering data and structural calculations inconnection with the design of the curtain wall system.
(b) Mock-ups, samples and test units.(If Specified)
(c) Performance testing of the curtain wall framing and glazing assembly.(If Specified)
(d) Co-ordination with the work of other trade.
(e) Insulation with glass wool 48 kg/cum at spandrels area.
(f) Protection.
(g) All final exterior and interior cleaning and finishing of the curtain wall system.
(h) As built record drawings and photographs.
(i) Guarantees and warranties.
(j) All hoisting, scaffolding, staging and temporary services.
(k) Conceptualising and design of a suitable maintenance system for curtain glazing,

(v) The water tightness and structural stability of the whole curtain wall system shall be the prime responsibility of the contractor. Any defect or leakage found within the guarantee period shall be sealed and made good all at the risk and cost of the contractor.

(vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should bedesigned to accommodate thermal and building movements.

45.4 DESIGN REQUIREMENTS

(i) Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.

(ii) All curtain walling, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following requirements.

45.4.1 **Basic requirement:** The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However the contractor may propose alternatives on the construction details for approval of the Engineer-in-Charge, provided that all basic functional and architectural requirements are fulfilled.

45.5 QUALITY CONSIDERATION AND OTHER ACTIVITIES

(i) The contractor while submitting the detailed design calculations should submit the following information on the quality of materials to be used and other aspects as detailed below:

(1) Metal quality, finishes and thickness
(2) Glass quality, coating and thickness and proposed manufacturer‟s brand names.
(3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer‟s brand name and also the name of agency proposed for fabrication work.
(4) Arrangement and jointing of components.
(5) Field connections especially mullion to mullion and transom to mullion.
(6) Fixing and anchorage system of typical wall unit together with structural calculations.
(7) Drainage system and provision in respect of water leakage in the curtain wall system.
(8) Provisions for thermal movements.
(9) Sealant and sealing methods.
(10) Glazing Method
(11) Wind load and seismic load and any other specific load considered in the design

(ii) Design concept over lighting protection link-up system of the curtain wall for connection and incorporation into the lighting conductor system of the building (Lighting conductor system of the building shall be done by other approved specialized agency).

(iii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

45.6 TOLERANCES

Any parts of the curtain wall, when completed, shall be within the following tolerances:

1. Deviation from plumb level or dimensioned angle must not exceed 3 mm per 3.5 m length of any member, or 6 mm in any total run in any line.
2. Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.
3. Change in deviation must not exceed 3mm for any 3.5 m run in any direction.

45.7 SAMPLES

The contractor shall also submit samples of aluminium extruded sections; mullion and transom sections in lengths of 300 mm with the same finish and workmanship as per the tender proposals and 300 mm x 300 mm samples of glass for approval of the EIC. (samples to include exposed screws and other exposed securing devices if any).

45.8 ANCILLARY REQUIREMENTS TO BE FULFILLED BY THE CONTRACTOR

(i) The contractor / approved specialized agency shall submit a maintenance manual for the curtain wall system inclusive of all metal parts, glass and finish etc.

(ii) During detailed design scrutiny and also during the actual execution of the work any additions and extra provisions that will have to be made as per theoretical requirements or site conditions shall be implemented and executed by the contractor at his own cost, without claiming any thing extra under any circumstances.

45.9 EXECUTION OF WORK

Performance Testing (To be done if specified and shall be paid under relevant item) - General Requirements

i) Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the face of the building.

ii) After the approval of structural calculations and the drawing for construction of the curtain wall, one test

unit for performance testing of the curtain wall shall be constructed by the contractor at an independent laboratory or at a laboratory approved by the Engineer-in-Charge.

(iii) Erect mock-up under manufacturer's / Fabricator's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

(iv) The contractor shall submit to the Engineer-in-Charge the test procedures to be adopted, test schedule and location for testing before the work of actual testing is taken up.

(v) Prior to the fabrication of test units, the contractor shall submit shop drawings and design calculations of the test unit for approval of the Engineer-in-Charge.

(vi) The contractor shall not start the work of erection of curtain wall on site till the approval for the successful completion of the mock up test and clear instruction in writing to start the work is received from the Engineer-in-Charge.

(vii) The decision of the Engineer-in-charge in respect of the procedure to be adopted, in conducting the mock-up test and the judgment over the net results, shall be final and binding on the contractor.

45.10 TEST OF WIND PRESSURE

(i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the "pressure chamber" at which the test unit is fixed.
(ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.
(iii) The variation of dynamic pressure shall be of any approximate sine curve line.
(iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.
(v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

45.11 THE DEFLECTION ON THE MAIN STRUCTURAL PARTS IN THIS CONDITION SHALL NOT EXCEED

(1) 1/175 of the span between supports or 20 mm, whichever is less for vertical elements.
(2) 1/250 of the span between supports for horizontal elements.
(3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

45.12 TEST OF LATERAL DEFLECTION PER FLOOR HEIGHT

(i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.
(ii) The deflection of every ± 2.5 mm shall be increased up to ± 13 mm on the test unit (static deflection test)
(iii) The dynamic deflection shall be applied up to ± 13 mm.
(iv) The variation of dynamic deflection shall be of an approximate sine curve line, one period of 3 seconds.
(v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the damage shall be observed.
(vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

45.13 WATER-TIGHTNESS TEST

(i) Water shall be sprinkled to the Test Unit under wind pressure.
(ii) Pressure shall not be applied to the test unit.
(iii) The volume of the sprinkling water in one minute shall be 5 litres per sqm minimum.
(iv) All water leakage and drainage system at the joint and the openable sash of the curtain wall system shall be observed from the outside of the chamber.
(v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.
(vi) Water leakage shall not be observed inside at all parts of the test unit during first water-tightness

test.

(1) Install the test unit.
(2) Hold first water-tightness test.
(3) Hold test of wind pressure as described above.
(4) Hold second water-tightness test.
(5) Lateral deflection test.

45.14 TEST REPORT

The contractor shall submit five copies of test report to the Engineer-in-charge.

45.15 COST OF PERFORMANCE TEST

(i) The contractor shall allow in his tender for the cost of the performance testing(if specified in item) and fabrication, erection, corrections to and demolition of the test units including any special provision required in the testing laboratory for the tests mentioned above.
(ii) The contractor shall allow for amendments and adjustments to the mock-up unit as instructedand required by the Engineer-in-Charge / Architect or the consultant.
(iii) If the mock-up test unit fails to pass the initial testing, the contractor shall make the necessary corrections to the test unit and shall get the test unit retested by the testing laboratory until it passes the test.
(iv) Cost of corrections to the test unit and the cost of retesting shall be borne by the contractor.
(v) The contractor shall be allowed six calendar months time after the work is awarded to set upthe test unit and conduct the required test as described above to the satisfaction of the Engineer- in-charge.
(vi) In case the contractor fails to conduct the necessary tests as described above or fails to meet the required test results, without any genuine cause within the allotted period of six months, the Engineer-in-charge shall be free to rescind the contract with all costs including the forfeiture of
E.M.D. and any other securities deposited by the contractor under the condition of contract.

45.16 RECORD OF TEST AND DRAWINGS

(i) The testing laboratory shall keep the approved copy of the shop drawing and calculations of the test unit at testing laboratory during testing of test unit.
(ii) The testing laboratory shall accurately and nearly record on the above mentioned shop drawings all changes, revisions, modifications etc. made to test unit, which shall become the record drawing.
(iii) On completion of testing and after approval of the test reports the testing laboratory shall submit the final record drawings to the Engineer-in-charge.

45.17 FABRICATION AND ERECTION

(i) Frames shall be square and flat, both the fixed and openable frames shall be constructed ofsections, which have been cut to length, mitred and mechanically jointed at the corners, Sub- dividing bar of units shall be tenoned and riveted into frames.
All frames shall have corners welded to true right angles. For jointing hollow sections flash butt welding, argon arc welding or mechanical jointing by inserts shall be used. (Gas welding or brazing shall not be done). Concealed screws shall be used for joining the sub-units.
(ii) The grid for the curtain wall system shall be fabricated carefully with aluminium extruded sections like mullions and transom in the exactly same pattern as per the final drawings with amendments if any received from the laboratory after conducting the mock-up unit test.

(iii) The sizes of different members of the curtain wall system shall be exactly as adopted for themock-up unit tests and the grid shall be fixed to the building member as shown in the drawing, received after conducting the mock-up unit test.
(iv) Care should be taken to see that any gap between the frame and support and the frame itselfis sealed with silicon sealant.
(v) Finish of grid frame shall be either anodized, organic coating, backed enamel finish or as specified in the item of work, no visual variation in anodizing / colour shall be accepted.
(vi) Care shall be taken to see that the curtain wall system is not deformed, damaged during erection and it shall be protected from direct contact with wet or intermittent wet cement concrete mortar etc.

45.18 REPRESENTATIVE OF THE CONTRACTOR

Full time attendance of a qualified civil engineer with sufficient experience in construction of curtain wall system shall be provided for erection of test unit, all testing and later on actual construction.

45.19 PERFORMANCE GUARANTEE

The contractor shall provide a performance guarantee as indicated in the Schedule of Quantities for a period of five years, to provide for expenses to cover the risk and cost of rectification of defect, noticed during the five years guarantee period. Guarantee period shall start from the date of completion and handing over of the project.

45.20 MEASUREMENTS

a) On area basis:

(i) The breadth and the height of the finished work including the openable windows shall be measured correct to a centimeter and the net quantity for payment shall be calculated in SqM up to two places of decimal.

(ii) The area to be considered for measurement shall be the net area of the exterior face of the curtain wall as fixed including the openable windows, if any, as part of the curtain wall.

b) Framework on weight basis

i) The measurement of aluminium sections shall be taken only after the frames along with shutters are fixed in its final finished position in line, level and plumb. Length of each extruded section used for fabrication shall be measured **outer to outer of cut length** correct upto 5 mm.

The weight of material used shall be calculated on the basis of actual weight of extruded sections used for fabrication and shall be compared with the weights given in the catalogue of the approved manufacturer subject to the condition that the variation in actual weight should not exceed (+ / -) 10% than the approved catalogue weights. The payment shall be made for the actual weight of the extruded section **after anodising**. The final weight shall be calculated in kgs upto two places of decimal.

ii) **Glazing/ paneling work(on Area basis):** The length and width of opening for glazing/ paneling inserts shall be measured correct to a centimeter and area for payment shall be calculated in square metre nearest to 0.01 SqM.

45.21 RATE

The rate shall include the cost of all operations (excluding performance test which shall be paid separately) described above including the cost of materials, labour, design, shop drawings, fabrication, erection, finishing, scaffolding, undertaking performance guarantee etc.. No other claims of any kind pertaining to this work shall be entertained.

Payment for performance test/ mock-up test, if specified in the Schedule of quantities, shall be paid separately.

46 STRUCTURAL GLAZING

46.1 INTRODUCTION

Due to its smooth mirror like exterior finish, Structural Glazing nowadays, has become widely used modern material for external walling in high rise commercial as well as residential buildings; it reflects a large

portion of the solar radiation falling on the building thereby reducing the heat load inside the building. This leads to better temperature control inside the building even during hot weather.

46.2 SPECIFICATION FOR MATERIALS TO BE USED IN STRUCTURAL GLAZING

Aluminium extruded sections shall be from approved and reputed / renowned manufacturer. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works.

46.2.1 **Structural Sealant:** Silicone structural glazing utilizes a high performance silicone sealant to attach glass, metal or other panel material to a metal frame in lieu of gaskets and mechanical attachments. The wind load stresses on the façade are transferred through the structural silicone sealant to the structure ofthe building. The structural silicone sealant must maintain its adhesive and cohesive properties in order to support the panels under wind load. Only silicone sealant is suitable for use in structural glazing application.

Substrate for structural glazing shall be selected considering the joint design and adhesive of the structural silicone. A flat surface with no gasket races, key slots, serrations, or other irregularities is required. For extruded substrates the width of extrusion must be adequate to achieve the calculated minimum structural bite with a suitable spacer attached. Extruded mill finish aluminum is not an appropriate surface for structural silicon application due to poor adhesion. The sections should be either Anodized or polyester powder coated as per specification.

In addition to suitability of substrate for adhesion, gasket and other accessory material like cleaning liquid, spacer tape,masking tape,weather sealant etc. must be compatible with the structural sealant. Forextruded substrates the width of extrusion must be adequate to achieve calculated structural bite (minimum width or contact surface of the silicone sealant on both the panel and the frame) with a suitable spacer attached.

46.2.2 **Glass:** Glass to be used in structural glazing shall be tempered glass as per relevant specifications under chapter „Glass & Glazing."

46.2.3 **Aluminium Composite Paneling (ACP):** Aluminium Composite Panel is being widely used in exterior cladding in combination with reflective glass paneling in structural framing.

Aluminium Composite Panel consists of a non-aluminium core bonded between aluminium sheets coated with PVDF or polyester paint. Non- aluminium core is made of a non-combustible antitoxic polyethylenecore material which is sandwiched between two high alloy fine aluminium sheet with superior quality PVDF(Fluor carbon) resin or polyester paint to ensure durability, stability and corrosion & weather resistant. ACP can be cut to shape, punched and bent (with limitation in bending radius) using roll bending machine.

46.2.3.1 **Technical Specification:** Aluminum composite material is manufactured using a continuous aluminum panel making plant with an online laminator, using catalytic fusion process. It is composed of a thermoplastic core of low density polyethylene sandwiched between two skins of aluminum sheets of thickness ranging from 0.2mm to 0.5mm depending upon the grade. The surface is finished with Kyanar500 flurocarbon coating on the top.

Table 38.1: Combination of Skin and Core for Aluminium Composite Material

Grade	Thickness	Aluminium skin (Front)	Combination Core	Aluminum Skin
EX 1	4 mm	0.5 mm	3.0 mm	0.5 mm
EX 2	3mm	0.25 mm	2.5 mm	0.25 mm
HBX	3mm	0.2 mm	2.6 mm	0.2 mm
HBXII	3 mm	0.3 mm	2.4 mm	0.3 mm

46.2.3.2 Product Dimension and Tolerance

Panel thickness : 3mm & 4mm(readily available),5mm,6mm

Panel size
Width - 1000mm to 1750mm Length : 2000 to 6000 mm Standard size : 1220x 2440 mm

Tolerance
Width : ± 2.0 mm Length: ± 4.0 mm Thickness : ± 0.2 mm
Bow : Max. 0.5% of the length / widthSquareness : Maximum 5 mm
Surface defect: The surface shall not have any irregularities such as roughness, buckling and other imperfections.

Panel weight:
3.0 mm: 4.6 kg/m^2
4.0 mm : 5.5 kg/m^2
Thermal Expansion : 1.2 mm /m/50^0C

46.2.3.3 Method of Fixing Composite Panel

Preparatory Work: The surface where composite panel has to be provided shall be true to line and level. Anodized aluminum frame work with suitable rectangular sections are used for fixing the panels.

Metal surfaces should be cleaned by using toluene (rectified). Clean soft, absorbent, oil free and lint freecloths can be used.

Weather Proofing: Composite panel cladding shall ensure a weather proof façade. Hence joints shall be sealed effectively by the following guidelines for designing workable joints, selecting the correct sealant, performing appropriate surface preparation and performing quality checks to ensure proper performance.

In all cases, a minimum depth of 6mm sealant/substrate bond is necessary to ensure adequate adhesion. Minimum width of 6mm opening shall be provided to ensure that sealant applied from caulking gun will flow into the sealant joint.

One part silicone sealants require atmosphere moisture to fully cure. Therefore the fully joint must be designed to ensure that the sealant is not isolated from air.

46.2.3.4 **Measurement:** Length and breadth of Cladding shall be measured correct to one centimeter andarea shall be calculated correct to two places of decimals.

46.2.4 General Specification and Tolerances for Aluminium Extrusions

Dimensions and weights of the sections shall be as per approved drawings.

46.2.4.1 Circumscribing Circle Diameter (CCD)

i) The product range shall be broadly as categorized below;

a) For solids upto 190mm.

b) For hollows upto 135mm

ii) Sections with higher CCD, if required, shall be produced from reputed / renowned manufacturer as approved by the Engineer-in-Charge.

46.2.4.2 **Manufacturing Tolerance:** Dimensional extrusions shall be normally as per IS / BSS. Special tolerances shall be mutually agreed upon.

46.2.4.3 Tolerance on cut length

i) The standard cut length is 3.66M the tolerance on cut length shall be as follows:

Table 38.2: Tolerance on Cut Length

Length	Upto 6 metres	Over 6 metres
Tolerance	+ 5 mm	+ 7 mm

ii) Sections shall also be acceptable in random lengths between 1500 to 5000mm depending upon actual requirements.

46.2.4.4 **Tolerance in Weights:** A tolerance of ± 10% shall be acceptable on Sectional weight per metre

46.2.5 Scope of Work

This shall be as described in the item of work.

46.2.6 Execution of Work:

46.2.6.1 **Installation:** Structural glazing applications must be reviewed by the Technical Service Staff of the sealant manufactures.

46.2.6.2 **Joint Design:** The design of silicone structural joint must be prepared based on industry accepted design guidelines. Basic design parameters include

(i) Glue line thickness must not be less than 6.4 mm

(ii) Structural bite must not be less than glue line thickness. The bite to glue line ratio must be between 1:1 and 3:1.

(iii) The structural sealant joint must be able to be filled using standard caulking practices.

(iv) The joint design must allow the sealant exposure to air so that it can cure and obtain the ultimate physical properties.

(v) The structural joint must not move during curing. The joint must be fully cured and adhered priorto removal of temporary fasteners.

46.2.6.3 **Preparatory work:** All the joints and glazing pockets shall be cleaned to remove all foreign matter and contaminants. The substrate and glass should be cleaned by using Toluene and clean, soft, absorbent, lint free cloth. Multiple cleaning may be required to properly clean a substrate. Organic solvent must be removed with dry cloths before the solvent evaporate.

38.2.6.3 Fixing: Primary sealant is the structural silicone adhesive which holds Glass to the Aluminum section and transfers stress to the structure from wind load, dead load, stress due to differential thermal expansion, vibration etc. it has excellent bonding capacity to hold the weight of glass. After bonding glassto the section, the primary sealent shall be applied by an applicator gun from inside to get good penetration. This structural adhesive shall be applied from top to bottom and tooling shall be from bottomto top to avoid air bubbles.
Temporary fasteners or clip must be used to retain the structurally glazed tiles or panels until the siliconehas fully cured. Alternatively, a two sided adhesive tape used as structural spacers may be considered sufficient temporary support.

The silicone sealant must be fully cured and adhered before the adhesive is stressed. After curing secondary sealant is applied.

Secondary sealant is weather proofing sealant, which seals the joint in between glass panels. A minimum width of 6mm is recommended. Depth of sealant shall be minimum 3mm. Depth of joint shall be filled with backer rod or Teflon tape to avoid three point adhesions.

46.2.7 Testing

1. Tempered glass shall be tested as per IS 2553- (Part-I)1990.
2. The fragmentation test shall also be carried out.
3. Silicone sealant shall be tested as per manufacturers" specifications.

46.2.8 Inspection

- Size of structural bite
- Size of structural glue line
- Adhesion of Silicone sealant with panel & frame
- Joint type/ condition of sealant applied
- Appearance of sealant/ Uniformity of colour/ Bubbles etc.

46.2.9 Notes on Aluminium Curtain Wall System and structural glazing

1) Though both the systems i.e. curtain wall system and structural glazing are very much similar, still the type and shape of aluminium extruded sections, that are used in this case are totally different.
2) Another noted difference between the two systems is that in elevation the structural glazing looks as total glass surface without any beading visible externally, whereas in case of curtain wall system the cover plate used on the surface is clearly visible in elevation.

38.2.10	Representative of the Contractor	These shall be similar to the Specifications for Aluminium Curtain Wall System as far as applicable
38.2.11	Performance Guarantee	
38.2.12	Measurements	
38.2.13	Rate	

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47 CEMENT PLASTERING FOR WALLS & CEILINGS AND SAND FACE / ROUGHCAST PLASTERS

47.1 SCOPE OF WORK

The work covered under these specifications consists of supplying all materials and rendering all types of plaster/pointing finishes strictly in accordance with these specifications, applicable drawings etc. For all finishing works mentioned above, only blended cement shall be a used.

47.2 GENERAL

Blended cement, sand and water required for the work shall conform to specifications laid down herein before under chapter 4 i.e. Plain and reinforced cement concrete, except that sand for finishing coat shall be fine sand conforming to I.S. 1542. The plastering works shall generally conform to I.S. 1661 (Pt. III) (Code of practice for cement and cement plaster finish on walls and ceilings). All general precautions asspecified in I.S. 1661 (Pt. III) clause-8, shall be taken and preparation of the back ground shall be done as laid down in I.S. 1661 clause 12 and I.S. 2402 shall be generally followed for rough cast and sand faced plaster work. Scaffolding required for facility of working shall be provided by the contractor at his own cost. This may be double or single according to the requirement and shall be approved by the Engineer-in- Charge. Stage scaffolding shall be erected when ceiling plastering is done. The contractor shall be responsible for accidents, if any, take place. The contractor shall co-operate with the other agencies also. Whenever electrical contractor/agency has to fix up switch boxes in walls, necessary Thiyyas, Tapanish or Dhadas shall be arranged to be given in advance of actual plastering process at these locations so that the boxes are fixed properly in line with finished plaster surface. All finishing in and around these boxes as also around the conduit boxes in ceiling shall be done by plastering contractor without any extra cost to the Department. The decision of the Engineer-in-Charge in this regard shall be final and binding on the contractor.

47.3 PREPARATION OF SURFACE

The surface to be plastered shall first be thoroughly cleaned of all muck and cleaned down. All joints shall be raked out in case of brick work / stone masonry and closely hacked in case of concrete, as per the relevant masonry / concrete/formwork items. The surface to be plastered shall be well wetted for a minimum period of 6 hours before commencing the work. The mortar for all plaster work shall be blended cement mortar of mix as specified in the schedule of quantities.

After erection of scaffolding and before commencement of plastering work, top most junctions/joints/sides with beam/column shall be thoroughly packed with blended cement mortar to prevent cracks.

Before commencement of plastering operation, the contractor shall ensure that all the service pipes, electrical conduits, boxes, switch boxes etc. have been installed in position by other agencies and the plastering surface is duly approved by the Engineer-in-Charge. In order to enable other service contractors to fix the electrical conduits, conduit boxes, EDBs, pipes, outlets etc. in proper level and line with reference to the finished surface of the plaster, Thiyyas and Tapanis i.e. finished plaster patches shall be given by the main civil contractor on walls, ceiling at regular intervals well in advance of his plaster work at no extra cost to the Department. The entire work of preparation of surface before plastering shall thus be co-ordinated by the main civil contractor with all other agencies working at site.

Just before actual plastering work is taken up in hand, all the ceilings and walls etc. shall be marked withTapanis or Thiyyas indicating the thickness of plaster required and which shall be in true line, level andplumb. The contractor shall get these marks approved by the Engineer-in-Charge before starting the plastering work. The contractor shall also be responsible to render the final surface true to line, level and plumb etc.

All building operations like construction of walls, concreting etc. shall have been completed before plastering is taken up. The plastering operation should be taken up only after the service pipes etc. that are to be embedded in the wall or ceiling are completed and suitably protected against erosion by other agencies and okayed by the Engineer-in-charge. Damage if caused to any of the existing fittings, fixtures, including doors and windows etc. during the plastering operation shall be made good by the contractor at his own cost.
If the surface which is to be plastered either internally or externally is out of plumb and not in line and level and if the plastering to be done is more than specified thickness to bring the plastered surface to perfect line and levels, in such specific cases, chicken wire mesh is to be provided by the contractor at his own cost and the plaster should be done to required line and level with no extra cost whatsoever.

The finished plastered surface shall be free from cracks, fissures, crevices, hair cracks, blisterings, local swellings and flakings. The finished surface shall be true to line, level, plumb & plain and durable. The adhesion of the mortar with the background surface is of prime importance as this affects durabilityof plaster. Preparation of surface which has to take plastering is of great importance. Before starting the plastering work the surface should be got approved by the Engineer-in-charge.

In order to avoid the formation of deep and side cracks and for dispersion of cracks at the junctions between concrete surfaces and brick masonry work as also between junction of windows/door frames and brick masonry works, cautionary measures such as fastening and lapping of chicken mesh over the junction areas should be carried out over which the plastering work has to be taken up as required by the Engineer-in-charge.

The minute gap between window/door frames with cills and jambs should be filled up/caulked by plaster of paris/epoxy putty/silicon sealants, Rubber based sealants (brand name TECHMAT/TECHCOAT) by caulking guns or by approved methods as instructed/approved by Engineer-in-Charge.

47.4 GROOVES

The grooves shall be of required dimensions. The same shall be made to turn wherever necessary. The finish, inside, shall be of the same finish as that of the plaster. The lines of the grooves shall be well defined and rounded. The grooves are to be provided in plastering in internal and external surfaces and shall be paid extra in the rates given in schedule of quantities.

47.5 MIX PROPORTIONS

The mortar for plastering shall be of proportion as specified in the item schedule. The mixes specified in the schedule are volumetric.

47.6 MIXING

Cement and fine aggregates shall be mixed dry in the required proportions to obtain a uniform colour. Water shall then be added to get the required consistency for the plaster.

Mixing shall be done mechanically. However, manual mixing will be allowed only in exceptional circumstances at the discretion of the Engineer-in-Charge. Manual mixing, where adopted, shall be carried out on a clean water tight platform. After water is added during mixing, the mix shall be held back and forth for 10 to 15 minutes.

In machine mixing, the mixer shall run atleast five minutes after placing all the ingredients in the drum. Only so much quantity of mortar which can be used within half an hour after the addition of water shall be prepared at a time. Any mortar for plaster which is set or partially set shall be rejected & shall be removed forthwith from the site.

47.7 PLASTER - THICKNESS 6 / 12 / 15 MM.

The plaster shall be laid with somewhat more than 12 mm. thickness and pressed and levelled with wooden ruler to a finished thickness of 12 mm. Straight edges shall be freely used to ensure a perfectly even surface. All exposed angles and junctions of walls, doors, windows, beams, slabs etc. shall be carefully finished so as to furnish a neat and even surface.

Note: For 6mm plaster, approved bonding agent shall be used as per manufacturer"s specifications, wherever specified in the Schedule of Items.

47.8 PLASTER - THICKNESS 20 MM.

The proportions of sand and cement shall be as specified and shall cover all irregularities, undulations, depressions due to chasing etc. in the surface to be plastered. The mortar shall be applied slightly more than 20 mm. thick and pressed and leveled with wooden ruler or straight edge to finished thickness of 20 mm. Straight edges shall be freely used to ensure a perfectly even surface. The finished surface shall be true and even and present uniform texture throughout and all joining marks shall be eliminated. All corners, edges and angles shall be made perfectly to line, plane and plumb. All exposed angles and junctions of walls, doors, windows, beams, slabs etc. shall be carefully finished so as to furnish a neat and even surface.

Plastering items amongst all other things as described in various items also include:

i) Preparation of surfaces to receive the plaster, providing cement plaster of the specified average thickness and proportions with specified number of coats.

ii) All labour, materials, scaffolding, use of tools and equipment to complete the plastering work asper specifications.

iii) Curing for 10 days.

iv) Cleaning the surface of doors, windows, floors or any other surfaces where plastering might have splashed.

v) Finishing the portion of plaster left above the terrazo, plain cement tiles, ironite or any type of skirting work to be finished rounded or as directed by the Engineer-in-Charge, in a separate operation after laying of floor tiles skirting.

vi) Curing the surface shall be carried out after 24 hours of application at least for 4 days using lightwater spray.

47.9 PLASTER OF PARIS (POP - $CaSO_4$, 1 / $2H_2O$) FINISH

Wherever specified, the wall / ceiling surfaces shall be finished smooth with approved quality Plaster of Paris (POP). POP shall be mixed in water for dehydration at site. Sufficient quantity, which can be usedwithin half an hour only, shall be prepared at a time.

POP shall be applied immediately after the under coat of cement plaster has set. An entire unobstructedarea shall be finished in one operation. POP shall be applied on top of finished coat of plaster which should be levelled without any scratch/key marks to the prepared and partially set. It shall be ensured that the surface to be covered is free of loose particles, dust, dirt, grease, oil and paint.It shall be applied withsteel trowel to a thickness slightly exceeding 2 mm and rubbed down to 2 mm. It shall be polished to perfectly silk smooth and even finish working from top to bottom. All corners shall be truly brought to desired lines and levels in the base plaster along and the thickness of POP shall not exceed 2 mm, at these locations.

If blow holes / cracks are observed in POP plaster at any time during the contract period and during the defects liability period, the contractor will have to rectify the same including redoing painting to match with the adjacent surface etc., all at his own cost to the entire satisfaction of the Engineer-in-charge.

47.10 SAND FACED CEMENT PLASTER

47.10.1 **General :** Materials and preparation of surfaces and scaffolding etc. for sand faced plaster wherever applicable shall conform to specification laid down here-in-before under section cement plastering and the following specifications are also to be complied with.

47.10.2 **Preparation of Surface :** The surface to be plastered shall first be thoroughly cleaned down. All joints shall be raked out in case of brick work / stone masonry and closely hacked and wire brushed in case of concrete, as per the relevant masonry / concrete /formwork items. The surface to be plastered shall be well wetted for a minimum period of 6 hours before commencing the work. The mortarfor all plaster work shall be cement sand mortar of mix as specified in the schedule of quantities.

Double scaffoldings required for facility of construction shall be provided by the contractor at his own expenses wherever directed by the Engineer-in-Charge. Scaffolding shall be erected with pipes or ballies or bamboos of adequate strength so as to be safe for all the dead, live and impact loads likely to sustain by it during construction operations. The contractor shall take all measures to ensure the safety of the work and workmen. Any instruction of the Engineer-in-Charge in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to Government property or injury to persons, resulting from faulty scaffolding, defective ladders and materials or otherwise arising out of his defaultin this respect. Proper scaffolding shall be provided to allow easy approach for workmen and supervisory staff to every part of the work. Ballies, bamboos etc. for scaffolding shall not be tied to the windows, doors, mulliions, ventilators etc. Any damage done to the windows, doors etc. shall be made good by the contractor to the original conditions at his own cost. For better safety, steel pipe scaffolding is preferred.

47.10.3 **Workmanship :** The surface to be plastered shall first be dubbed out with cement mortar to cover all irregularities and faces upto proudest part. The dubbing coat which shall be of proportion as specified in schedule

and a 12 mm. thick (1/2") layer shall then be applied/scored and keys shall be formed on the surface by thoroughly combing it with heavy horizontal lines about 12 mm. (1/2") apart and about 3 mm. (1/8") deep when mortar has just set.

The cement mortar for sand faced plaster shall have washed and approved sand with slightly larger proportions of coarse materials, but not exceeding 3 mm. The proportion of cement to sand shall be as specified in the schedule. The water is gradually added to make the mixture homogenous. The thickness of finishing coat excluding key shall be 8mm. (about 5/16"). After application the surface should be finished with a wooden float lined with cork closely pricked on with a wet sponge tapped gently to bring sand particles into prominence.

The chajjas and any other horizontal portions shall be cleaned and set mortar that might have been fallen at the time of plastering at higher elevation, before plastering work is taken up. Junction of wall and chajja shall be rounded off simultaneously as directed by the Engineer-in-Charge.

47.11 ROUGH CAST PLASTER

All materials shall conform to the standards already specified for plaster described above. The preparation of the surface to received the rough cast plaster shall be as described under sand face plaster. Rough cast plaster shall be carried out in two coats. First coat shall consist of 1 part of cement to 3 parts of clean sand or as specified otherwise. The finished thickness of the first coat shall be 12mm. and shall be laid by throwing the mortar (By using strong whipping motion) on the prepared surface with a trowel in a uniform layer but shall not be smooth. The second coat consists of 1 part of cement and 3 part of 6 mm. to 10 mm. down gravel all as approved by the Engineer-in-Charge. The gravel shall thoroughly be got cleaned with water removing all dirt and other organic materials. All these ingredients shall be mixed into a paste which shall be flung upon the first coat with large trowels to form an even protective coat. The second coat must be applied while the first coat is still soft and unset. The thickness of this coat shall be 10 mm. only. Due care shall be taken to avoid concentration of either large size or small size of gravel in one place. A sample of rough cast plaster shall also be got approved by the Engineer-in-Charge as regards the texture etc. before proceeding further with the work. All subsequent work shall generally conform to the approved sample panel. The finished work shall be cured for a minimum period of seven days.

General workmanship, scaffolding, preparation of surface, curing etc. shall conform to the specification already laid down under sand faced plastering.

The contractor shall take special care at the time of plastering or pointing to keep the m.s./aluminium window/wallspan etc. fixed by other agency in correct shape, position and to cover the same withrequired hessian cloth/gunny bags to keep away from sprinkling of plasters/paint etc. The damage caused to the above if any, shall be made good by the contractor at his own cost.

47.12 MODE OF MEASUREMENT

Area of plastering will be measured net and shall be paid for. The measurement of length of wall plastering shall be taken between walls or partitions (dimensions before plastering shall be taken) for thelength and from top of the floor or skirting or dado as the case may be to the underside of ceiling for the height. All openings more than 0.1 sqm. shall be deducted and all jambs, soffits, sills of these openings if done, will be measured to arrive to the net area for payment. No opening less than 0.1 sqm. shall be deducted and no jambs etc. for such openings shall be measured for payment. The rate shall include the cost of finishing all the edges, corners, cost of all materials, labours, scaffolding, transport, curing etc.

The rate shall include the cost of finishing all the edges, corners, cost of all materials, labour, transport, scaffolding, curing etc. and grooves if so specified in the item of schedule of quantities.

The rate for plastering should include the cost of work towards the following items for co-ordination with electrical item:

1. Neatly plastering around DBs, junction boxes, M.S. boxes etc. should be done and made matching

with the wall finish after installation of electrical equipments.

2. All DBs, service boxes, covers etc. should be covered by a plastic cloth or other suitable covering materials such that water or materials should not splash the same during brick work and plastering work. This is to be done in such a way that electrical equipments as well as painted surfaces are not spoiled.

3. For fixing M.S. boxes, DBs etc. Thiyya should be given such that the required face of the M.S.box, DB covers etc inline with final finished plastered surface.

4. The rate for the item shall also include rounding up of corner and angles making sharp corners and angles finishing around ceiling rose and electrical fittings etc. fixed by other agencies, finishing

of top of dado and skirting (zad finishing), junctions of roof and wall or beam with the finish as specified in the item. Plastering of brick and concrete cornice and copings and plastering in restricted areas if any shall not be measured separately. Architectural bands and narrowwidths of plaster over structural as well as non-structural and the line when prepared in thesame thickness of plaster shall not be measured separately and shall be covered by respective plaster items.

47.12.1 **Rough Cast Plaster:** The area of surfaces actually plastered will be measured net and shall be paid for. The measurements of length and height of wall plastered shall be correct to a centimeter taken between walls or projections including the width of corner edge strips including the areas of grooves. All the openings more than 0.1 sqm. shall be deducted and all jambs, soffits and sills of these openings, if plastered will be measured to arrive at the net area for the payment. No opening less than 0.1 sqm. shall be deducted and no jambs etc. for such openings shall be measured for payment. Corner/edges finishing will not be measured separately and the rate shall include the cost of finishing all the edges, corner strips in addition to the cost of all materials, labour, transport, scaffolding, curing etc. and grooves if so specified in the item of schedule of quantities.

47.13 WASHED STONE GRIT PLASTER

47.13.1 **: Materials:** i) Stone chippings obtained by crushing hard stone shall be free of dust and deleterious material. 10 mm nominal size stone chippings, where specified, shall pass 100% through 12.5 mm sieve and fully retained on 6.3 mm sieve. Stone chippings shall be thoroughly washed with water and sieved before use.
ii) Mortar : Cement mortar for under coat and cement mortar to be mixed with stone chippings for top coat shall be of mix proportion and thickness as specified in item.

47.13.2 Application of Plaster

47.13.2.1**: 12 mm Under Coat :** Under coat of cement mortar 1:4 (1 cement : 4 coarse sand) shall be applied as specified earlier except that the finishing, after the mortar has been brought to level with the wooden straight edge, shall be done with wooden float only. The surface shall be further roughened by furrowing with a scratching tool. Furrowing shall be done diagonally both ways and shall be about 2mm deep to provide a key for the top coat. The scratched lines shall not be more than 10 cm apart. The surface shall be kept wet till top coat is applied.

47.13.2.2**: 15 mm Top Coat :** Top coat comprising cement mortar and stone chippings shall have an overall proportion of 1:0.5:2 (1 cement : 0.5 coarse sand : 2 stone chippings 10 mm nominal size) or as specified. The top coat shall be applied a day or two after the under coat has taken the initial set. The surface of the under coat shall be cleaned and a coat of cement slurry at 2 kg of cement per sqm shall be applied before the application of coat. The top coat shall be applied in uniform thickness on the under coat after the application of slurry and sufficiently pressed with wooden float for proper bonding with the under coat. Vacant space, if any, shall be filled with the specified mix.

47.13.3 **Finish:** The top coat of plaster shall be finished to a true and plumb surface. The surface shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumbbobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. All the corners angles and junctions shall be truly vertical or horizontal as thecase may be. Rounding or chamfering of corners junctions etc. Where required shall be true to template.

Finished surface of the top coat after the mix has taken the initial set, shall be scrubbed and washed withsuitable brushes and plain water. Scrubbing and washing shall continue till the stone chippings are sufficiently exposed. Stone chippings which may come out while scrubbing shall be replaced using the specified mortar mix. A sample of the washed stone grit plaster shall be got approved from the Engineer- in- Charge.

47.13.4 **Grooves:** Grooves of size 15 mm x 15 mm or as specified shall be provided as shown on the drawing or as required by the Engineer-in-Charge. Tapered wooden battens to match the size and shapeof the grooves shall be fixed on the under coat with nails before the application of the top coat and theseshall be removed carefully so that the edges of the panels of top coat are not damaged. Damage, if any,shall be made good by the contractor.

47.13.5 **Curing:** Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days. During this period, it shall be suitably protected from all damages at the contractor"s expense by such means as the Engineer-in-Charge may approve.

47.13.6 **Measurements:** Length and breadth shall be measured correct to the nearest cm and the areashall be calculated in sqm correct to two places of decimal.

Measurements shall be taken for the work actually done. All the openings more than 0.1 sqm. shall be deducted and all jambs, soffits and sills of these openings, if plastered will be measured to arrive at the net area for the payment. No opening less than 0.1 sqm. shall be deducted and no jambs etc. for such openings shall be measured for payment. Corner/edges finishing will not be measured separately. However, no deduction is to be made for the grooves provided as specified above.

47.13.7 **:** The rates shall include the cost of all labour and materials, scaffolding,curing etc. involved in allthe operations described above except for providing grooves. The length of grooves shall be measured in running metres and paid for separately.

48 CEMENT POINTING

48.1 PREPARATION OF SURFACE

The joints shall be raked out properly under masonry item. Dust and loose mortar shall be brushed out. Efflorescence if any, shall also be removed by brushing and scrapping. The surface shall be thoroughlywashed with water, cleaned and kept wet before pointing is commenced.

48.2 MORTAR

Mortar mix for pointing shall be as described in the schedule of quantities. Specifications for cement, sand and water shall be as described herein before for concrete works.

48.3 APPLICATION OF MORTAR & FINISHING

The mortar shall be pressed into the raked out joints with a pointing trowel, either flush, sunk, ruled or raised according to type of pointing specified in the schedule of quantities. The mortar shall not spread over the face of brick work or stone work, corners, edges of the masonry but restricted to the width of joints only.

The super-fluous mortar shall then the struck off and the surface of the masonry shall be cleaned off completely. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight, neat and clean. The pointing lines shall be straight, regular and uniform. No false joints shall be allowed.

48.4 CURING

The pointing shall be kept wet for atleast seven days. During this period it shall be suitably protected from all damages.

48.5 TYPES

48.5.1 Raised and Cut Pointing : Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm. raised and width 10 mm. or more as directed.

48.5.2 Flush Pointing : The mortar pressed into the joints shall be finished off flush and level with the edges of bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edges.

48.5.3 Ruled Pointing : The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as directed shall be formed by running a forming tool straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. All vertical lines shall make true right angles at their junctions with horizontal lines and shall not project beyond the same.

48.6 MODE OF MEASUREMENT

The area of surface actually pointed will be measured net and shall be paid for. The measurement of length and height of walls pointed shall be taken correct to a centimetre. All the openings of doors, windows, ventilators etc. shall be deducted and jambs, soffits, sills etc. if pointed will be measured to arrive at the net area for the payment. The rate shall include cost of all materials, labour, transport, scaffolding, curing etc.

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49 WALL CARE PUTTY

49.1 SCOPE OF WORK

Wall care putty consists of white cement, high quality polymers and specialty chemicals and mineral fillers and is formulated to make it suitable to apply even on damp surfaces. Being cement based putty, it has better compatibility with the base plaster and forms a durable base for paints. It can be applied on both, Interior and exterior plastered surfaces. It is a water resistant base coating to the plastered surfaces to provide fine leveling and a protective base for the surfaces to be painted.

49.2 GENERAL

Wall care putty shall have superior water resisting properties to prevent paint from flaking even if the walls are damp. It should fill-up fine pores in walls and ceilings to get the smooth and dry surface for painting. Wall care putty shall have better properties in terms of water-resistance, adhesive strength and durability as compared to the ordinary putties. The putty shall provide a breathable surface and allow any trapped moisture to move out keeping the wall dry and clean.

49.3 MATERIAL

Wall care Putty shall be in dry free flowing powder form. Required quantity of Wall care putty shall be procured from the reputed manufacturers like M/s. Birla White Wall Care Putty / M/s. Walplast Products Pvt. Ltd. or equivalent approved manufacturers, or from their authorised dealers. The putty shall conform to the International standards (viz. HDB-Singapore Standards with Water-resistant properties).

The putty shall be procured in the form of FINE or COARSE (MATT) finish as specified in the description of the item.

49.4 PREPARATION OF SURFACE

- Surface should be clean of loose particles, dirt, grease and traces of foreign material. Sand papering or chipping shall be done if so required.
- Loose plastered areas/defective materials shall be removed & surface re-plastered and cracks filled-up properly.
- Uneven ceiling/wall surfaces shall be made even by re-plastering.
- Surface should be pre-wetted prior to application. This helps in providing a strong bond with substrate.

49.5 MIXING

- 12 to 16 litres of clean water shall be required for a bag of 40 kg of wall care putty. Required quantity of putty (which is required to be used at a time) shall be added to the water in right proportion. (considering pot life of the mix as 60 minutes).
- Mix shall be stirred continuously by using an electric mixer or by hand to obtain a homogeneous lump-free paste.
- The paste shall be allowed to stand for about 10 minutes for the additives to dissolve.

- The paste shall be re-mixed again for about 2 minutes.
- This mix should be used within 60 minutes.

49.6 APPLICATION

- The plastered surface shall be dampened with clean water and excess water shall be allowed tobe drained-off.
- Over plastered / Coarse putty substrate, two coats of fine wall care putty shall be applied to smoothen the surface with a steel trowel. The thickness of each coat should not exceed 1.0mm and total wall putty thickness should be 1.5mm.
- Finished surface of wall care putty shall not require any dressing by Emery Paper but if at all it isdone, the paper should not be less than 500 number.
- Coverage of wall care putty depends upon surface quality. The coverage area of wall care putty on smooth normal mortor plastered wall is 2.0 to 2.5 Sqm per Kg per mm thickness.
- Application of primer before painting is not necessary over the surfaces finished with wall care putty.

49.7 SPECIFICATIONS

TABLE 41.1: Specification of Wall care putty - For smooth Finish

SL. NO.	PROPERTY	AS PER HDB (HOUSING DEVELOPMENT BOARD), SINGAPORE
1	Dry Adhesion	≥0.8 N/sqmm
2	Wet Adhesion	≥0.3 N/sqmm
3	Tensile Adhesion Strength (N/sqmm) @ 28 Days	>0.8 N/sqmm
4	Compressive Strength (N/sqmm) @ 28 Days	7-12 N/sqmm
5	Setting Time (Minutes) - Initial & Final	<360 <500
6	Water Absorption Coefficient - Kg/M2. H1/2	≤0.13 for W2 / ≤0.26 for W1
7	Water Retentivity %	≥95%
8	PH	Alkaline

Note: Putty being white cement based, it is alkaline, and hence direct eye and skin contact should be avoided. In case of eye contact, flush the same with clean water for 15 minutes and seek medical help.

49.8 **MODE OF MEASUREMENTAND RATE**: Same as described under plaster specification. Rate shall include cost of all materials, scaffolding, labours, tools etc. involved in work.

49.9 GYPSUM LIGHT WEIGHT PLASTER

49.9.1 : Material: Premixed light weight plasters essentially consist of retarded hemi-hydrate gypsum plaster and light weight aggregate which are characterized by low density, high thermal insulation and sound absorption properties. Other additions may be incorporated to impart desired properties. The physical and chemical requirements shall conform to IS 2547 (Pt. II)-1976. The minimum recommendedwater-premixed plaster ratio is 1:2 as per standard practice or as recommended by the manufacturers.

49.9.2 Application of Plaster: Application of plaster shall be as specified under plaster specification.

Thickness: Where the thickness required, as per description of the item is 12 mm, the average thickness of the plaster shall not be less than 12 mm whether wall treated is of brick/block/RCC work.

49.9.3 Finish: The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

49.9.4 Mode of Measurement and Rate: Same as described under plaster specification.

50 PAINTING

50.1 GENERAL

The specification for „Painting" includes various types of internal and external painting and polishing works over the specified surfaces such as plastered surface, woodwork, structural steel etc.

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50.2 MATERIALS

Paints, oils, varnishes etc. of approved brand and manufacture shall only be used. Ready mixed paints as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used. Approved paints, oilsor varnishes shall be brought to the site of work by the contractor in their original containers in sealedcondition. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or atleast a fortnights work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

50.3 COMMENCING WORK

50.3.1 Scaffolding: Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being painted. H-frame steel scaffolding shall invariably be used for multi-storied building structure.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

For painting of the ceiling, proper stage scaffolding shall be erected.

Painting, except the priming coat, shall generally be taken in hand after all other builders work, practically finished.

The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the paint work being started.

50.4 PREPARATION OF SURFACE

The surface shall be thoroughly cleaned. All dirt, rust, scales, smoke and grease shall be thoroughly removed before painting is started. Minor patches if any in plastered/form finished surfaces shall be repaired and finished with cement mortar of the same mix and cracks & crevices shall be filled with approved filler, by the contractor at no extra cost to the Department. The surface so prepared shall be inspected by Engineer-in-Charge for his approval to commence the painting work.

50.5 APPLICATION

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its containers. When applying also, the paint shall be continuously stirred in the smaller containers so that consistency is kept uniform.

The external surfaces of the buildings under reference including the R.C.C. Jalli, fins and the panels above and below the window etc. shall be finished in different colours of approved shade. The contractor will make suitable samples at site for Departments approval before taking up the work in hand and they will be allowed to proceed with the work only after getting Departments approval for the same.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the later in the direction of the grain in case of wood. The crossing & laying off consists of covering the area with paint, brushing the surface hard for the first time and then brushing alternately in opposite directions two or three time and then finally brushing lightly in direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying will constitute one coat.

Where so stipulated, the painting shall be done with spraying. Spray machine used may be (a) a high pressure (small air aperture) type or (b) a low pressure (large air gap) type, depending on the nature and location of work to be

carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner. Spraying should be done only when dry condition prevails.

Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied.This should be facilitated by thorough ventilation.

Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned of dust before the next coat is laid.

No left over paint shall be put back into the stock tins. When not in use, containers shall be kept properly closed.

The final painted surface shall present a uniform appearance and no streaks, blisters, hair marks from the brush or clogging of paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

In case of cement based paints/primers, the absorbent surfaces shall be evenly damped so as to give even suction. In any weather, freshly painted surfaces shall be kept damp for atleast two days.

In painting doors and windows, the putty around the glass panes must also be painted, but care must betaken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out while painting. In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

The additional specifications for primer and other coats of paints shall be as in accordance to the detailed specifications under the respective headings.

Any damage caused during painting work to the existing works/surfaces shall be made good by the contractor at his own cost.

50.6 BRUSHES AND CONTAINERS

After work, the brushes shall be completely cleaned off paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers, when not in use, shall be closed, kept air tight and shall be kept at a place free from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean & can be used again.

50.7 MEASUREMENT

a) Painting, unless otherwise stated shall be measured by area in square metre. Length and breadth shall be measured correct upto two places of decimal of a metre.

b) No deduction shall be made for opening not exceeding 0.05 sqm. and no addition shall be made for painting to the beading, moulding edges, jambs, soffits, sils, architraves etc. of such openings.

c) In measuring painting, varnishing, oiling etc. of joinery and steel work etc., the co-efficients as in the following table shall be used to obtain the areas payable. The co-efficients shall be applied to the areas measured flat and not girthed in all cases.

d) In case of painting of door shutter with push plates in plastic laminate, deduction will be made for area of such laminations.

50.7.1 Table of multiplying Co-efficients to be applied over areas of different surfaces to get equivalent plain areas is given in the Appendix- "C-2" of this book.

50.7.2 Explanatory notes on the table of Co-efficients.

1. Where doors, window etc. are of composite types other than those included in para 50.7 (c), the different portions shall be measured separately with their appropriate co-efficients, the centre line of the common rail being taken as the dividing line between the two portions.
2. Measurements for doors, windows etc. shall be taken flat (and not girthed) over all including

chowkhats or frames, where provided. Where chowkhats or frames are not provided, the shutter measurements shall be taken.

3. Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken forthe top and bottom guide, rails, rollers, fittings etc.

4. Rolling shutters of interlocked laths shall be measured for the actual shutter width and the height from bottom of opening to the centre of the shaft. No separate measurements shall be taken for painting guides and other exposed features within or outside the shutter area. The painting of top cover or hood shall however be measured separately.

5. Co-efficients for sliding doors shall be the same as for normal types of doors as mentioned in the table. Measurements shall be taken outside of shutters, and no separate measurements shall be taken for painting guides, rollers, fittings etc.

6. Measurement of painting of doors, windows, collapsible gates, rolling shutters etc. as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

7. The measurements as above shall be deemed to include also the painting of edges, blocks, cleats etc. for which no extra will be paid.

8. The co-efficients for doors and windows shall apply irrespective of the size of frames and shutter members.

9. When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge, and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

10. In the case where shutters are fixed on both faces of the frames, the measurements for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter area only excluding the frame.

11. Where shutters are provided with clearance at top or/and bottom, such openings shall be deducted from the over all measurements and relevant co-efficients shall be applied to obtain the area payable.

12. In case of trellis (or jaffri) work, the measurements shall include the painting of the frame member for which no separate measurements shall be taken. Trellis door or window shutters shall also be measuredunder terllis work.

13. Wherever air conditioning grill, lighting, fixtures etc. in false ceiling are painted along with, measurements shall be taken over all without deductions for opening in grills and no extra shall be paid for the grills. If grills, fixtures etc. are not painted, area of fixtures or grills as measured flat (not girthed) shall be deducted when it exceeds 0.05 sqm. individuals. Where walls and ceilings are painted in separate colours, the junctions of two paints shall be brought down on the walls in a straight line by about 6mm.to 12mm. if so desired, if the junctions of walls and ceilings are not even. Nothing extra shall

be paid to the contractor on this account. Beading wherever provided shall not be measured separatelybut shall be deemed to be included in the area of false ceiling etc. measured flat (not girthed).

14. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or palisades.

15. In the case of asbestos cement corrugated or semi-corrugated sheeting and iron corrugated sheeting in roofs, side cladding etc., the work shall be measured flat (not girthed) as fixed.

16. For trusses, compound girders, stanchions, lattice girder and similar work, actual areas will be measured in sqm. and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

17. Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

18. Measurements of wall surfaces and wood and other works not referred to already shall be recorded as per actual and opening exceeding 0.05 sqm. shall be deducted to get the net payable area. Length and breadth

shall be measured correct upto two places of decimal of a metre and area so worked out shall be correct upto two places of decimal of a square metre.

19. In case the items of work requiring painting are inclusive of cost of painting, the painting carried out shall not be measured separately.

50.8 PRECAUTIONS

All furniture, lightings, fixtures, sanitary fittings, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damage done shall be made good by the contractor at his cost.

50.9 RATES

Rates shall include cost of all labour and materials involved on all the operations described above and in the particular specifications given under the several items.

50.10 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

50.10.1 Primer

1. The primer for wood work, iron work or plastered surface shall be as specified in the description of the item.

2. Primer for Wood work / Iron & Steel / Plastered / Aluminium surfaces shall be as specified below

Table 42.1: Primer for Wood work / Iron & Steel / Plastered / Aluminium surfaces

SN	SURFACES	PRIMER TO BE USED
a	Wood work (hard & soft wood):	Pink conforming to I.S.3536-1999
b	Resinous wood and ply wood:	Aluminium wood primer conforming to IS.3585-
c	i) Aluminium and Light alloy ii) Iron , Steel and galvanised Steel	i) Zinc chromate primer conforming to I.S. 104-1979. ii) Red oxide Zinc chromate primer conforming to IS:2074-1992 or Zinc chromate primer as per (i)
d	Plastered surfaces, cement brick work, Asbestos surfaces for oil bound distemper and paint:	Cement Primer conforming to IS.109-1968

3. The primer shall be ready mixed primer of approved brand and manufacture.

50.10.2 Preparation of surface

50.10.2.1 **Wood work:** All wood work (doors, paneling, railing etc) to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any, shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material with same shade as paint shall be used where so desired by the Engineer-in-charge.

The surface treated for knotting shall be dry before painting is applied. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glaziers putty or wood putty (for specifications for glaziers putty and wood putty- refer as mentioned here-in-before). Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in the stopping and the latter is therefore liable to crack.

50.10.2.2 **Iron and Steel Work:** All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

50.10.2.3 **Plastered Surface:** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of paris and rubbed smooth or with wall care putty, if specified.

50.10.3 Application: The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described here-in-before.

50.10.4 Other Details: The specifications for Painting (General) shall hold good so far as it is applicable.

50.11 PAINTING WITH SUPERIOR QUALITY FLAT OIL READY MIXED PAINTS ON NEW SURFACE

50.11.1 Paint: Ready mixed paints shall be of approved brand and manufacture and of the required shades. They shall conform in all respects to the relevant I.S. specifications.

50.11.2 Preparation of Surface

50.11.2.1 **Wood work:** The surface shall be cleaned and all unevenness removed as in para 42.10.2 (a). Knots if visible, shall be covered with a preparation of red lead. Holes and indentations on the surface shall be filled in with glaziers putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

50.11.2.2 **Iron and steel work:** The primer coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

50.11.2.3 **Plastered surfaces:** The priming coat shall have dried up completely before painting is started. All dust or dirt that has settled on the priming coat shall be thoroughly wiped before painting is started.

50.11.3 Application: The specifications mentioned here-in-before shall hold good as far as applicable.

The number of coats to be applied will be as stipulated in the item. The painted surface shall present a uniform appearance and glossy/semi glossy finish, free from streaks, blisters etc.

50.11.4 Other details : The specifications for Painting (General) specified here-in-before shall hold good in so far as they are applicable.

50.12 PAINTING WITH SYNTHETIC ENAMEL/SEMI GLOSSY PAINT ON NEW WORK

42.12.1. Paint : Synthetic enamel/semi glossy paint of approved brand and manufacture and required shade shall be used for the top coat and an under coat of shade to match the top coat as recommended by the manufacturer shall be used. The paint shall be conforming to IS: 2933-1975.

42.12.2 Preparation of Surface: This shall be as per painting with superior quality ready mixed paint as mentioned here- in- before.

42.12.3 Application: The number of coats including the under coat shall be as stipulated in the item.

42.12.3.1 Under Coat: One coat of the specified paint of shade suited to the shade of the top coat shall be applied and allowed to dry over night. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface free from brush marks and all loose particles shall be dusted off. All the cracks, crevices, roughness etc. will be filled with approved putty as per manufacturer"s recommendations.

42.12.3.2 Top Coat: Finishing coats of specified paint of the desired colour & shade shall be applied after the under coat is thoroughly dried. Additional finishing coats shall be applied if found necessary to ensure a proper and uniform semi glossy surface.

42.12.4 Other Details: The specifications for "Painting (General)" mentioned here-in-before shall hold good as far as they are applicable.

50.13 PAINTING WITH ACRYLIC EMULSION/PLASTIC EMULSION PAINT.

50.13.1 Paint: This shall be polyvinyl based Acrylic/plastic emulsion paint of approved manufacture of the required shade, conforming to I.S.15489-2013 (Type-1).

50.13.2 Primer: The primer to be used for the painting with acrylic emulsion on cement concretesurfaces/ plastered surfaces shall be of approved brand and as recommended by paint manufacturer.

42.13.3. Putty: Plaster filler to be used for filling up (putting) uneven surfaces, small cracks and holes etc. shall be of approved compound and as per recommendations of the manufacturers. No oil based puttyshall be used. The putty should be made from a mixture of whiting and plastic emulsion paint or as per manufacturers recommendations.

Note: In the event of separate provision of application of wall care putty over concrete/ plastered surface in the work application of plaster filler (Putty) as mentioned above is not required.

42.13.4. Finishing coats: All the finishing coats shall be of matt finish or any other finish as required bythe Engineer-in-charge. The number of finishing coats shall be as specified in the item.

42.13.5 Mode of Measurement: All the measurements for payment shall be taken on net surface area actually painted, unless otherwise specified. Deduction will be made from the areas for fixtures, grills, ventilation, outlets, electrical boxes and such obstructions not painted, if they are individually more than
0.05 sqm.

50.14 WHITE WASHING WITH LIME

50.14.1 Preparation of Surface: Before new work is white washed, the surface shall be thoroughlybrushed free from mortar droppings and foreign-matter.

In the case of old work, all loose pieces and scales shall be scrapped off and holes in plaster as well as patches of less than 0.05 sqm. area each shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer-in-charge, the entire surface of old white wash shall be thoroughly removed by scrapping and this shall be paid for separately.

50.14.2 Preparation of lime wash: The wash shall be prepared from fresh stone white lime "Katani" or equivalent. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm. of gum dissolved in hot water, shall be added to each 10 cubic decimetre of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg. of lime.

Indigo (Neel) up to 3 gm. per kg. of lime dissolved in water, shall then be added and wash stirred well. Water shall then be added at the rate of about 5 ltrs. per kg. of lime to produce a milky solution.

The lime shall be tested in a chemical laboratory and test certificate submitted, to conform the quality oflime with regard to its physical and chemical properties. The cost of testing lime shall be borne by the contractor.

50.14.3 White Washing: The white wash shall be applied with brushes or by spray in the specified number of coats. The operation for each coat in the case of brush application shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer-in-charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

For new work, three or more coats shall be applied till the surface present a smooth and uniform finishthrough which the plaster does not show. The finished dry surface shall not show any sign of cracking and peeling nor shall it come off readily on the hand when rubbed.

For old work, after the surface has been prepared as described here-in-before, a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the

description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patched do not appear. The washing on ceiling should be done prior to that on walls.

50.14.4 Protective Measures: Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed shall be protected from being splashed upon. Splashings and droppings, if any, shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to painted surfaces, furnitures or fittings and fixtures etc. shall be recoverable from the contractor.

50.14.5 Measurements: All measurements for payment shall be taken on net surface areas actually white washed, unless otherwise specified. Deductions will be made from the areas for fixtures, grills, ventilation, outlets, electrical boxes and such obstruction not painted if they are individually more than 0.05 sqm. Length and breadth shall be taken correct upto two places of decimal of a metre and areas soworked out shall be correct upto two places of decimals of a square metre.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Table 42.2: Girthed Area for Measurement

Corrugated asbestos cement sheets:	20%
Semi-corrugated asbestos cement sheets:	10%

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.05 sqm. each with materials similar in composition to the surface to be prepared.

50.14.6 Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

50.15 COLOUR WASHING

In the case of colour washing, mineral colours, not affected by lime, shall be added to white wash with proper glue. No colour wash shall be done until a sample of the colour wash to the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is patchy or otherwise badly applied, it shall be redone by the contractor, at no extra cost to the Department.

For new work, the priming coat shall be of white wash lime or with whiting as specified in the description ofthe item. Two or three coats, shall then be applied as specified on the entire surface till it represents a smooth and uniform finish. Each coat after applying shall be got approved from the Engineer-in-Charge.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed. Other specifications as detailed for Whitewashing with lime shall be applicable. Indigo (Neel) shall however, not be added.

50.16 DRY DISTEMPERING

50.16.1 Distemper : Dry distemper (IS:427-2013) of approved brand and manufacture, colour and required shade shall be used. The dry distemper shall be stirred slowly in clean water using 0.6 litre of water per kg. of distemper or as specified by the manufacturers. Warm water shall preferably be used. It shall be allowed to stand for atleast 30 minutes before use. The mixture shall be invariably well stirred before and during use to maintain an even consistency.

50.16.2 Preparation of surface : This shall be as for Painting work mentioned here-in-before in so far asit is applicable.

50.16.3 Application : In case of new work, the treatment shall consist of a priming coat followed by the application of two or more coats of distemper till the surface shows an even colour.

50.16.3.1 **Priming coat :** Priming coat of whiting shall be applied over the prepared surface. The whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. Two kg. of gum and 0.4 kg. of copper sulphate dissolved separately in hot water shall be added for every cum. of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use. No white washing coat shall be used as a priming coat for distempering.

The application of each coat as mentioned in the specifications for painting (General) here-in-before,shall hold good, as far as it is applicable.

50.16.3.2 **Others:** The specifications in respect of scaffolding, protective measures, measurements andrate shall be as described in previous sections.

50.17 OIL EMULSION (OIL BOUND) DISTEMPERING

Oil bound distember (IS:428-2013) of approved brand and manufacture, colour and required shade shall be used. The primer where used as on new work shall be cement primer or distemper primer as specified in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by manufacturer. Only sufficient quantity of distemper required for days work shall be prepared.

50.17.1 Preparation of surfaces : The surface shall be prepared as described here- in- before for Painting work in so far as it is applicable and approved putty/filler shall be applied to the entire area to get uniform and smooth surface before application of primer.

50.17.2 Application: The cement primer or distemper primer shall be applied by brushing and not by spraying. Hurried priming work shall be avoided, particularly on absorbent surfaces. New plaster patches in old work before applying oil bound distemper shall be treated with cement primer/distemper primer. The surface shall be finished as uniformly as possible leaving no brush marks. priming coat shall be allowed to dry for at least 48 hours before oil bound distemper is applied. Before applying distemper, the surface shall be lightly sand prepared to make it smooth for receiving the oil bound distemper, taking care not to rub out the priming coat. A time interval of at least 24 hours shall be allowed between consecutive coats to permit the proper drying of the preceding coat. Two or more coats of distemper as are found necessary shall be applied over the priming coat to obtain an even shade.

50.17.3 Other details: The specifications for "Painting (General)" mentioned here-in-before shall hold good as far as it is applicable.

50.18 WATER PROOFING CEMENT BASED PAINT

50.18.1 Material: Cement based paint (IS:5410-2002) of approved manufacture, quality, shade and colour only shall be used.

50.18.2 Preparation of surfaces: The surface shall be thoroughly cleaned off all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing the surfaces. The surface shall be thoroughly wetted with clean water before the water proof cement paint is applied. The prepared surface shall be got approved before painting is commenced.

The water proof cement paint shall be mixed in such quantities as can be used up with in an hour ofits mixing as otherwise the mixture will set and thicken, affecting flow and finish.

Water proof cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes.Care shall be taken to add the water proof cement paint gradually to the water and not vice versa. Thesecond stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain liquid of workable and uniform consistency. In all cases the manufacturers instruction shall be followed meticulously.

50.18.3 Application: The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. To avoid direct heat of the sun

during painting, the cement based paint shall be applied on the surface which is on theshady side. Cement based paint shall not be applied on the surfaces already treated with white wash, colour wash, dry or oil bound distemper, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

50.18.4 Other details : The specifications for Painting (General) mentioned here-in-before shall hold good as far as they are applicable.

50.18.5 Mode of measurement for dry distemper, oil bound distemper and water proof cement paint : All measurement for payment shall be taken on net surface area actually painted unless otherwise specified and no co-efficient shall be applied for working out areas. Deductions will be made from areasfor opening/obstructions not painted, if they are individually more than 0.05 sqm. Length and breadth shallbe taken correct upto two places of decimal of a meter and areas shall be worked out correct upto two places of decimal of a square meter.
Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by thefollowing percentage to allow the girthed area: a) Corrugated asbestos cement sheets - 20%; b) Semi corrugated asbestos cement sheets - 10%.

The number of coats of each treatement shall be stated in the schedule of quantities. The whole surfaceshall be applied with approved putty/filler to get uniform and smooth surface at no extra cost to the Department.

50.18.6 Rates : The rate shall include cost of all materials and labour involved in all the operation described above.

50.19 EXTERIOR ACRYLIC PAINT

50.19.1 Material: The paint shall be (Texured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint) of approved brand and manufacture conforming to IS:15489-2013 (Type-2)

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fornight‟s work. The materials shall be kept in the joint custody of the contractor and Engineer-in-Charge.The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

50.19.2 Preparation of Surface: For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good,surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

50.19.3 Application: Base coat of water proofing cement paint: All specifications in respect of base coat of water proofing cement paint shall be as described under 42.18.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, whenapplying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer‟s instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described here-in before.

50.20 RESIN BASED THERMO PLASTIC PAINT (DECORATIVE AND PROTECTIVE FINISH)

50.20.1 Materials : Resin based thermo plastic paint such as Sandtex Matt or other equivalent approved manufacture, colour and shade shall only be used.

50.20.2 Preparation of Surface & General : The Specifications for Painting (General)described here- in-before shall hold good as for as they are applicable.

50.20.3 Protective Coatings : On surfaces such as ferrous metals, brass, copper and phospher bronze, a protective coating of suitable bituminous compound or chromated red oxide should be given. New wood should be treated with a leafing grade aluminium primer or a water based acrylic emulsion primer.

The surfaces with algae growth shall be thoroughly cleaned down to remove as much growth as possible and effective solution of stabilized house hold bleach (calcium hypochloride) of approved quality with approximate 35% chlorine content @ 2 kgs. per 50 ltrs. (or as per manufacturers recommendations) should be used to treat the surfaces.

On chalky or friable surfaces after removing the loose materials by stiff brushing or scraping the surface should be treated with one coat of advanced solvent based material such as snowsol stabilizing solution or other approved equivalent with white spirit.

50.20.4 Application: The ready mix Sandtex Matt or other equivalent approved resin based thermo plastic paint shall be applied on clean and wetted surfaces by means of brushes or roller. The solution shall be kept well stirred during the period of application. To avoid direct heat of the sun, the paint shall be applied on the side in shade.

On rough and textured surfaces, one under coat of cement based paint such as Snowcem or other equivalent shall be applied before application of undiluted Sandtex Matt finish coat. In case of application of two coats of Sandtex Matt at normal temperatures, the first one shall be diluted by additionof 25% water and the second coat direct. In extremely hot environs, the second coat shall be diluted @ 2.5 ltrs. of water to 20 ltrs. of paint or as directed.

Painting with resin based thermo plastic paint shall be carried out generally as per manufacturers specifications.

50.20.5 Other Details : The specification for Painting (general) mentioned here-in-before shall hold good as far as they are applicable. Snowsol stabilized solution shall not be applied over bitumen. Snowsol stabilized solution treated surfaces shall not be left unpainted for more than 2 (two) days. Gypsum based materials shall not be used for filling of exterior cracks while preparation of surfaces.

50.20.6 Mode of Measurement : The painting unless otherwise mentioned shall be measured by areain sqm. upto two places of decimal. Length and breadth shall be measured correct upto two places of decimal of a meter. Deduction will be made from the areas of fixtures, grills, ventilation, outlets individually more than 0.05 sqm.

The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.1 sqm. each with materials similar in composition to the surface to be prepared.

50.20.7 Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

50.21 ELASTOMERIC WATER PROOF PAINT

50.21.1 Material: Elastomeric paints have high degree of elasticity and as such provide protection against cracks in concrete/mortar surface mostly due to thermal expansion. Elastomeric character of paint takescare of all such surface cracks by forming a seamless barrier that shields the building from harsh environmental effects like rain, wind, heat and pollution. Elastomeric paints can expand up to 500% of itsoriginal length, therefore, can cover cracks across its width. The paint shall be water proof, U-V resistantand anti-fungal of approved shade and approved branded manufacturer such as Asian Paints, M/s Pidilite, M/s Apurva Buildcare Technologies, etc.

50.21.2 Surface Preparation and Application: Same as described above under Exterior paint and also as recommended by the manufacturer. The paint is ready to use mix, stirred well and applied by brush/ roller or spray in 2 coats over a coat of primer. The primer coat shall be applied using same elastomericpaint with suitable dilution as per manufacturer specification. The minimum dry film thickness of paint including primer coat shall

be 200 microns or as specified in item.

50.21.3 Other Details, Mode of measurement and Rate: These shall be generally same as for Painting mentioned here-in-before as far as they are applicable.

50.22 EPOXY PAINT

50.22.1 Material

50.22.1.1 **Epoxy Polyamide Primer:** Epoxy primer shall be a two component polyamide cured epoxy primer of M/s Asian paints or of approved/specified manufacturer.

50.22.1.2 **Epoxy Finish coat Paint**: Epoxy paint shall be a two component polyamine adduct cured epoxy paint of M/s Asian Paints or of approved manufacturer.

50.22.2 Surface Preparation - Non-Ferrous Substrate: Surface should be dry and clean. Any visible oil/grease should be removed. Cleaned surface should be abraded or sweep blasted using low pressureand non - metallic abrasives, then primed with a coat of wash primer/self-etch primer (Apconyl WP 636).

50.22.2.1 **New concrete or masonry surface:** Must be allowed to cure at least 30 days before coating.The moisture content of the concrete/masonry should be less than 6%. In case of large areas and for severe exposure conditions, the surface has to be prepared by light blasting. In less critical areas whereblasting is not practical, wire brushing has to be adopted to remove laitance, followed by treating with dilute hydrochloric acid (10%)and neutralizing the acid etched areas by washing with 5% solution of soda ash.
50.22.2.2 **Old concrete surface:** Remove the surface contaminants like grease, oil, etc., by solvent wiping or by 10% caustic solution. Preferably the surface has to be prepared by light blasting. In case, blasting is not practical, etch the surface to get a good profile by treating white dilute hydrochloric acid (10%) and neutralizing the acid etched areas by washing with 5% solution of soda ash.

Remove acid and contaminants by liberal wash with water. Ensure that acid solution does not retain on the surface and joints. Allow the surface to dry thoroughly before applying primer. Any cracks should be cut out and filled with suitable epoxy based toweling compound filler prior to painting.

50.22.3 Film Thickness: The recommended dry film thickness of the primer shall be 50 microns or as specified.

50.22.4 Application of Paint: Over the base coat of epoxy primer of specified thickness two or more coatof approved epoxy paint shall be applied strictly as per manufacturer specification to get desired thickness of paint 150micrn or as specified.

The contractor has to provide Elcometer sampling sheets for testing dry film thickness.

50.22.5 Other Details, Mode of measurement and Rate: These shall be as for Painting (General) mentioned here-in-before as far as they are applicable.

50.23 BEES WAXING OR POLISHING WITH READY MADE WAX POLISH:(NEW WORK)

50.23.1 Materials : The polishing shall be done with bees waxing prepared locally or with ready made wax polish of approved brand and manufacture, as stipulated in the description of item.

Where bees waxing is to be prepared locally, the following specifications for the same shall apply:

Pure bees wax free from paraffin or stearing adulterants shall be used. Its specific gravity shall be 0.965to 0.969 and melting point shall be 63^{o} C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2: 1.5: 1: 0.5 by weight.
The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved, the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and the entire mixture shall be well stirred.

50.23.2 Preparation of surface : Preparation of surface will be as mentioned here-in-under para 50.20.2 with the exception that knotting, holes and cracks shall be stopped with a mixture of fine saw dust formed of the wood being treated, beaten up with sufficient bees wax to enhance cohesion.

50.23.3 Application : The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The surface is then rubbed continuously for half an hour.

When the surface is quite dry, a second coat shall be applied in the same manner and rubbed continuously for one hour or until the surface is dry.

The final coat shall then be applied and rubbed for two hours (more if necessary) until the surface has assumed a uniform gloss and is dry showing no sign of stickiness.

The final polish depends largely on the amount of rubbing which should be continuous and with uniform pressure, with frequent changes in the direction.

50.23.4 Other details : The specifications for painting (General) as mentioned here-in-before shall hold good as for as they are applicable.

50.24 FRENCH SPIRIT POLISHING: (ON NEW WORK WITH A COAT OF WOOD FILLER)

50.24.1 Polish : Pure shellac varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm. of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade.

50.24.2 Preparation of surface : The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted off. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glaziers putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 kg. of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

50.24.3 Application : The number of coats of polish to be applied shall be as described in the item.
A pad of woolen cloth covered by fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

50.24.4 Measurement, Rate and other Details : These shall be as for Painting (General) mentioned here-in-before as far as they are applicable.

50.25 VARNISHING (ON NEW SURFACES)

50.25.1 Material: Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler. Varnish (conforming to IS 347) for the finishing and undercoatsshall be of the approved manufacturer.

50.25.2. Preparation of Surface : New wood work to be varnished shall have been finished smooth witha carpenter‟s plane. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:
On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter‟s chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling. The fillings when dry shall be rubbed down with a carpenter‟s file and then the entire surface shall be rubbed down

perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this caseeven the finest

marks will be visible when the varnishing is applied.

50.25.3 Sizing or Transparent Wood Filler Coat: The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

50.25.3.1 Sizing: When sizing is stipulated, an application of thin clean size shall be be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow. Any joining up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household utensils which are likely to disturb the size coatings and thus expose bare wood. Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

50.25.3.2 Transparent Wood Filler Coat: Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described in 42.25.2 shall be given as application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

50.25.4 Application of Varnish: The number of coats to be applied shall be as stipulated in the description of item. The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhances the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish. The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, latter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnish shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean. Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and damp air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use. Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

50.25.5 Measurement, Rate and other Details: These shall be as for Painting (General) mentioned here-in-before as far as they are applicable.

NOTE: Consumption of paint for some painting items is given in Appendix - "C-1".

50.26 VINERATEX OR VITROBRITE DECORATIVE TEXTURE COAT

50.26.1 General: Vineratex or vitrobrite decorative treatment/coating consisting of coating the plaster finished surfaces with decorative texured coat of ready mixed mixture of approved aggregate with bonding compound/synthetic adhesive manufactured by M/s. Vinera Industries & Co. or other approved

manufacturer. The vineratex or vitrobrite treatment coating shall be got done through approved agency as per manufacturers recommendations.

The vineratex or vitrobrite treatment shall be applied/coated directly over the sub-base of reasonably smooth/levelled and clean surface like plastered brick work (plaster not being raked or scratched) in-situ concrete,

precast concrete units, light weight blocks, asbestos cement sheet etc. as specified.

50.26.2 Material: The various aggregate and special bonding media/synthetic resin shall be strictly as per manufacturers recommendations. Only such aggregates shall be used, which are weather and corrosionresistant viz. glass, ceramic marble, chips, granite, quartz and flint, hametites, pyrites or one in natural vitrified, coloined or other processed forms as specified. The aggregate shall vary in sizes from 0.5 mm. to 2.5 mm. and shall be applied in shades as specified. The finish shall have a film thickness of 3 mm. average.

50.26.3 Surface Preparation: Before commencing, the surfaces should be cleaned thoroughly to remove any grease, dirt, dust or loose particle and should be free from surface water. Extremely porous surfacesshould be pre-sealed with a thin coat of suitable primer. Previous painted surfaces if any, should be prepared by thoroughly scrapping off all loose flaking paint film, washing down with a suitable detergentand rinsing thoroughly with clean water and allowed to dry.

50.26.4 Application: Vineratex or vitrobrite shall be brought to site in sealed containers. Addition of thinner at site will not be permitted. The material in the containers shall be mixed thoroughly before use, to off-set the settlement occurred due to heavy vibration while transporting and during storage.

A small amount of Vineratex or vitrobrite mixture shall be placed on a spot board. The spot board shall be held against the surface on which the treatment/coating is to be applied. The mixture shall be appliedto the surface evenly with the help of laying on trowel to uniform thickness of about 3 mm. on an area ofabout 0.18 sqm. Scrap off the excess material with the help of the steel float to obtain an even film thickness of 3 mm. This shall be achieved by using the steel float held slightly on the trailing edge, putting an even pressure and scrapping off the excess material/mixture, left on the spot board shallbe immediately put back into drum and shall be mixed well before reuse.

Level of the vineratex or vitrobrite film to a smooth and even finish using the flat edge of steel float. It isimportant that only small areas of about 0.18 sqm. shall be treated at a time. Wherever possible, whole work should be completed without stop in one operation by engaging sufficient number of workers, so that flowing edge may be maintained without forming any joint. If this is unavoidable, a suitable natural break in the application should be chosen and the joint shall be made using a straight edge, which can be continued when application is resumed the following day. Over lap or over troweling at joints shall beavoided. This treatment shall always be carried out in shade, away from full effect of hot sun.

At all times the completed work of vineratex or vitrobrite shall be protected against rain fall until complete hardness has been obtained which takes about 24 hours.

Once the treatment/coating is completed and set hard, no other treatment like polishing, cleaning, washing with acid etc. shall be resorted to in this area. The treatment/coating shall be taken up in hand when all other construction works viz. plastering, electrical wiring, plumbing, painting etc. have been completed.
After the whole work is completed, the vineratex/vitrobrite shall be given a coat of anti-fungus gel to avoid fungus growth on surfaces. The contractor shall be responsible to protect the finished surface from any damages for whatever reason whatsoever.

50.26.5 Mode of Measurement: Mode of measurement shall be similar to sand faced/roughcast plasteritems.

50.27 SYNTHETIC PLASTER AND PAINT FOR TEXTURE AND WALL FINISH (Renovo SyntheticPlaster)

50.27.1 General: Synthetic plaster is a synthetic fibre based water repellant cladding material which gives synthetic plaster flexibility to prevent cracks and also imparts good adhesion and anchorage to the underneath substrate. Textured wall finish of specified design and pattern such as natural stone finish, tile finish, etc. can be given to wall surface using synthetic plaster.

50.27.2 Material: Synthetic plaster shall be of approved specialized manufacturer such as Renovo of M/s Damani Dyestyff Ltd or equivalent approved make. The material shall be brought to site in sealed container.

Paint: Paint to be applied over the synthetic plaster shall be exterior grade acrylic emulsion or textured paint such as santex matt, etc. of approved manufacturer.

50.27.3 Surface Preparation: Surface preparation shall be same as described earlier.

50.27.4 Application: Synthetic Plaster shall be directly applied on plastered surface or directly overconcrete surface as specified in item.

Application of synthetic plaster shall be carried out by the specialized agency as per guidelines and specifications of the manufacturer. Synthetic plaster shall be applied to the thickness as specified by the manufacturer in order to get the required pattern of the design as mentioned in item or as shown in the drawing.

Over the texture plaster finish two or more coats of exterior grade acrylic emulsion or santex matt as specified of approved shade and colour shall be applied over a coat of primer as per painting specification.

50.27.5 Mode of Measurement : The synthetic plaster and painting unless otherwise mentioned shall be measured by area in sqm. upto two places of decimal. Length and breadth shall be measured correct upto two places of decimal of a meter. Deduction will be made from the areas of fixtures, grills, ventilation, outlets individually more than 0.05 sqm.
The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.1 sqm. each with materials similar in composition to the surface to be prepared.

50.27.6 Rate : The rate shall include the cost of all materials including synthetic plaster & paint and labour involved in all the operations described above.

50.28 MELAMINE POLISH

50.28.1 Material: Melamine is an organic compound that is often combined with formaldehyde to produce melamine resin, a synthetic polymer that is fire resistant and heat tolerant. The resin is a versatile material that has a highly stable structure. It is a closed pore polish i.e. it makes the wood non-breathable product that protects wood from mainly hot and cold surfaces placed over it.

50.28.2 Preparation of surface: The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Surface must be dry, free from dust, oil, wax, greases etc.

50.28.3 Application: Mix melamine (matt or gloss) base with the catalyst in the specified ratio as per manufacturers specification. Add melamine thinner upto 30% (as specified by the manufacturer) by volume of mixture. Stir it and allow it to mature for 2-3 minutes. The melamine is sprayed, using spray gun pressure of 45-55 psi, from a distance of 7"-10" from substrate. Precaution: Avoid eye contact, use of mask is mandatory during whole process.

50.28.4 Measurement & Rate: - The unless otherwise mentioned shall be measured by area in sqm. upto two places of decimal. Length and breadth shall be measured correct upto two places of decimal of a meter. The rate shall include the cost of all materials and labour involved in all the operations described above.

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51. TUBULAR/HOLLOW, SECTION TRUSSES PURLINS ETC.

51.1 STRUCTURAL STEEL TUBES

These shall be of :

i) hot finished welded (HFW) type, or

ii) hot finished seamless (HFS) type, or

iii) electric resistance or induction butt welded (ERW), having carbon content less than 0.03%, yield stress of 210 MPa. (YST 210) or specified grade YST240/YST310, conforming to the requirement of I.S. 1161-1998(for tubular steel) and IS.4923-1997(for Hollow square/rectangular section).The steel sectionswhen analysed in accordance with the method specified in I.S. 228-1987 shall show not more than 0.06 percent sulphur, and not more than 0.06 percent phosphorous.

Tubes shall be designated by their nominal bore. These shall be light, medium or heavy as specified, depending

on the wall thickness.

Tubes shall be cleanly finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut cleanly and square with the axis of tube, unless otherwise specified.

51.2 MINIMUM THICKNESS OF METALS

The tubular steel work shall be painted with one coat of approved steel primer after fabrication. Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm. and for construction not exposed to weather, it shall be not less than 3.2 mm., where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

51.3 FABRICATION

51.3.1 Assembling: The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per S.P-38 of B.I.S publication.

51.3.2 Straightening: All material before being assembled shall be straightened, if necessary, unlessrequired to be of a curvilinear form and shall be free from twist.

51.3.3 Bolting : Washers shall be specially shaped where necessary, or other means used, to give the nuts and the heads of bolts a satisfactory bearing.

In all cases where the full bearing area of the bolt is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together, and washers of appropriate thickness shallbe provided to allow the nut to be completely tightened.

51.3.4 Welding : Where welding is adopted, it shall be done as per relevant I.S. 820.

51.3.5 Caps and Bases for Columns: The ends of all the tubes for columns, transmitting loads through the ends, should be true and square to the axis of the tube and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plateshould be true and square to the axis of the column.

51.3.6 Sealing of Tubes : When the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube should be dry and free from loose scale.

51.3.7 Flattened Ends : In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded, riveted or bolted connections, provided that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

51.4 HOISTING AND ERECTION

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workmen. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. The contractor shall have to grout the bolts in column tops to receive the truss wall plates, hoist the trusses in position, erect it in a perfect line, level and plumb, fix it in position with nuts, bolts etc., cure the grouted portion and paint the truss with two coats of paint of approved colour and shade over a coat of approved steel primer. Proper equipment such as derricks, lifting tackles, winches, scaffolding, propping, ropes etc. shall be used.

51.5 MODE OF MEASUREMENT

The work as fixed in place shall be measured in running metres correct to a centimetre and their weights calculated on the basis of standard tables correct to the nearest kilogram, unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts , nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

51.6 RATE

The rate shall include the cost of labour and materials involved in all the operations described aboveincluding one coat of approved steel primer and painting as specified in the item.

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52. NON-ASBESTOS HIGH IMPACT POLY PROPYLENE REINFORCED CEMENTCORRUGATED/SEMI-CORRUGATED SHEET ROOFING

The sheets shall be of the approved quality and shall conform to IS 14871. The sheets shall be free fromcracks, chipped edges or corners and other damages

The product shall be composed essentially of an inorganic hydraulic binder (see Note) or a calcium silicate binder formed by the chemical reaction of a silicate binder formed by the chemical reaction of a siliceous(includes ground silica, pulverized fuel ash and amorphous silica) and calcareous material reinforced byorganic fibres and/or inorganic synthetic fibres. Pozzolanic materials process aids, fillers and pigments which are compatible with the fibre reinforced cement may be added. The inorganic hydraulic binder shall be either 33 grade ordinary Portland cement conforming to IS 269 or 43 grade ordinary Portland cementconforming to IS 8112 or 53 grade ordinary Portland cement conforming to IS 12269 or Portland pozzolana (fly ash based) cement conforming to IS 1489. (Part 1) or Portland pozzolana cement(calcined clay based) conforming to IS 1489 (Part 2) or rapid hardening cement conforming to IS 8041 or Portland slag cementconforming to IS 455. Fly ash used shall be conforming to IS 3812.

52.1 LAYING

The sheets shall be laid on the purlins and other roof members as indicated on the working drawings or as instructed by the Engineer-in-charge.

The top bearing surfaces of all purlins and of other roof members shall be in one place so that the sheets when being fixed shall not require to be forced down to rest on the purlins. The finished roof shall present a uniform slope and the lines of corrugations shall be straight and true. The sheets shall be laid with the smooth side upwards. The sheets shall be laid with a side lap of half a corrugation and an end lap of 6" (15.2 cm.) minimum.

Side laps should be laid on the side facing away from the prevailing monsoon winds.

The free over hang of the sheets at the eaves shall not exceed 30 cm. Corrugated sheets shall generally be laid from left to right starting at the eaves. The first sheet shall be laid uncut, but theremaining sheets in the bottom row shall have the top left hand corners cut or Mitred. The sheets in the second and other intermediate rows except the first and the last sheets, shall have both the top left hand corner and bottom right hand corner cut. The first sheets in those rows shall have only the bottom right hand corner mitred, while the last sheets shall have only the top left hand corner cut. The last or top row sheets shall have the bottom right hand corner cut with the exception of the last sheet which shall be laid uncut. If for any reason such as considerations of the direction of prevailing winds, laying must be started from the bottom right hand corner, then the whole procedure should be reversed.

The Mitred described above is necessary to provide a snug (close) fit where four sheets meet at a lap. It is cut from a point 15 cm. (or whatever the length of the end lap may be) up the vertical side of the sheet to a point 5 cm.

along the horizontal edge. This cutting may be done with an ordinary wood saw at site.

52.2 FIXING

Sheets shall be secured to the purlins and other roof members by means of 8mm. diameter galvanised iron J or L hooks bolts and nuts. The grip of the J or L hooks bolts on the side of the purlin shall not be less than 25 mm. Each G.I. J or L hook bolt shall have a bitumen washers and galvanised iron washers placed over the sheet before the nut is screwed down from above. On each purlin there shall be one hook bolt on the crown adjacent to the side lap on either side. Bitumen washer shall be of approved manufacture.

Each nut shall be screwed loosely at first. After a dozen or more sheets are laid, the nuts shall be tightened to ensure a leak proof joint.

Holes for hook bolts etc. shall be drilled and not punched in the ridges of the corrugations in the exact positions to suit the purlins while the sheets are on the roof in their correct position. The diameter of holes shall be 2mm. more than the diameter of the fixing bolts. No hole shall be nearer than 40mm. toany edge of a sheet or any accessory.

Roof ladders or planks shall always be used when laying and fixing the sheets, to avoid damage to the sheets, and to provide security to the workmen.

52.2.1 **Wind Ties:** Wind ties shall be of 50 x 6 mm. flat iron section or of other size as specified. Theseshall be fixed at the eave ends of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlin. Wind ties shall be paid for separately unless described as included in the items of the roof work.

52.2.2 **Finish:** The completed roof shall present a neat and uniform appearance and shall be leak proof.

52.3 MODE OF MEASUREMENT

The measurements for roofing sheets actually laid shall be taken for the finished work in superficial areas flat in the plane of the roof and not girthed. The laps between the. corrugated sheets both at the ends and at the sides shall not be measured. The over laps of the corrugated sheets over valley gutters, roof light sheets, and eaves filler pieces and the underlay of the corrugated sheets below ridges, hips, north light curves, apron flashing pieces and barge boards shall be included in the measurement and paid for. Deductions will be made in the measurements for roof light sheets if any, but no deduction shall be made for holes cut for extractors or cowl type ventilators.

Length and breadth shall be measured correct to a centimetre and its area calculated in square metre correct to two places of decimal. Roof with curved sheets shall be measured and paid for separately.The breadth of the roof shall be measured along the trough of the curved sheets.

No deduction in measurements shall be made for opening in roof for chimney stacks, ventilators etc. of area upto 0.4 sqm. nor shall any extra be paid for extra labour in cutting, wastage etc. informing such openings. For openings exceeding 0.4 sqm. in area, deductions shall be paid for extra labour involved in cutting, wastage etc. in forming such openings.

52.4 RATE

The rate shall include the cost of all materials and labour involved in all the operations described above. The rate shall not include the cost of roof members, wind ties and specials such as finals, ridges, hips, valleys, north light curves, apron flashing pieces, barge boards, cowl type ventilators, extractors and roof light sheets, which shall be paid for separately. The rate of the item shall be deemed to be for straight sloping roofs.

52.5 **RIDGES :** Ridges and hips shall be of the same manufacture as the corrugated or semi-corrugated sheets used for roof, unless specifically permitted in writing by the Engineer-in-Charge. The sections shall be free from cracks, chipped edges or corners or other damages.Care shall be taken to match thecorrugations of the sheets with the ridges. The ridges shall be embedded in the end wall to the sameextent of the roofing sheets. If any small gap remains between the ridges and the roofing sheets, the same shall be rendered water proof by the contractors, with cement mortar 1:2 and as directed by the Engineer-in-charge at no extra cost to the Department. The overlapping of adjacent ridges shall beas per manufacturers specifications, scaffolding if

any shall be provided by contractors at their owncost.

52.6 Mode of Measurement: Linear measurements for the pairs of ridges shall be taken between the finished surfaces of the end walls and shall be correct upto two places of decimal of a metre. No laps or embedment shall be considered for measurements. The rate shall include all operations involved including cost of contractors materials, tools and plants, labour etc. No damages or losses shall be permitted.

52.7 EAVE CURVES

The corrugated eave curves shall be hoisted, placed and fixed in position in perfect line and level with hooks, nuts, washers etc. with the over laps provided as per manufacturer‟s specification. The holes for hooks shall be drilled and not punched. The areas around hooks shall then be made water tight. Nodamage or loss shall be permitted in the departmentally supplied materials. The eave curves shall be embedded in the gable walls to the same extent as that of sheets. Scaffolding, props etc. if required, shall be provided by the contractors at their own cost.

52.7.1 **Mode of Measurement:** Measurements shall be taken between the finished surfaces of walls and shall be correct upto two places of decimal of a metre. No laps or embedment shall be measured for payment.

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53. MANGALORE PATTERN TILE ROOFING

53.1 SCOPE OF WORK AND GENERAL

The specification refers to supplying and laying Mangalore tile roofing with cement mortar bedding over R.C.C. slopped slab. Cement mortar required for this job shall conform to specifications given here-in-before.

53.2 MATERIALS

Mangalore (The Commonwealth tile/earlier, Bassel mission tile or equivalent) tile shall be double channeled tiles and shall conform to class-AA or class-A type tiles as per I.S.654-1992 classification. The sample of tiles shall be got approved before procuring materials on mass scale and incorporating in works. Mangalore tiles (The Commonwealth Tile, The Malabar Tiles ,The Albuquerque tile, The Calicut tile Co. or equivalent manufacture) shall be made of the best Malabar clay, well dried and thoroughly burnt in patent kilns. The tiles shall be well burnt, close grained and homogeneous without segregated lumps of clay. Mangalore tile‟s (class-AA / class-A) should meet strength (breaking load) and water absorption parameters as per IS: 654-1992.

53.3 LAYING: Tiles can be laid in either of the following two methods:

53.3.1 CROSS BOND METHOD: A method of installing tiles such that the side laps of the tiles arestaggered to the preceding course.

53.3.2 **STRAIGHT BOND METHOD:** A method of installing tiles such that the side laps of the tiles are in direct line to the preceding course.

Mangalore tiles of approved make and quality shall be well-soaked in water for four hours before taking up for laying. Tiles shall be stacked nearby to facilitate installation and minimize tile movement. The mortar of specified proportion (1:4) and thickness(20MM) shall be spread uniformly and laying of tiles should startsimultaneously. At eaves line additional mortar is put to elevate eave edge of tile in order to match profile with the remaining roof tiles. If specified in item, Mangalore tile can also be laid on cement mortar band of 50mmx25mm size made at 320mm centre to centre.

The tiles shall be laid from the eves towards ridge. The minimum overlap shall be 60mm lengthwise and25mm widthwise .The laying of Mangalore tiles and laying of cement mortar shall go concurrently. The ridge Mangalore tiles shall be of standard type duly approved and shall be set in cement mortar as specified. Finished top slope of roof shall be uniform from ridge to eaves. The eaves line and the ridge lineand all intermediate lines shall be perfectly

straight, horizontal and parallel to each other. Tile should be properly cut to form straight edge at center of hip/ridge. The lowest layer of tiles at the eves shall have cut edges instead of round edges and/or as directed by the Engineer-in-Charge. For Wall Abutments tiles shall be cut to fit approximately 12mm to base of wall. For Rake/Gable Tile place mortar bed along roof edge and point smooth to a straight edge finish. All joints shall be pointed with cement mortar 1:2 with mixture of red ochre to preserve uniformity of colour and the joints shall be made perfectly secured and water tight .At valley i.e. at the intersection of two sloping roof planes, aluminium or galvanised steel sheet flashing(A rigid or flexible material used to prevent water infiltration at roof projections and to redirect water from walls, chimneys, valleys) with proper underneath overlaps should be provided as specified and as approved by Engineer-in-Charge.

The general procedure described above for Mangalore tile roof laying, also holds good for tile laying over pitched roof type other than RCC slab using tile fasteners and sealants compatible with batten and other underlayment material. Tile fasteners (nails ,screw fasteners ,ring shank nails etc.) shall be of corrosion resistant steel and should be compatible with batten material.

53.4 CURING

After laying of Mangalore tiles as specified, roofing shall be watered and cured for a minimum period of 7 days. After curing is over, the roof shall be thoroughly cleaned and all excess stays of mortar etc. shall be scraped off.

53.5 MODE OF MEASUREMENT

The rate shall be per square meter of actual area of finished roofing. The area shall be measured net without any overlaps. Opening for sky lights, cut outs etc.upto 0.4 sqm. shall not be deducted and no cutting for forming such openings shall be measured. The linear dimensions shall be measured flat from edge to edge of tiled roof and area worked out correct upto two places of decimal. Ridge tiles laid shall be measured in running metre. Portion covered by ridge tiles shall not be measured under roofing tiles. Metal flashing in valleys or at the junctions, if provided shall be measured separately and paid for on actual area basis. The rate shall include providing, erecting and removing scaffolding and necessary ladders. It also include all labour, materials, transport, cleaning, curing etc. to complete the job as specified.

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54. PROFILED GALVALUME ROOFING SHEETS

54.1 GENERAL

Galvalume is a high tensile steel sheet coated with aluminum and zinc alloy by hot dip method. In some countries this material is known as Zincalume. The basic material is cold rolled steel sheets of yield strength 550 Mpa. The coating for corrosion resistance is given at 150 gm/sqm , total on both sides. The alloy coating comprises of 55% aluminum, 43% zinc and 1.5% silicon. This coating combines the advantages of superior barrier protection of aluminum and the sacrificial cut edge protection of zinc.

Galvalume comes in the form of coils and is not manufactured in India. BHP Australia is the leading manufacturer of galvalume in the world. This material also comes in 300 Mpa yield strength. Galvalume conforms to ASTM 1397 or ASTM - A - 792 and ASTM - A - 446.

54.2 COLOUR

The bare galvalume is fit to be used as a roofing material. However, for better aesthetics the materials can be given colour coatings of required shade with silicon modified polyester (SMP) at factory itself. The exterior coat of SMP is usually 20 microns thickness given over a 5 micron polyester back coat applied over 5 micron primer. Sheets with 20 micron exterior coat of PVF2 (fluropolymer) paint system containing 70% KYANAR 500 resins are also being imported. These colour coatings exhibit excellent life to first maintenance in excess of 20 years.

54.3 SPANS

Deep profiles of the galvalume sheets facilitate more purlin spacing. Purlin spacing upto 3.5 to 4.5 meters are possible for normal live loads and wind loads with 88mm deep profiles. Shallow profile sheets can span up to

1.8 meters for average loadings.

54.4 THICKNESS

Galvalume sheets are available in thickness ranging from 0.25mm to 0.8mm. The most commonly used thickness is 0.55mm for profiled sheets and 0.65mm for flashing and gutters. The approx. weight of 0.55mm sheet is 5kg/m^2 and the coverage is 200sqm/tonne.

54.5 LAYING AND FIXING

Profiled Galvalume sheet roofing system shall be laid and fixed to the purlins with all fittings, fixtures, fasteners, nut and bolts,washers, clips, frames and all other accessories including appropriate side laps and end laps all as per the manufacture‟s specifications. The roofing sheets shall be laid at right angles to the purlins and at the required slope as specified.

Generally „KLIPPON‟ system of M/s Interarch is followed for method of fixing of sheets which is boltlessfixing using clips. In this system the roof sheets are designed to be fastened to roof purlins with fixing clips which are concealed during fixing and do not require any fastening holes through the sheets.The clip must be positioned with the short leg engagaging over the male rib of the underlapping sheet. This system eliminates the ingress of water through screw hole penetration.

54.6 INSPECTION & TESTING

The contractor shall submit the manufacture‟s test certificate and all other documents relating to the procurement of galvalume sheets. The Engineer-in Charge at his discretion may get the samples tested to ensure that the material conforms to specification.

54.7 MEASUREMENT: Length and breadth of completed work shall be measured correct to a cm and area shall be worked out upto two decimal of sqM.The area under the laps shall not be measured for payment.

55. POLYCARBONATE ROOFING SHEETS

55.1 General: Polycarbonate sheet is a unique engineering thermoplastic material which combines a high level of mechanical, optical and thermal properties. Due to its high impact strength (200 times stronger than glass),high Light transmission(>80%),cold bend ability to limited radius and thermo foldable properties polycarbonate sheet is widely used as roofing material in skylights, monumental skylight (domes etc.),walkway and also as vertical glazing as an architectural element in civil construction.

55.2 Material: i) Polycarbonate sheet shall conform to IS 14443-1997. Polycarbonate sheets are available in various sheet form with or without standing seam such as (a) solid compact sheets of thickness varies from 1mm to 12mm.(b)Embossed/Textured sheet,(c)Polycarbonate profile sheets and (d)Polycarbonate structured(hollow) sheet---multiwall/multi-cell of thickness 4.5 to16mm or more on specific requirement. These sheets can be clear, colour tinted, transparent, translucent or opaque as specified. To provide long lasting high stability against UV-radiation and also to protect against outdoor weathering and retain its original colour, coextruded UV absorption and protection layer shall be provided on top or both the faces as specified.

55.3 Polycarbonate sheet Connection Profile: The connecting profile system shall be made of either aluminium or polycarbonate material as specified and Profile connectors and finishes accessories shall be as per guidelines of approved specialised manufacturer/agency.

55.4 Fixing: Polycarbonate sheets as specified in item shall be fixed with aluminium system or other specified system (with top cover and bottom section to be fixed with a self-tapping screw) and EPDM gaskets to ensure maximum uplift capability including End-cap/Aluminium U-Profile to protect exposed edges. The sheets shall be fixed to preinstalled structural frame work (structure shall be paid separately in relevant item) and be secured with aluminium system at all levels including all accessories like screws, washers, flashing, trims etc complete to make a water tight skylight system. including transportation, lift, scaffolding, etc. conforming to manufacturer‟s

specifications and as approved by Engineer-in Charge.

55.5 Mode of Measurement: The top surface area of the polycarbonate sheets covering including projections and facias,if any, shall be measured net in sqm upto two decimal places for payment. Overlapping shall not be measured. The rate to include designing the system, cost of all materials, connecting profiles and accessories, wastages, scaffolding, equipments, labour etc. complete.

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56 SUSPENDED NON-METAL NON-ASBESTOS (GYPBOARD, MINERAL FIBERREINFORCED TILE, DENSIFIED CALCIUM SILICATE TILE) FALSE CEILING SYSTEM

56.1 GENERAL

The work covered by these specifications shall consist of providing all materials, labour, and installation of the suspended false ceiling and vertical masking system with NON-ASBESTOS MINERAL FIBER TILES/GYPBOARD/ CALCIUM SILICATE DENSIFIED TILES of specified texture and finish usingsuspended pressed GI frame grid work, interlocking, suspended by adjustable M.S. suspenders with necessary cut outs in the false ceiling for lighting fixtures, trap doors, A.C. grills etc., providing MS lighting troughs etc., erecting to proper line and level in the specified areas, floors and levels as indicated in the drawing and as directed by the Engineer-in-Charge.

56.2 MATERIAL

i) Gypsum Board (Pain or perforated) 12.5mm thick, moisture resistant-(Gyprock.MR of M/s SaintGobain or equivalent) as specified/approved.

ii) Acoustic mineral fiber reinforced ceiling tiles with factory applied latex paint surface finish 15/16/19mm thick, fire class-A, RH99,NRC>0.50 with specified surface design and edge profile-(M/s Armstrong or equivalent) as specified/approved.

iii) (A) Calcium silicate ceiling tile with low thermal conductivity(0.043w/m.^{0}C),non-combustile as per BS476,Part4, 100% RH resistant,12mm or specified thickness with specified surface design and edge profile-(M/s Aerolite or equivalent) as specified/approved.

(B) Calcium silicate ceiling board(Hilux) with low thermal conductivity(0.13w/m.^{0}C),non-combustile with fire propagation index 4,100% humidity resistant,12mm or specified thickness with specified surface design and edge profile-(M/s Ramco Industries or equivalent) as specified/approved

56.3 SUSPENDED(NON-METAL, NON-ASBESTOS) FALSE CEILING AND MASKING ETC. WITH PRESSED STEEL FRAME WORK/ ANODIZED ALUMINIUM FRAME WORK

56.3.1 **General:** The work covered by these specifications shall consist of furnishing all labour, materials and equipment necessary for installation of the suspended false ceiling and vertical masking, with falce ceiling tile/board as specied in item on pressed steel frame work, inter locking, Aluminium frame work suspended by adjustable M.S. suspenders with necessary cut outs in tile/board sheet for lighting fixtures, trap doors, A.C. grills etc., providing m.s. lighting troughs etc., erecting to proper line and level in the specified areas, floors and levels as indicated in the drawing and as directed by the Engineer-in- Charge.

56.3.2 **Materials:** All materials which are to be in-cooperated in work shall be got approval prior to bulk procurement.

56.3.2.1 **Fabrication of Pressed Steel (M.S/G.I) Frame :** The frame work for "snap grid" false ceiling shall be made out of tested special springs grade steel or approved cold rolled sheets of specified gauge as per schedule, accurately formed and die cuts with identical ends in automatic machine with precision tools. All workmanship shall be best quality as followed in a modern sheet metal shops equipped with all machines such as press, dies, spot welding machine, baking oven etc. All materials shall be done by a process approved by the Engineer-in-Charge and in a manner that will not damage the materials. All work shall be accurately formed to the required dimensions,

true to line, level and plane in all directions and properly sized to suit the exact dimension within permissible tolerances. Twisted or bent sections shall not be permitted to be used on work. Main runners and cross tees shall be of sizes as specified in the schedule/shown in the drawing. The main runners shall be slotted for cross tees and punched for hangers/suspenders. Cross tees shall have identified die formed ends accurately cut for easy, correct and proper fit assembly. Shearing, cropping shall be clean, reasonably square and free from distortion. Surfaces and joints to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials. The surface shall be wire brushed vigorously. Welding sequence shall be followed to avoid needless distortion and minimise shrinkage stresses. Holes to be made in pressed M.S./G.I sheet shall not be made by flame cutting. The flame cut or unfair holes are not acceptable connection of supported members with erection clearance for all members. Where for practical reasons greater clearance is necessary, suitable designed seating should be provided. Any damages done to the walls/ceiling shall be reinstated to original condition. The contractor shall not be entitled for any extra cost on this account.

56.3.2.2 **Suspended Aluminium Grid system:** Aluminium grid system shall be of bestlok/eezilock or equivalent approved standard suspended aluminium grid system. The suspended ceiling grid shall be of self interlocking anodized aluminium T bars for main runners and cross runners of specified section and pattern as required to suit the span as per drawing.

56.3.2.3 **M.S. Works:** All MS works shall conform to relevant specification mentioned Under Structural Steel here-in-before.

56.3.2.4 **Fastening:** All bolts, nuts, screws, fittings & fixtures shall be of best quality and of approved manufacture.

56.3.4 Fixing: The contractor shall take all necessary field measurements before the commencementof the frame work to ensure proper fittings of the work to actual condition of work at site. Particular care should be taken to examine the positions of all recessed lighting, trap doors and other openings indicated on drawings or as directed by the Engineer-in-Charge. The correct panel sizes shall be decided to suit each location. The false ceiling levels shall then be marked on walls. Mark the position of the runners to suit the span of the area. Fix up the wall angles with approved metal fasteners and level then correctly. The position of suspender shall then be marked on the R.C. slab as per the sizes of the panels decided for each area with due consideration to location of air-conditioning ducts, grills etc. Suspenders of type and design fabricated as per drawing and approved by the Engineer-in-Charge,

Shall then be securely fixed at correct points with approved metal fasteners/expansion bolts of specified dia., as per manufacturers specifications. It shall be ensured that the hanger/suspender shall remain perpendicular and not pulled by the suspension system to any side. Fix up the runner to the suspenders and lock up the runners at the joints, complete the levelling starting from the fixed points and proceed towards the other end. Fix up the the cross tees to every runner joints to have stability while levelling. Neoprene rubber gasket shall then be fixed all along the frame work with approved type of adhesive. As specified in item ceiling tile/board cut to correct sizes shall then be placed on the runner, starting from the centre of the width and work side wards. Connect all cross tees and put on the approved spring type hold down clip/pins as per drawing. Holes if required to be provided in tile/board sheets shall be drilled and on no account holes shall be punched. The runner tees and tiles shall be locked with hold down clips/pins as required. Wherever grouting for frame work, suspenders etc. is required to be done in masonry walls columns/beams etc., the same shall be done after the entire frame work is properly levelled.

The contractor shall take into consideration all wastage in materials, aluminium grid system frame work/pressed steel frame work, M.S. suspenders, screws, nuts, bolts, washers etc. required for fixing false ceiling and vertical masking while quoting his rates. False ceiling and vertical masking shall be fixed to pressed steel frame or Aluminium grid system by means of spring clip (brass counter sunk machine screws in case of masking) of approved size, make and at approved spacing or as shown in drawing or as instructed. After fixing the tile/board, all holes of screws etc. shall be filled with approved putty/jointing compound with paper tape and sand papered, so that no sign of screw is visible on the sheets. For all the sheets false ceiling and vertical masking work, the tile/board of required size and shape shall be cut as per approved panel size shown in drawing and fixed on pressed steel

frame in the best workman like manner. It is to be noted that in case of mineral fiber board no load (such as fire insulation glass wool)should be put directly over mineral fiber board instead it should be on suspended grid frame.

Trap doors/lighting recesses/troughs of approved size and shape with approved matching work, shall beprovided in the false ceiling and vertical masking at the specified places.

Any damage done to the walls/columns/ceilings/plasters/floors etc. shall be made good to the original condition at his own cost. The contractor shall not be entitled for any extra cost on this account. During the execution of this work, the contractor shall take all the precautions to prevent damage to the painted surface, plaster, floor tiles, doors etc. Contractor should specifically note that the area where the false ceiling is required to be provided will be in advance stage of completion with various finishing items such as painting, floor polishing etc. Any damage to these finishes will have to be made good by him at no extra cost to the Department.

56.3.5 Safety Precautions: No person other than workman employed by the false ceiling contractor shallbe permitted access to any area over which the sheeting is being laid. The contractor should take protective measures during the progress of work. Cat ladders or roof boards, scaffolding etc. should invariably be used by men working on the roof/false ceiling/masking etc.

56.3.6 Work to Include: Cost of all labour, false ceiling sheets with anodized aluminium/pressed steel frame work, wastages, adjustable gavanised/ m.s. suspenders, m.s. cleats, nuts, bolts, washers, screws, all labour, materials, tools, plants, approval scaffoldings, providing m.s. cleats and fixing them with metal fasteners/expansion bolts, nuts, washers, screws etc. to the concrete/wall surfaces and then fixing the adjustable suspenders in m.s. clamps, painting two coats of synthetic enamel paint on m.s. work as directed/as shown in drawing.

56.3.7 Mode of Measurement: Measurement shall be as per actual area of false ceiling alongwith trap doors, if any. No deduction shall be made for lighting troughs and diffusers/grills, cut-outs etc. upto 0.4 sqm. area. Also, nothing extra shall be paid for making additional framing arrangements around such cut- outs for trap door, lighting troughs and grills/diffusers.

56.4 LIGHTING TROUGHS / FIXTURES

Lighting troughs/fixtures shall be fabricated out of anodized aluminium sheet or out of m.s. sheet of specified gauge and shall be free from scale, blisters, laminations, cracked edges, defects of any sort and shall conform to relevant I.S. specifications.

Lighting troughs shall be fabricated in a modern, well equipped workshop, as per the size and profile given in the drawing. The M.S. lighting trough shall be stove enamelled in the shop with approved type of colour & shade on both the surfaces. Aluminium troughs shall be anodized as per standard practice. Sample of lighting trough fabricated as per drawing shall be got approved by the Engineer-in-Charge before manufacturing on large scale. Aluminium/ MS frame work sections and sizes, as per drawing, shall be fabricated and got approved before fixing in position.

The MS lighting troughs along with MS frame or aluminium lighting troughs with aluminium frame shall be fixed in position to correct line and level with MS suspenders as per drawings. One or more sample lighting troughs shall be fixed in position and got approved before fixing all the lighting troughs. The end of the lighting troughs on both sides shall be provided with MS. covers of the same gauge as per drawings.

The materials and fabrication of lighting trough, MS/ aluminium frame and suspenders shall conform to the relevant specification given in this tender. The MS. work shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer as per specification under relevant head.

56.4.1 **Mode of Measurement:** The lighting troughs alongwith m.s or aluminium frame work, suspenders, end covers etc. duly fixed in position shall be measured along the length of the trough in running metres upto two places of decimal of a metre and paid for unless otherwise specified in schedule of work.

56.5 TRAP DOORS

The materials viz. M.S. frame, aluminium frame and A.C. sheet and fabrications shall conform to the relevant specification given in this tender.

The trap doors shall be fixed in position with necessary M.S. angle frame out of M.S. angle of size 40 x 40 x 6mm. for the shutter and fixed to M.S. wall angle of size 40 x 25 x 6 mm. which is to be fixed bymeans of 40 x 25 x 6 mm. M.S. angle cleats, fixed to wall by means of M.S. hold fasts out of M.S. flats of size 40 x 6mm., 150 mm. long and grouted with cement concrete 1:2:4 in case of brick wall and with 100 mm. long M.S. coach screws and rawl plugs in case R.C. columns etc. M.S. angle of size 40 x 25 x 5 mm. shall be provided for receiving the lever of the locking arrangement. This angle shall be supported by 40 x 6 mm. M.S. flat suspenders from ceiling fixed with 3/8" diameter metal fasteners/expansion bolts. This angle, meant to receive the lever of the lock, shall be supported by two numbers of M.S. angle of size 40 x 25 x 5 mm. on either side. The two angles also shall be provided with M.S. flat (40 x 6 mm.) suspenders @ 800 mm. centers at all other convenient spacing as per drawing and as approved by the Engineer-in-Charge.
Sample of trap doors of single, double and multi panels shall be fabricated and fixed in position and got approved before taking up fabrication of trap doors on large scale.

All the exposed surfaces of M.S. work including the suspenders shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

56.5.1 Mode of Measurement

The area of trap door visible from underside of the false ceiling only shall be measured in square metres for payment. The m.s. angles to be provided for locking arrangements and supporting M.S. angles which shall not be seen from underneath shall not be measured for payment and are supposed to be included in the rate quoted for trap door, unless otherwise specified in the schedule of work.

56.6 FIBRE GLASS THERMAL INSULATION WORK AT CEILING WITH T.W. BATTENS FRAMEWORK AND COVERING WITH A.C. SHEET

56.6.1 **Scope of Work:** The work envisaged under these specification covers providing and fixingfibre glass thermal insulation to ceiling at any floor, location and height as specified including T.W. battens frame work in required grid and insulation work covered with A.C. sheet/flexo board of specified thickness.

56.6.2 Materials

56.6.2.1 **T.W. battens for frame :** Battens required for frame work shall be as specified under chapter "Wood work in frames, shutters and panelling".

56.6.2.2 **Thermal insulation media :** The thermal insulation media shall be of fibre glass Crown 150 or equivalent approved make with K value of 0.0285 K. Cal/sqm. hr.^{o}C, 50 mm. thick and density of 24 kg/cum. or as specified in the description of item/ in drawing. Sample of fibre glass to be used on the work shall first be furnished by the contractor and got approved from Engineer-in-Charge before mass procurement.

56.6.2.3 **Mineral fiber/ Gypboard/calcium silicate board/G.I sheet covering :** Covering to insulationmedia shall be as specified in item.

56.6.2.4 **Fire resisting paint :** The fire resisting paint shall be of M/s. Garware Paints Ltd. or any other approved equivalent make and shall conform to I.S. 163. Sample of fire resisting paint to be used on work shall first be got approved from Engineer-in-Charge before bulk procurement. Ready mixed paint as received from the manufacturer without any admixture shall be used.

56.6.3 Erection / Fixing Of Insulation

56.6.3.1 **Frame work :** The workmanship shall be of best quality. All wrought timber is to be sawn, drilled or otherwise machine worked to the correct sizes and shall be as indicated in drawing or as specified. All joinery

work shall fit truly and without wedging or filling. All necessary mortising, tennoning, grooving, matching, tonguing, housing rebate and other necessary work for correct jointing shall be carried out in the best workmanship like manner. The frame work shall be made in required grid as specified in schedule item and in drawing. The frame work shall be rigidly screwed to the ceiling with 100 mm. long G.I. wood screws and rawl plugs @ 300 mm. centre to centre (or as specified) both ways by drilling holes in ceiling through frame work. The wood work shall be painted all over withfire resisting paint of M/s. Garware Paints Ltd. or any other approved equivalent make before erection ofthe same in position as per manufacturers specifications and as directed by Engineer-in-Charge.

If after fixing the frame work in position, any shrinking or substandard material or bad workmanship is detected, the contractor shall forth with remove them and replace the same at his own cost.

56.6.3.2 **Sticking of insulation material & fixing of fiber glass :** After fixing of the frame work as above,a thick coat of bitumen of approved grade shall be applied as vapour barrier in the grids of frame workand then fibre glass of required thickness shall be sticked to ceiling and panel of grids as directed by the Engineer-in-Charge. The panels of fibre glass shall be cut exact to grid size and evenly pressed.

Approved tile/board sheets cut to correct sizes as specified in item description shall then be placed on the frame works starting from the centre of the width and work side-wards. Holes required in board shall bedrilled and on no account holes shall be punched. Covering tile/board/sheet shall be fixed to wooden frame work with suitable size of C.P. brass screws @ 300 mm. c/c. 4 mm. wide groove or as shown in the drawing shall be kept to correct line, level and plane at the junctions of sheets.

Any damage done to the finishes and to walls, columns, ceilings, plasters, floors etc. shall be made good to the original condition by the contractor at his own cost. The contractor should take protective

measures during the progress of work. Cat ladders or roof boards scaffolding should invariably be used by men working on the thermal insulation work.

56.6.4 **Mode of Measurement :** This work shall be measured on square metre basis. The length and width shall be measured between plastered surfaces of walls upto two places of decimal of a metre for working out the area.

56.6.5 **Rates:** Rates quoted by the contractor for the work shall include cost of all materials and labour required to complete the work as per item description, as per above specifications and as shown in the drawing.

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57 SUSPENDED METAL FALSE CEILING SYSTEM & THERMAL INSULATION

57.1 MATERIALS: Manufacturing and Product: Hunter Douglas India Private Ltd. or equivalent.

57.1 .1 Product : Suspended metal ceiling systems shall be one of following type and profile as per manufacturer specifications.

i) Linear metal ceiling system (perforated or plain)-84/150mm series with specified edge profile. ii)Linear wide panel ceiling (perforated or plain)-300mm and more width with specified edge profile. iii)Plank and Tile- square or rectangular (perforated or plain)-sizes 600 x 600mm to 600 x3000mm.
iv) open cell ceiling system

57.1.2 Material

i) Metal ceiling panel shall be of Corrosion resistant Aluminium Magnesium metal alloy AA 5050/3105 heets of thickness(0.5/0.7mm) as specified and painted either Factory Applied Polyester paint or Powder coated (.025) as specified in item of approved shade and colour. It should conform to ASTM B 209 - "Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate".

ii) Metal ceiling system components to be used shall be from a single manufacturer to provide consistent

quality in appearance and physical properties and these should be in conformity withthe metal ceiling system requirement as specified in item.

iii) Suspension system components shall also be from a single manufacturer to provide compatible components for a complete metal ceiling system installation. They should conform to ASTM C 635 - "Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings".

57.1.3 Product Certification: Agency shall produce manufacturer‟s certifications that products comply with specified requirements and governing codes including product data, laboratory test reports and researchreports showing compliance with specified standards.

The Specification detailed below pertains to linear metal ceiling system (perforated or plain)- Luxalon150C profile metal ceiling and also generally applies to other type/profile metal ceiling systems of M/s Hunter and Douglas with respect quality, installation and workmanship.

57.2 LUXALON 84C/ 150 C/ 300C METAL CEILING

57.2.1 Panel: The panel shall be cold roll formed panels of specified width (84mm, 150mm, 300mm), depth 12.5mm and 0.5mm thick. with a 5mm beveled edge creating an 8mm V groove made from corrosion resistant Al.-Mg. Alloy AA5050, The length of each panel shall be upto 6000mm. The aluminium panels shall be chromatised for maximum bond between metal and paint enameled twice under high temperature, one side with a full primer and finish coat in a polyester paint for a dry film thickness of 20 microns, the other side (inner side) with a primer coating and skin coat on a Continuous Paint Line.

57.2.2 Carrier: The carrier on which the panels shall be clipped on to will be 62mm wide, 29mm deep, made of black stove enameled 0.95mm thick aluminium alloy AA5050. When two or more carriers are tobe joined, they shall be joined together by means of splices, which will clip on to holes provided for the same.

57.2.3 Wall Trim: The wall trim shall be having L-profile of size (29.2mm wide x 19..4mm deep x 0.5mmthick) or as specified of Aluminium Alloy AA5050 of length upto 5 m .

57.2.4 Rod Hanger: The rod hanger of suitable length shall be made of 4mm dia. galvanised steel (Zinccoating 120 gms/Sqm.)

57.2.5 Suspension Clip : The adjustment suspension clip shall be made of galvanised spring steel V shaped with two holes to accommodate the rod hanger.

57.2.6 Anchor Fasteners : The single piece sleeve anchor with assembled hanger taper bolt and nut which has smaller driller dia. Anchor fastener shall be of arrow make or equivalent with thread size 5mm.

57.2.7 Suspension System : The carriers would be suspended from the roof by 4mm dia galvanised (Zinc coating 120gms/Sqm.) steel wire rod hangers with height adjustment springs out of galvanised spring steel. Hangers shall be fixed to roof by 'J' hooks and Anchor Fasteners

57.3 FINISHING OF SURFACE OF STRIPS FOR INTERNAL USE (ALUMINIUM)

The coils from which aluminium panels are made shall be cold roll formed & stove enameled on a continuous coil coating paint line with dried in place roller coated application for pre-treatment. The coils togo through four stages of pre-treatment, three times oven baked through conversion coating, priming and finished coat, ensuring superior adhesion, high corrosion resistance and good colour retention. The coilsshall be painted on both sides after being degreased. Prime coat of at least 5 microns to be applied on both sides and a back coat of 5 micron of neutral colour to be applied on the inside surface and 5 micron of binder and 15 microns of top coat of desired colour shall be additionally provided on the exposed surface.

The paint shall be of approved colour and coating will consist of tough and durable Luxacoat finish in nominal thickness of approximately 20 microns, applied in a continuous coil coating process ensuring uniform coating thickness as per manufacturer‟s specification. The finish shall be guaranteed for optimum adhesion and excellent

resistance to weathering.

57.3.1 Shop Drawing: Agency has to submit shop drawings for reflected ceiling plans (RCP‟s) indicating penetrations and ceiling mounted items, Suspension System, Carrier and Component Layout and details of system assembly and connections to building components

57.3.2 Fixing: The panels shall be clipped on to a aluminium panel carrier of specified size. The carriers to be suspended with an adjustment spring of galvanised spring steel, V shaped with two holes to accommodate the rod hanger. The rod hanger shall be made of 4mm dia, galvanised steel and suspended form the ceiling by J hooks fixed at 1.3m centre to centre.

Trap doors/lighting recesses/troughs of approved size and shape with approved matching work, shall beprovided in the false ceiling and vertical masking at the specified places.

57.3.3 Workmanship: The ceiling shall be erected in continuous sequence. Spans would not exceed those recommended by M/s. Hunter Douglas India Pvt. Ltd. All work in this section shall be performed in an efficient manner by the installing agency approved by the manufacturers and as per manufacturer's recommended procedures.

57.3.4 Fire Resistance: The false ceiling including the paint shall be fire resistant as per DIN 4102.Class A2. It should also be classified as P-NOT EASILY IGNITABLE - AS PER BS 476. Part 6 and should have a fire propagation classification of Class as per BS 476 Part 6.

57.3.5 Mode of Measurement: Measurement shall be as per actual area of false ceiling alongwith trap doors, if any. No deduction shall be made for lighting troughs and diffusers/grills, cut-outs etc. upto 0.4 sqm. area .Also, nothing extra shall be paid for making additional framing arrangements around such cut- outs for trap door, lighting troughs and grills/diffusers.

57.4 THERMAL INSULATION

57.4.1 Underdeck Insulation: Method of Application as follows
Clean the surface and make it free from dust and loose particles. Apply a coat of Shalicoat to the underside of the roof. Apply CPRX compound to the underside of each prelaminated Phenolic Foam panel and press the slabs in position. But the joints well together. Secure panel in position with the help of screws, rawl plug and washers. Deal all the joints with the help of self adhesives Aluminium tapes.

57.4.2 Insulation above False Ceiling: The insulation tiles shall be placed above the A1 carriers, which are a one meter c/c. The insulation tiles should be cut to the required size for placement over carriers as Per the spacing and pattern of false ceiling lay out. The rate quoted shall be inclusive of cutting to the required size, wastage etc. The tiles shall abut each other to provide a continuous barrier for effective thermal insulation

57.4.3 General

(i) Extremely low 'K' value 0.018 Kcal/hrM.C.
(ii) Low water vapour transmission level.
(iii) Should be available in a single component system.
(iv) Should be approved by both TAC and NIC.
(v) Should be mildly antiseptic with resistance to fungal and bacterial growth and should not attract rodents/insects.
(vi) Should have good acoustic properties.
(vii) Temperature Range : + 125 degrees C to - 190 degrees C.
(viii) Material shall be classified as P [not easily ignitable] - BS 476 Part 5.
(ix) Material should conform to Building Classification "O" based on the propagation index BS 476 Part 6.
(x) Material shall have a Class I surface spread of flame, the highest rating possible BS 476 Part 7.
(xi) Lowest smoke obscuration 5% (almost negligible) - BS 5111 Part 1 .
(xii) Toxicity index of 0.04478 - Naval Engineering Standards 713 (NES) Ministry.

58 SUSPENDED POLYESTER FIBRE HD PANEL FALSE CEILING SYSTEM

58.1 GENERAL

The work covered by these specifications shall consist of providing all materials, labour, and installation of the suspended false ceiling and vertical masking system with polyester fibre HD panel of specified density, colour and finish usingsuspended pressed GI frame grid work, interlocking, suspended by adjustable M.S. suspenders with necessary cut outs in the false ceiling for lighting fixtures, trap doors, A.C. grills etc., providing MS lighting troughs etc., erecting to proper line and level in the specified areas, floors and levels as indicated in the drawing and as directed by the Engineer-in-Charge.

58.2 MATERIAL

Suspended false ceiling system using 18mm thick, 2000 GSM, 595mm x 595mm size poly HD panels made out of fine, long, 100% polyester fibre of suitable deniers, thermally bonded with presence of low melt fibre ("NO CHEMICAL TO BE USED AT ANY STAGE OF THE PROCESS TO BIND THE FIBRE"), 100% fire retardant, approved design, color with polyester cloth fixed on one side and placed in a suspended grid of size 600 x 600mm made of hot-dipped G.I. sections having an exposed surface capping of pre-finished baked polyester painted coil wherein the main tee of size 24mm x 38mm x 0.33mm x 1200mm shall be inserted in to slots between the main tees at 600mm cetre and there after in direction vertical to the longer tees, cross tees of size 24 x 28 x 0.33mm x 600mm shall be inserted to form a grid of size of 600mm x 600mm resting on the periphery walls on wall angles of size 20mm x 20mm x 0.40mm x 3000mm. The rate shall include providing necessary opening for light fixtures, diffusers, trap doors etc. to be made as per layout drawings. The work shall be carried out as per directions of engineer-in-charge. The main tees to be suspended from the ceiling / soffit with the help of metal dash fasteners of 6mm x 50mm, soffit clips of 25mm x 35mm x 1.6mm and 4mm dia. G.I wire with galvanised spring steel levelling clips etc. The entire grid system shall be designed to bear a distributed load of minimum 15 Kg/Sqm.

49.3 **Mode of Measurement**: Measurement shall be as per actual area of false ceiling alongwith trap doors, if any. No deduction shall be made for lighting troughs and diffusers/grills, cut-outs etc. upto 0.4 sqm. area. Also, nothing extra shall be paid for making additional framing arrangements around such cut- outs for trap door, lighting troughs and grills/diffusers.

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59 WATER PROOFING

59.1 GENERAL

The contractor shall execute the water proofing work by engaging specialized water proofing agency duly approved by Engineer-in-Charge. The water proofing agency has to furnish guarantee bond on stamp paper as per the specified proforma in respect of the entire waterproofing treated areas for maintaining the surroundings and undersides in bone dry condition for 10 years which shall be countersigned by the contractor in token of his over all responsibility. In the event of non-attendance of any duly conveyed

dampness/leakages problem within reasonable time frame, the main contractor shall be held responsible and liable for action as deemed fit by Engineer-in-Charge as per contract.

59.2 WATER PROOFING PLASTER IN TOILET AREA

The following specification shall be followed unless otherwise stated in schedule of quantities. This shall be 15 mm. thick plaster including an under coat not exceeding 8 mm. thick. Approved water proofing compound like CICO No. 1 or other approved equivalent shall be added @ 3% by weight of cement in cement mortar or as per manufacturers specifications in both the coats. The workmanship and material shall be same as described in plaster work in general. All exposed surfaces shall be finished smooth with a coat of neat cement as directed, except areas where tiling work is to be done, where the plaster shall be left rough / float finish.

59.3 INTEGRAL CEMENT BASED WATERPROOFING WITH BRICK BAT COBA (ROOF, OPEN TERRACE)

59.3.1 **General:** The waterproofing treatment shall be essentially a cement based integral waterproofing treatment. The waterproofing treatment shall consist of providing cement slurry mixed with waterproofing compound, at desired proportions including grouting the cracks and crevices with cement slurry mixed with waterproofing compound, laying brick bats over cement mortar bedding to the required slopes for roof drainage, filling and grouting the joints with cement mortar, finishing the surface smooth/chequered with cement plaster mixed with waterproofing compound etc. as directed.

Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras ,grooves to tack the fibre cloth layer(if specified in item), lead flashings , fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

59.3.2 **Fibre Glass Cloth:** The fibre glass cloth shall be of approved brand and shall be thin, flexible uniformly bonded mat composed of chemically resistant borosilicate glass fibre distributed in random open porous structure bonded together with a thermosetting resin.

49.3.2 Preparation of Surfaces : All the rubbish, debris and other materials left over by other agencies will be got removed by the Department through other agencies. After removal of this rubbish, debris etc., the surface to receive the waterproofing treatments shall be thoroughly cleaned with wire brushes including removing of scales and laitance, set mortar etc. by the waterproofing contractors. If any honey combing including cracks and crevices are observed at column junctions/and elsewhere, the same shall be grouted with cement slurry mixed with approved waterproofing compound.

49.3.3 Blending Cement/Water with Water Proofing Compound: The required quantity of cement bags to be used for a particular portion of work should be emptied on a dry platform. Water proofing compound bearing ISI mark and conforming to IS 2645-2003 should then be mixed properly with the cement. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement. The quantity of cement and water proofing compound thus mixed should be thoroughly blended and the blended cement should again be packed in bags.
For the water proofing compound in liquid form, the blending is to be done with water. This can be done by taking the just required quantity of water to be mixed in the particular batch of dry cement mortar.

The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water proofing compound from sealed tins with ISI mark. The water thus mixed with water proofing compound shall be thoroughly stirred so that the water is blended with water proofing compound properly.

49.3.4 Treatment: The water proofing treatment shall be as specified in item mainly consisting of following activities of work.

i) Applying cement slurry coat using cement @2.75Kg/sqm. blended with approved waterproofing compound for the entire surface to be treated. The application of the slurry should continue upto a height of 300 mm on the parapet wall.

ii) Laying Base Coat 20 mm thick: Immediately after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5
(1 blended cement : 5 coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

iii) Laying Brick Bat Coba :Brick bat of size 25 mm to 115 mm out of well burnt bricks shall be used for the purpose of brickbat coba.The brick bats shall be properly dampened for six hours before laying.Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15-25 mm gap between two bats. Cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be poured over the brick bats and joints filled properly. Under no

circumstances dry brick bats should be laid over the base coat. The haunches/gola at the junction of parapet wall and the roof shall be formed only with brick bat coba.

In case the brick bat coba is laid on the base coat immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba. However, if the brick bat coba is to be laid on the subsequent day, cement slurry shall be applied over thetop surface of the base coat, then only the brick bat coba shall be laid.

iv) After two days of curing of brick bat coba cement slurry shall be applied on the surface of brick bat coba. The application of slurry shall be the same as described above which should cover thehaunches/gola, and the remaining small portion of parapet wall.

v) Laying Finishing Layer (Protective Coat): Immediately on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green 20mm thick joint less cement mortar(1:4) admixed with waterproofing compound shall be laid as finishing/protective layer. The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry. The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the entire surface.

If the item specifies for providing glass fibre cloth as mentioned above the same shall be spread evenly on the green cement slurry surface without kink and pressed to expel any air spaces. Thefibre glass cloth shall be taken upto a height of 300mm on parapet walls and tucked in the grooves specially prepared at that height. A minimum overlap of 100 mm width shall be provided when the fibre cloth has to be joined. The joining of 100 mm overlap shall be done with the same slurry used for the application on surface as first layer. The fibre cloth shall also be extended upto a height of 100 mm over pipes projecting from the surface. 20mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended cement: 4 coarse sand) over the entire fibre glass cloth including the haunches/gola and the small portion on the parapet wall.The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove.The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry. The finished surface shall be allowed to dry for a while and then pattern of 300 mmx 300 mm groove, 8 mm deep shall be made over the entire surface.

vi) Curing and Testing the Treatment: The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.

The contractor shall ensure that sufficient slope for effective roof drainage is provided within the average thickness of waterproofing treatment proposed by the contractor. In case the average specified thickness of treatment exceeds, the fact shall be specifically brought to the notice of the Engineer-in-Charge, before adopting the extra thickness.

49.3.5 Testing and Guarantee: The contractor shall test the surface for the bone dry condition by ponding water over roof for minimum seven days period to the entire satisfaction of the Engineer-in-Charge. Alternately, the curing of the finished surface done by ponding of water on the entire surface for two weeks, can also be used for testing water tightness. After a period of two months, once again the roof should be ponded with water to check its efficiency of waterproofing treatment against leakage. The contractor shall furnish guarantee in the proforma as per Appendix D for the waterproofing treatment provided by them, for maintaining the underside of the roof in bone dry condition for a minimum period of ten years.

During this period, the contractor shall be liable to attend all the leakages, defects etc. if noticed free of cost, starting his work of checking and rectifications within a week‟s time from the date of receipt of intimation of such leakages etc. by him.

49.3.6 Mode Of Measurement : Net area in square metre of the roof measured in between the side walls, i.e. plan dimensions including rounded junctions, kerbs, parapets where waterproofing treatment provided etc. shall be measured for payment. No deduction shall be made for openings upto 0.02 sqm such as rain water outlets etc., but the same shall be finished as directed by the Engineer-in-Charge. The rate shall include the cost of labour, materials, scaffolding etc. and shall cover the cost of rounding of junctions etc. which will not be measured separately. Brick bat filling done under this item will not be measured separately and is deemed to be

included in the waterproofing treatment for roof with an average thickness of 65/115mm.as specified in item.

59.4 CHINA MOSAIC WATER PROOFING

59.4.1 **General :** This type of water proofing shall consist of setting in thick cement slurry selected colour/white glazed tile broken pieces of approved make and size over 20mm. thick bedding of cement mortar 1:4 with approved waterproofing agent or as specified in schedule of work, to the required slopeand level, over brick bat coba and finishing with neat cement and cleaning to the required degree of fineness and evenness.

The different materials and workmanship shall conform to the relevant I.S. specifications and shall be got approved before incorporating in the work. The surface of brick bat coba shall be thoroughly cleaned of dust,dirt and loose particles removed and adequately watered. Thick coat of cement slurry of the honey like consistency shall be sprayed on the base before cement mortar screed of specified thickness is laid.

59.4.2 **Laying :** Over the prepared surface of brick bat coba, a layer of cement mortar, 20 mm. thick or as specified, shall be laid and cement slurry of consistency of honey, shall be spread over it using cement at a rate of not less than 0.01 cum. per 10 sqm. While the bed is fresh, broken pieces of 6 mm.thick selected white/colour glazed tiles not less than 25 mm. and not more than 50 mm. in any direction shall be set closely by hand at random. The glazed tile pieces shall be soaked in water before setting inposition. The glazed surfaces shall be kept exposed and pressed with wooden mallet. Over the glazed tile pieces a neat cement slurry, using cement not less than 0.01 cum. per 10 sqm. shall be spread and the surface brushed in and lightly rolled with wooden roller, taking care that no air pocket is left between brick bat coba and china mosaic flooring.

The top surfaces shall be cleaned with saw dust and cotton waste. Finally the surface shall be cleaned with weak acid solution to remove cement marks over the white glazed tile pieces. The finished work shall becured for at least 7 days. Care shall be taken to see that cement in joints does not get dissolved due to acid washing. At corners and junctions with parapet, the water proofing course shall be rounded off withcement mortar as per drawing and shall be included in the quoted rate.

59.4.3 **Mode of Measurement:** The length and breadth shall be measured to two places of decimal of a metre, alongside the surface including rounding of junctions of walls and wall & slab etc. and area worked

out in square metre. The rain water out-lets shall be finished as directed and no deduction shall be made for the same (area upto 0.02 sqm.) while arriving at the net area for payment.

59.5 BITUMEN FELT WATER PROOFING

59.5.1 **General:** Water proofing treatment with self finished felt shall be four courses or six courses as described in the item. Four course water proofing treatment with self finished felt is a normal duty treatment suitable for buildings where the cost of roof treatment is required to be restricted. Six course water proofing treatment with self finished felt is a heavy duty treatment suitable for important structures.

59.5.2 Materials

a) Self finished felt (Appendix A and B) shall conform to the type and grade given in the description of the item. This shall be one of the following types:

(i) Type 3 grade 1 hessian base felt conforming in all respects to IS 1322-1993.

(ii) Type 2 grade 1 fibre base bitumen felt conforming to IS 1322-1993.

b) Bonding Materials: This shall consist of blown type petroleum bitumen conforming to IS 702 or residual petroleum bitumen conforming to IS 73. The bonding material shall be so selected as to withstand the local condition of temperature and gradient satisfactorily. The penetration of bitumen used shall not exceed 40 in any case. Suitable residual type petroleum bitumen of penetration 30/40 (IS grade S-35), residual type petroleum bitumen with higher penetration and low softening point and suitable blown type petroleum bitumen of IS grade 85/25 or 90/15 of approved quality shall be used.

c) Stone Grit and Pea-sized Gravel: Stone grit shall be 6 mm and down size. Where pea-sized gravel is used it shall be hard, round and free from dust, dirt etc. The stone grit or pea-sized gravel shall not be spread over vertical and sloping faces of flashings and at drain mouths. At these places the surface shallbe painted with two coats of bituminous solution.The quantity of stone grit or pea-sized gravel required for the final course of four or

six course treatment with hessian base self finished bitumen felt type 3 grade 1shall be 6 cubic decimeter/ sqm. The workmanship for waterproofing of roofs with bitumen felt shall conform to I.S. 1346-1991.

59.5.3 **Preparation of Surfaces :** The existing roof surface shall be prepared by cutting cracks if any to V section, cleaned and filled flush with cement sand slurry or a suitable grade of bitumen or both and the surface shall be allowed to set and dry. The surface of the roof and that part of the parapet and guttersdrain mouths etc., over which the waterproofing treatment is to be laid shall be cleaned of all foreign matters viz. fungus, moss, dust etc. by wire brushing and dusting The surface to be treated shall have aminimum slope of 1 in 120.

59.5.4 **Treatment:** The water proofing shall consist of a four or six course treatment, as given in the description of the item, each layer of bonding materials, self finished bitumen felt or stone grit or pea sized gravel being counted as a course. The choice of a four or six course treatment will depend on the climatic condition, the importance of the building, the durability required, cost and other relevant considerations.

A four course treatment shall consist of the following layers:

(a) Initial layer of bonding material applied hot at specified weight per unit area.

(b) 2nd layer of self finished bitumen felt conforming to the type and grade given in the description of the item.

(c) Third layer of bonding material.

(d) Final layer of stone grit of pea sized gravel spread at specified volume of material per unit area. In a six course treatment, the first, second and third layer shall be of the same as in the four course treatment. The fourth and fifth layer shall consist of self finished felt and bonding material respectively. The sixth layer shall consist of stone grit or pea sized gravel. The primer or underlay where required to be provided shall not count against the number of courses specified.

59.5.5 **Laying :** The felt shall be laid in lengths at right angles to run off gradient commencing at the lowest level and working upto the crest, thus providing adequate overlap of the adjacent lower felt.

The bituminous primer conforming to IS 3384-1986 shall be brushed @ 0.27 ltr./sqm. over the roof surface thus prepared and allowed to dry. The bitumen bonding material (60/70 or suitable grade) shall be prepared by heating to the correct working temperature and conveyed to the point of work in a bucket or pouring cane.

The felt shall be first cut to required length(6 to 8 m), brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. Each length of the felt prepared for laying as described shall be laid in position and rolled up for a distance of half of this length. The hot bonding material shall be poured on to the roof across the full width of the rolled felt @ 1.2 kg/sqm. as the latter issteadily rolled out and pressed down. Light rollers as required on the work shall be used to even up the treatment at the contractors cost. The excess bonding material is squeezed out at the ends and is removed as the laying proceeds.

When the first half of the strip of felt has been bonded to the roof, the other half be rolled up and unrolled on to the top bonding material in the same way. Minimum overlaps of 10 and 7.5 cm. shall be allowed at the end and sides of strips of felt. All overlaps shall be firmly bonded with hot bitumen. Streaks and trailings of bitumen near edges of laps shall be levelled by heating the overlap with a blow lamp and levelling down unevenness.
The third layer of bonding material in the four course treatment shall be carried out in a similar manner after the flashing has been completed.

In a six course treatment the third and fourth layers of bonding material and self finished felt shall be laid in the manner already described, taking care that laps in the felt are staggered from those in the second layer. The fifth layer of bonding material shall be carried out after the flashing is done.

Final course of Pea size gravel as mentioned in item description shall be uniformly spread on this hotbitumen layer @ 0.0609 cum. to 0.0761 cum./10 sqm. (2 to 2.5 cft. per 100 sft.) on horizontal surfaces and over the rounded junctions, a coat of cement slurry shall be applied and grit shall be pressed into the slurry coat followed by curing.

Flashings for Parapet Walls, Chimney Stacks etc.: Felts shall be laid as flashings wherever junctions of vertical and horizontal surfaces occur.

For flashing in existing parapet walls, a groove or chase at a minimum height of 15 cm. above the roof level shall be cut in the vertical face of the wall and shall be filled with cement mortar 1:3 after waterproofing compound is thoroughly set. This groove shall be of dimension 7.5 cm. wide and 6.5 cm deep. In case of low parapet where the height does not exceed 45 cm. grooves shall be provided and water proofing treatment shall be carried right over the top.

Felt shall be laid as flashing in widths wherever junction of vertical and horizontal structures occur with minimum over lap of 10 cm. The lower edge of flashing shall overlap the felt laid on flat portion of the roof and the upper edge of the flashing shall be taken along the entire vertical face of the tucked groove made in the parapet and over the top surface so as to provide a continuous water proof layer. Each layer shall be so arranged that the joints are staggered with those of the layer beneath it.

Drain mouths, gutters, drain outlets; projections, pipes etc. shall be given the special treatment conforming to I.S. 1346 - 1991.

59.5.6 **Guarantee :** The contractor shall furnish guarantee as per appendix D for maintaining the roof leak proof for a minimum period of 10 (ten) years. If any defects occur during guarantee period, the contractor shall rectify the same within three days of intimation at their own cost to the satisfaction of the Engineer-in-Charge. The decision of the Engineer-in-Charge shall be final and binding.

59.5.7 **Mode of Measurement:** Only plan dimensions between brick / concrete walls shall be measured in sqm. to second place of decimal for payment. Rainwater outlets shall be finished as directed and no

deduction shall be made for the same (area upto 0.02 sqm.), while arriving at the net area for payment. The rate shall also include rounding of junctions between walls / wall & slab.

59.6 EXPANSION JOINTS

Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. The treatment shall generally be as per typical standard drawing of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precast RCC cover slabs or as specified in item.

The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken tosee that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint andcover slabs shall be carried out by the water proofing agency. Measurement shall be either on the area basis or in running metre basis of expansion joint treatment as specified in item. No extra shall be paid for the junction fillers or for the sealing of the cross joints in the cover slab with 15 cm width of bitumen strips.

59.7 WATER PROOFING TREATMENT WITH APP (ATACTIC POLYPROPYLENE POLYMERIC) PREFABRICATED MEMBRANE

Atactic Polypropylene Polymer modified prefabricated five-layer water proofing membrane shall be of thickness as specified. In selecting thickness of membrane due consideration shall be given to the type and construction of building, climate and atmospheric condition and permanence required. Five layeredtreatment 2.00 mm thick with glass fibre is with a normal duly treatment suitable for pitched roofs. Five layered 3.00 mm thick with glass fibre matt treatment is suitable for moderate condition of rainfall (50 to 150 mm) and fine layered 3.00 mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

59.7.1 Materials

a) Bitumen primer for bitumen membrane shall have density at 25°C in the range of 0.87 - 0.89 kg./litre and viscosity of 70-160 CPS primer shall be applied @ of 0.40 litre/sqm.

b) Atactic Polypropylene Polymer Modified Prefabricated Membrane: It is a polymeric water proofing membrane with high softening point of 150°C and cold flexibility of (-)2 to(-)3 °C conforming to ASTM D6222 / D6222M.

This shall be one of the following types:
(i) 2 mm thick with glass fibre matt. (Tear strength of 60/80N in longitudinal/transverse direction)
(ii) 3 mm thick glass fibre matt. (Tear strength of 60/80N in longitudinal/transverse direction)
(iii) 3 mm thick with non-woven polyester matt. (Tear strength of 300/250N in longitudinal/transverse direction)

It is prefabricated five layered black finish water proofing membrane comprising of centre core of 50 gsm. Glass fibre matt/170 gsm nonwoven polyester matt sandwiched on both sides by APP polymer modified bitumen which is protected on both sides by 20 micron thermo fusible polyethylene sheet. Composite thickness of the membrane including all five layers shall be 2/3 mm with glass fibre matt and 3 mm with non woven polyester matt. It is available in 1 m width and variable lengths. Atactic polypropylene modified

black finished pre-fabricated membrane shall conform to physical/strength properties as per ASTM-D6222/D6222M when tested in accordance with ASTM D-5147. The work should be got done through authorized applicator/specification agency.

59.7.2 **Preparation of Surface:** The surface to be treated shall have a minimum slope of 1 to 120.This grading shall be carried out with cement concrete or cement plaster with coarse sand, as desired,to the average thickness required and finished smooth. Such grading shall be paid for separately. For pitched roof surface shall be cleaned off any loose material dust etc.

To ensure good adhesion between the surface and water proofing treatment suitable method to dry the surface shall be adopted. All hair line cracks in the surface should be filled with approved sealant.

59.7.3 **Laying:** Bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and allother surfaces where polymer modified membrane is to be laid. The five layered water proofing membrane shall be laid using Butane torch and sealing all joints and preparing the surface complete.Drain outlets shall be given same treatment as specified for the roof in the description of the item in themanner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm.The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outsets by at least 10 cm.

The APP polymer modified prefabricated water proofing membrane shall be cut to the required length. Water proofing membrane shall normally be laid in length in the direction of the slope and laying shall becommenced at the lowest level and worked upto crest. APP water proofing membrane shall be laid in 6 to 8 m lengths. The roof surface shall be cleaned and bitumen primer shall be applied in the correct quantity, over this specified water proofing membrane shall be laid with butane torch after allowing 24 hours for primer to dry. Each strip shall overlap the preceding one by at least 10 cm. at the longitudinal edges and 15 cm. at the ends. All overlaps shall be firmly bonded with bitumen primer and levelled by heating the overlap with butane torch. If the roof is accessible the treatment is protected by brick tiles laid over 12 mm thick cement mortar of specified grade bedding and joints sealed with cement mortar of which shall be measured and paid for separately.

APP water proofing membrane shall be laid as flashing wherever junction of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The upper edge of flashing membrane shall be well tucked into the flashing grooves in the parapets, chimney stack etc. to a depth of not less than 6.5 cm; corresponding applications of primer coat shall also be made. The flashing treatment shall be firmly held in the grooves and it shall be sealed with the approved sealant after terminating the membrane.

Where parapet walls are of height 45 cm or less AP water proofing membrane flashing shall be provided in the same manner as for splashing in the core of high parapet walls except that upper edge shall be carried out the full

height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.

Where low dividing walls or inverted beams are met with, the same treatment shall be provided as for themain roof, the lateral bearing carried down both sides of the wall and overlapping the roof treatment.

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment same as forthe main roof.

Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing treatment. The formation of the expansion joints and provision of cover slabsshall be the responsibility of construction agency. The formation of the junctions fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillets or for the sealing of the cross joints in the cover slab with 15 cm. widthof bitumen strips.

59.7.4 **Measurements**: Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal.

Measurement shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints at pipe projections etc. overlapsand tucking into flashing grooves shall not be measured.

No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 40 square decimeter (0.4. sqm.) nor any thing shall be paid for formingsuch openings. For areas exceeding 0.40 sqm. deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

59.7.5 **Rate:** The rates shall include the cost of all labour and materials involved in all the operations described above.

59.8 EXTRA FOR COVERING OF APP MODIFIED PREFABRICATED MEMBRANE WITH GEOTEXTILE

If the water proofing treatment of flat roof has been done with APP modified five layered membrane andthe roof is accessible, a separation layer on top of membrane should be laid before any protected treatment is done. Brick tiles in cement mortar or 25 mm thick cement concrete 1:2:4 shall be laid as final layer as shown in drawing.

59.8.1 **Material:** Geo-textile 120 gm/sqm. non woven 100% polyester of thickness 1.0 to 1.25 mm manufactured by a company of repute shall be used. Geo-textile of the specified thickness is bonded to the water proofing membrane with intermittent touch by heating the membrane by Butane torch as per manufacturing recommendations.

59.8.2 **Measurements:** Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the entire exposed area of roofing.

59.8.3 **Rate:** The rate shall include the cost of all labour and material involved in all the operation described above. Final layer of brick tiles or 25 mm thick cement concrete shall be measured and paid for separately.

59.9 CEMENT BASED WATER PROOFING TREATMENT TO WC , BATH AND THE LIKE AREAS

59.9.1 **General:** Before the water proofing treatment, the internal plaster of ceiling and walls of WC blockleaving the portion for dado/skirting should be completed. Grooving / chasing for doing the concealed work of GI/CI pipes/Electrical conduits should be completed. Cleaning the depressed/sunken portion of WC ofall debris, extra mortar sticking to the vertical and horizontal surface etc. Necessary holes for „P" trap /Nahani trap/Water escape pipe etc should be completed.

59.9.2 **Preparing Surface and Fixing Pipes and Fittings:** Before the water proofing treatment work, proper key in the concrete surface should be provided. The depressed/sunken portion should be hackedby a hacking tool, after the concrete slab is cast and when this concrete is still green. The vertical surfaces of the depressed /sunken portion should be hacked with a hacking tool just after the shuttering is removed. All the drainage fittings and other pipes work shall be fixed properly and the holes should be plugged carefully before taking up the water

proofing work.

59.9.3 Treatment

1st Course: Cement duly blended with water proofing compound as specified shall be used for preparingthe cement slurry. The consistency of the slurry should be such that 4.4 kg. of blended cement with water proofing compound is used per sq. metre area of surface to be treated. The slurry should be started fromthe vertical faces towards the bottom of the floor. Particular care should be taken to see that the slurry isapplied to corners without leaving any gap.

2nd Course: Immediately on applying the blended cement slurry on the surface to be treated cement plaster 20mm thick in CM 1:3 (1 blended cement: 3 coarse sand) shall be applied both on horizontal andvertical surfaces .The cement plaster course of thickness 15mm.shall continue upto 600mm. above finished floor level. Care should be taken to complete the entire depressed/ sunken portion of WC within a day so that the plaster can be done without any joint. Junctions shall be properly rounded. The surfaces of the plaster shall be left rough but finished in one plain and cured for a week. On completion of the curingperiod both horizontal and vertical surfaces shall be cleaned properly and gently and allowed to dry.

3rd Course: After the surface is completely dried the blown or residual bitumen shall be applied @ 1.7 kg. of bitumen per sqm area.

4th Course: PVC sheet 400 micron thick shall be spread evenly without any kink immediately, so that thePVC sheet sticks to the surface firmly. PVC sheet shall be continued to be laid over the main slab upto 100mm. Overlapping of PVC sheet should be done with a minimum overlap of 100 mm, duly pasting theoverlapped sheet with an application of bitumen @ 1.7 kg./ sqm. The projections of pipes and „P" trap outlet etc. inside the depressed/sunken portion of WC shall also be cladded with water proofing treatment layerupto a height of 150 mm, using a coat of bitumen with PVC sheet complete

The surfaces of depressed/sunken portion of WC shall not be left without covering with specified filling material and base concrete, otherwise the PVC sheet layer may be tampered by the labour working in the vicinity.

Fixing up of WC pan, filling specified material and the top base concrete should be done as early as possibleand the top horizontal layer of water proofing may be taken up later i.e. just before laying the floor tiles.

59.9.4 **Measurement:** Length and breadth shall be measured along the finished surface correct to a cm.and area shall be worked out to nearest 0.01 sqm. No payment however shall be made for the 100 mm overlap of PVC Sheet over the roof slab.

59.9.5 **Rate**: The rate shall include the cost of labour and materials involved in all the operations described above.

59.10 INTERNAL WATERPROOFING FOR OVERHEAD WATER TANK / LIFT PIT / UNDERGROUND SUMP OR TANKS

59.10.1 **General :** The waterproofing treatment for overhead water tanks shall be essentially a cement based waterproofing treatment using injection grout and surface method through a specialized agency.The treatment consists of providing water proof cement plaster after preparing the internal surfaces, filling the cracks, crevices and junctions by means of injection and surface method, with rich cement grout (Blended cement + water proof compound) as per waterproofing agency"s specifications and testing O.H. Tank for water tightness and furnishing guarantee as specified.

59.10.2 **Preparation of Surfaces :** The surface to receive the waterproofing treatment shall be thoroughly cleaned of scales, laitance, set mortar etc. The surface shall be roughened with close hacking to provide adequate key for the waterproofing treatment. All honey combs in concrete surface shall be carefully hacked and loose materials removed and all pockets plugged suitably well before commencing waterproofing treatment.

59.10.3 **Treatment :** Before any work of waterproofing is taken in hand, all the surface preparation mentioned above shall be got approved from the Engineer-in-charge. All plumbing work will be got completed by the

Department before commencing the treatment.

The treatment shall then be commenced with injection into RCC members wherever required by cementslurry mixed with water proofing compound of appropriate consistency to fill up all cracks and crevices if any. A layer of waterproofing plaster in the specified proportion as per manufacturers/waterproofing contractors recommendations with admixture of approved manufacture waterproofing compound, shall then be laid over floor from inside and will be continued along the sides and partition walls to their full

height. The thickness of this treatment on the floor shall not be less than 50 mm. and that on walls not less than 20 mm. The entire surface shall be finished smooth with steel trowel in cement colour. The plastered surfaces shall be kept continuously wet immediately after 24 hours so as to cure it properly for at least seven days.

59.10.4 **Testing :** The tank will thereafter be got filled upto the full height immediately by the Contractor as specified, and water stored for a minimum period of seven days so as to observe any leakages/defects for necessary compliance by the waterproofing contractor.

In the case of tanks whose external faces are exposed, the requirements of the test shall be deemed to be satisfied in the external faces shown no sign of leakage and remain apparently dry over the period of observation of seven days after allowing a seven days period for absorption after filling the tank for full height. If the structure does not satisfy the conditions of test, the period of test may be extended for a further period of seven days and if specified limit is then reached, the structure may be considered a satisfactory. Suitable remedial measures shall be taken by the contractor at his own cost till the test as specified above is carried out satisfactorily.

In the case of tanks whose external faces are exposed or can be left exposed prior to testing all leakages, wet patches and the like, shall be marked out on the outside of walls during test. The tank shall then be dewatered and the defects made good by grouting, waterproofing, plastering etc. as necessary to the entire satisfaction of the Engineer-in-Charge, at no extra cost to the Department. The tank shall again be tested for leakage after rectification. The work shall not be accepted unless the water tightness is established.

Back filling in case of underground sump and waterproofing the roof where specified, shall be carried outafter testing and rectification of defects. The completion certificate shall not be given unless the test for water tightness as described above is carried out to the entire satisfaction of the Engineer-in-Charge. After a period of two months after the tank is left dry, once again the tank should be filled with water to check the efficiency of the waterproofing treatment done. If there is any leakage or wet patches, the same shall berectified, with no extra cost, by the contractor.

59.10.5 **Guarantee :** The contractor shall furnish service guarantee in the prescribed proforma vide Annexure 'D' of the Tender for the workmanship and the materials provided and for maintaining the waterproofed surfaces of the tanks in bone dry condition for a minimum period of ten years. If any defect occur during the guarantee period, the contractor shall rectify the same at his own cost to the satisfaction of the Engineer-in-Charge, and start his work of checking and rectification within seven days after receipt of intimation by him.

59.10.6 **Mode of Measurement:** Measurement for payment of waterproofing treatment shall be as per actual area covered by waterproofing treatment including offset, overlapping, rounded junctions, haunch etc. as provided at site. The length and breadth of the surface actually treated with water proofing treatment shall be measured upto two places of decimal of a metre. No deduction shall be made for inlet, outlet, scour connection, but the same shall be finished as required. The rate quoted shall include allthe cost of materials, labour, transportation, testing of water tank for water tightness, furnishing necessary guarantee for waterproofing so provided, all as detailed above.

59.11 CRYSTALLINE WATER PROOFING SYSTEM

59.11.1 **General:** Crystalline water proofing is a surface-applied, integral crystalline waterproofing material, which consists of portland cement, specially treated quartz sand and a compound of active chemicals. It is mixed with water prior to application to a concrete surface. On application the active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction which generates an insoluble, crystalline structure. These crystals fill the pores and minor shrinkage cracks in the concrete toprevent any water ingress (even under

pressure).

It can be applied to either the positive side (side exposed to water) or the negative side (side opposite water) and meets all waterproofing requirements.

59.11.2 **Scope:** Crystalline water proofing compound is generally applied on the positive side (side exposed to water) of water retaining structure. However it can be applied on the negative side (side opposite to water).

The scope consists of preparation of surface, application of 2 coats of crystalline water proofing compound as per manufacturers specification, finishing with 15mm thick neat cement plaster (CM 1:4 with 2% waterproofing compound or as specified) for walls, 30mm thick I.P.S (Concrete grade 1:2:4 with 2% waterproofing compound or as specified) to required gradient including vattas, rounding of corners, junctions, etc. and testing the water retaining structure for water tightness. **Note:** The crystalline water proofing compound shall be of standard manufacturer and shall be approved by Engineer-in-Charge. Work shall be executed through specialized water proofing agency as per the guidelines of manufacturers specifications.

59.11.3 **Other Details:** Other details with repect to treatment, testing, providing guarantee, mode of measurement etc, shall be as per the above item "internal waterproofing for overhead water tank / lift pit / underground sump or tanks.

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60 INTEGRAL CEMENT BASED BOX TYPE WATER PROOFING TREATMENT OF UNDER GROUND WATER TANKS, SWIMMING POOLS, BASEMENTS,LIFT PIT ETC.

60.1 ON HORIZONTAL SURFACES

60.1.1 **Preparing the Surface:** The water proofing treatment over the lean concrete/leveling course surface should adhere to the surface firmly. The surface of leveling course should be roughened when the concrete is still green. In case the surface is not made rough in the initial stages itself (i.e. before the concrete is set, the work of water proofing shall not be permitted till proper key is provided for the 25 mmthick base layer. This key cannot be achieved by hacking the already set concrete surface, instead a spatter-dash key should be provided without any extra cost, as it is the responsibility of the contractor toroughen the surfaces properly over which plaster or similar coat is to be laid.

60.1.2 **Blending Cement/Water with Water Proofing Compound :** Mixing water-proofing compound inpowder or liquid form, to already prepared cement mortar shall not be allowed. **Blending Cement** with water-Proofing Compound shall be prepared as followed:

i. The required quantity of cement bags to be used for a particular portion of work should be sortedout and the contents of each bag should be emptied on a suitable dry platform. Water proofing compound in powder form manufactured by reputed approved manufacturer, bearing ISI mark, conforming to IS 2645 should be mixed with the contents of each bag. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding3% by weight of cement.

ii. The quantity of cement (50 kg) and water-proofing compound in powder form should be mixed thoroughly, blended by employing skilled labourers and the cement thus blended should again be packed in gunny bags so that the material can be readily used for preparing mortar/slurry for thewater proofing works, to achieve best results.

Note: Unless otherwise specified, all waterproofing works shall be carried out using blended / PPC cement.

60.1.3 : Blending Water with Liquid Water Proofing Compound.

(i) In case the water proofing compound to be used is in liquid form then instead of blending cement with water-proofing compound the water to be used in the particular mix should be blended with water proofing compound.

(ii) This shall be done by taking just required quantity of water to be mixed in the particular batch ofdry cement mortar. The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water-proofing compound from sealed tins with ISI mark and manufactured by

reputed approved manufacturer.
(iii) The water thus mixed with water-proofing compound shall be stirred so that the water is blendedwith water proofing compound well.
(iv) The quantity of blended water thus prepared should only be used per batch of dry cement mortar/dry cement to make slurry to be used for water-proofing works to achieve the best results.

Note: Use of cement mixed with water-proofing compound is referred as "blended cement" in this chapter which shall mean use of water proofing compound in powder/liquid form for use in cement mortar/slurry.

60.1.4 **: Rough Shahabad stone:** The stone slabs to be used for this item shall be carefully selected for uniform thickness. Stones with varying thicknesses shall not be permitted to be used. Unless otherwise specified, the size of rough Shahabad stone shall not be less than 300x300mm and thickness 22mm (±) 3mm.

60.1.5 **: Preparation of Cement Slurry:** Cement slurry normally prepared and used on general buildingworks with just 1.50 to 2 kg of cement to cover an area of one sq.m shall not be applicable for such works instead it should have thick honey like consistency. Each time only that much quantity of slurry shall beprepared which can be covered on the surface and the surface in turn would be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained un-used for more than half an hour shall be totally rejected.

60.1.6 **Preparation of Cement Mortar:** The cement mortar 1:3 (1 blended cement : 3 sand) shall be prepared with cement / water duly blended. Each time only that much quantity of cement mortar that can be consumed within half an hour, shall be prepared. Any quantity of cement mortar that is prepared andremains unused for more than half an hour shall be totally rejected.

60.1.7 : Laying Water Proofing Course

60.1.7.1 First layer : 25 mm thick Base Course in Cement mortar 1:3

(i) Before laying the first course of cement mortar 1:3 base the lean concrete surface shall be cleaned neatly with water and cement slurry shall be applied only on the area of the concrete surface, that can be covered with the cement mortar (1:3) base course within half an hour.
(ii) The cement slurry should cover every spot of the surface and no place shall remain uncovered.
(iii) Just after the application of cement slurry on the surface, the cement mortar should be used forlaying the base course.
(iv) For laying base course to a perfect level at least 3 Nos. 25mm high wooden strips with 3 legs shall be placed on the concrete surface at suitable distances and the cement mortar shall be laid to the exact level of the strips and tamped gently. The top surface should be finished neatly and later scratched when green with a suitable instrument.
(v) Before the base course dries and gets hard that is just before the base course takes up initial set, the 2nd layer of Shahabad stone/slab cladding shall be taken up immediately.

Note : As far as possible work of different layers of this water proofing treatment shall be taken up in immediate succession without allowing any time gap in between the layers, otherwise it would be difficult to achieve homogenous treatment, which is the basic necessity.

60.1.7.2 Second layer : Shahabad stone.

(i) When the 25 mm thick base course is just getting set the cement slurry should be spread over the base course up to the area that shall be covered with just two to three stone slabs.
(ii) The Cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap, or dry spots.
(iii) Each time only the area that is required to clad two to three stone slabs shall be taken up for spreading the slurry and only after fixing the stone slabs over the slurry further area shall be taken up.
(iv) Immediately on applying cement slurry on the base course the Shahabad stone slabs shall be laid over the base course and pressed gently so that the air gap can be removed.
(v) The slurry applied on the surface which gets spread when the stone slab is pressed shall get

accumulated in the joints of adjacent stone slabs and if any gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry.

(vi) For laying the stone slabs in perfect level, two slabs at adjacent corners/ends shall be fixed firmly to the required level and a string stretched over the two slabs, the intermediate slabs shall then be set to the level of the string.

60.1.7.3 Third layer : 25 mm thick course in cement mortar 1:3

(i) On filling all the joints of the Shahabad stone slabs with cement slurry and after a gap of 6 to 8 hours the area of stone slabs shall be cladded with cement mortar 1:3.

(ii) The surface of stone slabs shall be cleaned and lightly watered. The cement mortar (1:3) shall be used for laying this course, no cement slurry need be used and the mortar can be laid on the slab surface directly.

(iii) For laying this course in perfect level, 25mm high wooden strips with legs used for laying base course shall be used and the top surface shall be finished smooth without using additional cement or slurry.

60.1.7.4 Fourth Layer : Top Finish with Stone Aggregates 10 to 12 mm Size

(i) Immediately after laying 3rd course and before the cladded mortar takes the initial set, stone aggregate of 10mm to 12mm nominal size shall be pressed into the finished surface @ 8 cudm/sqm.

(ii) The aggregates though embedded shall be clearly visible on the surface, i.e. the stone aggregates shall not be embedded totally inside the mortar.

Note: This treatment is provided over the surfaces which are originally in slope or in level & no attempt under any circumstances shall be made to provide any slope by altering the 25 mm thickness of base course, to lay the water-proofing course in slope.

In case a slope is to be provided for the water proofing layer on a surface which is in perfect level, grading with additional cement concrete/cement mortar shall be provided and then the water-proofing layer shall be laid on the graded surface.

60.1.8 : Curing

60.1.8.1 Water Proofing on Lean Concrete Surface

Immediately after completing the fourth layer, arrangements shall be made to lay the top RCC slab as quickly as possible and in the mean time till the top slab is concreted the water proofing treatment shall be kept wet continuously. In case the concreting of slab gets delayed for more than 2 weeks the curing can be stopped after 14 days.

60.1.8.2 Water Proofing on Horizontal Surface of the offset of floor slab.

The water proofing treatment done on the offset of the floor slab shall be kept wet continuously for 14 days minimum.

60.1.9 **: Measurement:** Length and breadth shall be measured along the finished surface correct to a cmand area shall be worked out to nearest 0.01 sqm.

60.1.10 **: Rate:** The rate shall include the cost of labour & materials involved in all the operations described above.

60.2 ON VERTICAL SURFACES

The vertical water proofing treatment either from inside or outside shall be undertaken only when the entirework is structurally complete.

60.2.1 Preparing the Surface and Providing Ancillary Arrangements.

I. The surface of the structure to be treated shall be roughened properly either by raking joints when the mortar is still green in case of brick/stone masonry structures, or by hacking the cement concrete surface with a specially made hacking tool just after removing the shuttering.

II. In case the raking joints/hacking concrete surface is not done properly the surface should be roughened by providing "**Spatter dash key"** (rich polymer modified cement mortar using coarsesand splashed forcefully on surface to act as bond key) which shall be done by the contractor without any extra cost.

III. For doing the water proofing treatment from outside or inside, al-round scaffolding shall be erected which

shall be strong enough to support the stone slabs. Also proper strong scaffold boards, strong ladders and coir ropes shall be made available for using while erecting the stone slabs. Similarly, while doing the water proofing to vertical faces from inside, a particular care shall be taken to see that the water proofing layer of floor slab is not get damaged while resting the vertical props of scaffolding. As a precaution it is advised to rest the bellies on the strong and proper size sole piece placed on the horizontal water proofing treatment of the floor slab.

IV. Alternatively, water proofing for vertical surface shall be provided before horizontal floor slab water proofing. In order to arrest any leakage through junction of vertical/horizontal water proofing, a proper haunch in cement concrete shall be provided.

V. For the stone slabs that are used for arresting the leakages, while executing this type of water proofing treatment, the first and foremost mandatory condition is that the number of joints in the portion covered by the stone slabs shall be minimum and this condition can be achieved only by using the maximumpossible size of stone slabs. Normally the size of stone slabs used for the purpose is 600 x 600mm x900mm each stone slab weighing approximately 16 kg and 25 kg respectively.

VI. The Rough Stone slabs used for such works though are basically rough on the surface still that much roughness will not be sufficient for the stone slabs to remain in vertical position held by cement slurry. Therefore the grip for the stone slabs has to be increased and this can easily be done by planting 12mm to 15mm nominal size stone aggregate fixed with araldite on the face ofeach stone slab.

VII. A 20mm thick clear gap has to be formed between the masonry/concrete surface and the stoneslabs erected in vertical position for pouring the cement slurry. This gap can be maintained by fixing with araldite the 20mm x 20mm cover blocks made out of rich cement mortar on the four corners of the stone slabs and also at centre.

60.2.2: Preparation of Cement Mortar (1:4)

Cement mortar shall be prepared as explained above except that the proportion shall be 1:4 (1Blended Cement : 4 Coarse sand) instead of 1:3.

60.2.3: Fixing Water Proofing Courses on Vertical Surfaces.Note :

1. Normally the item of work prescribes executing the first layer as base course with Cement slurry, second layer fixing rough Shahabad stone slab, third layer as plastering the surface and the fourth layer as finishing surface with neat cement punning, but in actual execution, a gap of 20mm width has to be formed for pouring cement slurry. The 20mm wide gap can be formed by erecting the 20 mm thick Shahabad slab at a distance of 20 mm from the Masonry/concrete surface, overwhich the cement slurry is to be cladded and can be termed as first step for construction.

2. Hence for all practical purposes, chronology of layers shall be considered as per actual construction i.e. as laid in particular serial and not as actually formed later. To avoid confusion and to distinguish between the two different layers laid and the actual work executed, actual working is termed as Step I, Step II etc.

Step I: Erecting Shahabad Stone Slab forming 20mm wide gap.

i. The Shahabad Stone slab duly fixed with 20 x 20 mm cover blocks and 12 to 15mm size stone aggregate on the surface shall be erected against the masonry/concrete surface to be treated byabutting the 20mm thick cover block against the surface, thus forming a clear gap of 20 mm.

ii. The stone slabs thus erected shall be supported with ballies/pipes to the scaffolding already erected for the purpose.

iii. The joints of stone slabs shall be temporarily closed from outside with cement mortar so that thecement slurry poured in the gap does not escape through the joints. The bottom portion of the stone slabs shall also be closed with cement mortar.

iv. While erecting the stone slabs, proper care shall be taken to see that stone slabs are of uniform size. In case similar width slabs are used, it shall be ensured that these are not fixed at the corners but the same should be at the middle portion.

v. Interlinking of the Shahabad Stones of horizontal layer of water proofing with this vertical layer ofwater proofing shall be done very carefully, as per standard practice.

vi. The Stone slabs shall be erected in perfect plumb and fixed in position and it will be considered as 2nd layer of water proofing on completion.

vii. Further lifts of Shahabad Stone slabs up to the full height of the masonry/ concrete wall shall be erected

only after filling the gap of each lift erected, with cement slurry.

Step II :Filling Cement Slurry in the gap formed by erecting Shahabad Stone Slabs:

i. When the first lift of stone slabs are erected and checked to be in perfect plumb, cement slurry shall be poured in the gap till the gap is filled completely.
ii. The further filling of slurry in the second lift shall be done when the second lift of stone slabs are erected in position and thus the work on 2nd and 1st layer of the item shall be completed simultaneously till the cladding over the entire height of the wall is complete.
iii. Thus on completion of filling cement slurry and erecting stone slabs for the entire height of the wall, it can be considered that the first layer (i.e the layer of cement slurry) and the second layer (i.e. the layer of erecting Rough Shahabad Stone Slabs) is complete as per the item.

Step III : 3rd Layer: Plastering Over 2nd layer with Cement Mortar 1:4 (1 Blended Cement : 4 Sand)

i. Immediately on completion of the work of cladding the entire masonry/ concrete wall with Shahabad Stone slabs, the cement mortar applied over the joints shall be removed and the joints exposed. The entire surface shall be cleaned with water neatly to start the plastering work.
ii. Cement mortar 1:4 (1blended cement : 4 coarse sand) shall be used for the purpose. Care shallbe taken to see that the 20mm thickness of cement plaster over the entire surface is maintainedcorrectly.
iii. The work of plastering shall be taken up immediately on completion of cladding the wall surface,rather it should be a continuous process from the day of starting the erection of stone slabs till the finishing work of plastering is done.
iv. The plastering shall be done from top to bottom without leaving any joint. As far as possible thejoints in plaster shall be minimum. In case a joint has to be left to continue the work on the subsequent day, cement slurry shall be applied over the entire joint, and then only the further work of plastering shall be taken up.

Step IV: 4th Layer: Finishing with Neat Cement Punning:

When the surface of plastering is still green, the cement slurry shall be applied over the plastered surface and the surface shall be finished neatly to a smooth surface with specially made semi rounded thapis. The surface should show a smooth and neat finish without any undulations.

60.2.4: Curing and Testing: On completion of water proofing course from outside, the tank shall be cleaned from inside, scaffoldings shall be removed and tank is gradually filled with water for testing, which shall commence within two or three days. The exposed faces of the water proofing course shall be kept wet for 14 days. No back filling shall be done before expiry of 14 days from the date of completing the water proofing course from outside.

60.2.5: Measurement: Length, width/height shall be measured along the finished surface correct to a cm and the area shall be worked out correct to nearest 0.01 sqm.

60.2.6: Rate: The rate shall include the cost of all labour and materials involved in all the operations described above and for all heights.

Note: The only difference between treatment of horizontal and vertical surfaces is the thickness and thetype of treatment per layer that is to be provided. The same is tabulated below for clear understanding:

Table 60.1: Thickness for horizontal and vertical surfaces

Horizontal Surfaces			Vertical Surfaces		
Layers	**Details of Layer**	**Thickness**	**Layers**	**Details of Layer**	**Thickness**
First Layer	25mm thick base course in C.M 1:3	25mm	First layer	Base course with cement slurry	20mm
Second Layer	Shahabad Stone Slab	22(±) 3mm	Second Layer	Shahabad Stone Slab	22(±) 3mm
Third Layer	Finishing with CM 1:3	25mm	Third Layer	Plastering II Layer with CM 1:4	20MM

Fourth Layer	Embedding 10 to 12mm Aggregates in third layer	----	Fourth Layer	Punning with neat cement	---
	Total Thickness	**72 (±) 3mm**		**Total Thickness**	**62 (±) 3mm**

61. Chemical Based Water Proofing System

61.1 Material

61.1.1 FIBRE REINFORCED ELASTOMERIC LIQUID WATER PROOFING MEMBRANE WITH RESILIENT ACRYLIC POLYMERS: - Fibre reinforced elastomeric liquid water proofing membrane is a ready-to-use waterproofing, white product, with high solar reflectance and sun Reflectivity Index (SRI) of 105, for external applications. This is made from resilient acrylic polymers and synthetic resins in water dispersion, and when dry forms a continuous, flexible waterproofing membrane. This is resistant to all atmospheric conditions and UV rays, and guarantees long- lasting protection for the substrate.

61.1.2 POLYMER MODIFIED FLEXIBLE CEMENTATIOUS NEGATIVE SIDE WATERPROOFING COATING WITH ELASTIC WATERPROOFING POLYMERS: - Flexible cementatious negative side waterproofing coating with elastic waterproofing polymers is a one- component, concentrated liquid admixture used to enhance the performance of cementations repair mortars, plasters, stuccos, concrete mixes and toppings for restoration of horizontal, vertical and overhead concrete; concrete masonry units (CMU); and masonry surfaces.

61.2 Preparation of Surface: - All the substrates, whether they are new or old, must be sound, clean, dry and free of all traces of oil, grease, old paint, rust, mould and nay other material which could compromise the bond. Application temperature may be from 7^0C to 40^0C. Concrete and in general mineral substrates must be sound and dry with no rising damp. Any loose parts must be removed with wire brushes. All wax, water-repellent treatments, etc. must be removed from the surface of ceramic substrates with a suitable detergent and/ or by sanding. Any hollows and gaps in the surface must be repaired properly with appropriate material as described and instructed by the manufacturer of this product or Engineer-In-Charge as per item specifications. The tools to be used must be properly cleaned.

Applications: - It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface, suitable for occasional light foot traffic. This can with stand normal expansion and contraction stresses caused by temperature variations due to its flexibility.
For Horizontal Surfaces- Prime the surface by dilution of water proofing compound with water in the ratio 1:0.5 and apply @ 8 – 10 Sqm / L, or as per dilution and consumption specified by manufacturer. Apply first coat of water proofing @ 550 ml / Sqm.Place one layer of GeoTextile 40 / 50gsm when the coat is still wet Apply second coat of water proofing @ 550 ml / Sqm and allow it to dry. Finally apply the top coat of water proofing @ 500 ml / Sqm to get a minimum 1.5 mm DFT.
For Vertical Surfaces- Prime the surface by dilution of water proofing compound with water in the ratio 1:0.5 and apply @ 8 – 10 Sqm / L, or as per dilution and consumption specified by manufacturer. Apply first coat of water proofing @ 550 ml / Sqm. Finally apply the top coat of water proofing @ 500 ml / Sqm to get a minimum 1.0 mm DFT.

61.4 **Measurement:** - The Length & breadth/height of the coated area shall be measured in metre correct to two places of decimal. Measurement shall be made in sqm of the area.

61.5 Rate: - The rate shall include the cost of all the labour, material and equipments involved in all the operations described above.

62. UNDERGROUND TANK EXTERNAL HDPE WATERPROOFING

62.1 Surface preparation: Prepare the rendered surface free from loose particles and clean the surface. Sqm CRACK TREATMENT: Supply and application of Low modulus joint sealant having elongation more than 700 % applied on the wall & floor area wherever required by making a "V" groove and filled with PU sealant with a base coat of primer.

62.2 Tie road packing: High strength modified cementitious mortar to be filled in to the tie rod hole gap and allowed to cure completely. The top 10mm depth of the hole is filled with PU sealant

62.3 Underground water proofing with HDPE membrane: Supplying and installing of 1.5 mm average thick self - adhesive HDPE membrane having puncture resistance of 990N, water absorption - 0.5%, tensile strength - longitudinal - 37.23 MPa & Transverse - 33.09 MPa, elongation of 650%. hydrostatic head resistance of 71 m water head & peel adhesion to concrete of 880 N/m.

62.4 Application Procedure: The pre -applied, fully bonded HDPE sheet membrane shall be loosely laid on PCC and gets bonded to the underneath of the poured concrete of UG Tank base slab and will be continued till full height of the wall and gets bonded to the poured concrete of RCC wall. The membrane shall have minimum of 75mm side laps and end laps which shall be sealed with double sided adhesive tape.

62.5 Measurement

The length and breadth/ height shall be measured in running metre correct to two places of decimal and the area of applications shall be measured in sqm correct to two places of decimal.

62.6 Rate: The rate shall be including the cost of all the labour and material involved in all the operations described above.

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63. EXPANSION JOINT

63.1 SCOPE OF WORK

The work contemplated under these specifications consist of supplying the expansion joint filler boards, sealing compound, aluminium plates etc. strictly as per these specifications and relevant drawings.

63.2 MATERIALS

63.2.1 **Expansion joint filler boards:** Joint filler boards shall be either of following types as specified initem descripyion

63.2.2 **Bitumen Based-** It shall be pre-moulded bitumen impregnated non-extruding, resilient type fibreboard of specified thickness and shall conform to IS1838-1983(Part-1).

63.2.3 **Non-bitumen based (HD100 Dura board)-** HD100 is a Cross linked Closed cell Polymer compressible Expansion Joint Filler Board and is flexible as well as has high compression-recovery (95%). It is in sheet form-semi-rigid, UV resistive, high performance laminated closed cell polyethylene foam joint filler. It is suitable for use as expansion joint filler in concrete, brick, block work and isolation joints wherereadily compressible low load transfer joint filler is required.

Table 63.1: Technical Specification: (HD100 dura board)

Sr. No.	Parameters	Units	Test Observation

1	Density	Kg/m^3	109
2	Water Absorption	Kg/m^2	0.03
3	Compression recovery (After 50% deflection)	%	95
4	Compression extrusion (After 50% reduction in thickness)	Mm	3.5

63.2.4 **Sealant:** The sealing compound to close the gaps at the edges, for bitumen based filler board shall conform to IS1834-1984 and shall be of best quality rubberized bituminous hot pour, made from special grades of bitumen. It shall not show flowing tendency in hot weather and is resilient in the cold weather.

Alternatively, if specified high performance elastomeric polysulphide based sealant (gun-grade) as per ASTM C920-79/BS5212-90 shall be used as sealant to close the gaps of specified size and depth.

63.2.5 **Primer:** The liquid primer shall be made from blown grade bitumen of approved quality and shall conform to IS 3384-1986.

63.2.6 **Covering Plate:** The aluminium plates for fixing at floor level shall be of specified size and out of extruded sections, free from any rolling defects.
The aluminium sheet for fixing at bottom of beams or sides of columns shall be of specified size without any defects.

63.3 PREPARATION OF SURFACES

All the concrete surfaces already cast and where the expansion joint is to be formed, shall be properly cleaned off all dirt, mortar/concrete sticking, dust etc. One coat of primer shall be applied by brush to the entire concrete surface, just prior to the next concreting.

63.4 WORKMANSHIP

63.4.1 **Bitumen based Fibre board:** Soon after the primer is applied, the filler board shall be placed at the side and held tight with the concrete surface, by suitable means. Care shall be taken that the boards do not get damaged or warped during all the operations. Utmost care shall also be taken to ensure that the board is held tightly to the concrete surface and no stone chip, concrete etc. is allowed to splash between the board and the existing concrete surface against which the board is placed.

63.4.2 **HD-100 Dura board:** In an expansion/movement joint HD100 shall be fixed in position to substrate using either a double sided adhesive foam tape or synthetic rubber based adhesive tape as specified or as per manufacturer specification .When forming expansion joints with HD100 in inside concrete, joint sealing slot shall be readily formed by simply cuting off a strip of the required depth. The strip is then pinned back using two inch or appropriate length nails at intervals. The filler is installed and flushed with the finished surface. Before the sealing, the top strip shall then be pulled comfortably from the joint to provide an uncontaminated sealing slot ready for sealing.

After the de-shuttering, the surface shall be cleaned off all grit, mortar, cement plaster etc. and edges filled with the sealing compound, and properly pressed to render smooth and uniform surface.

63.4.3 **Aluminium Sheet Covering:** The aluminium plates/sheets of specified thickness and sizes shall be fixed to under side/above beams ,along columns and floor as mentioned in item. The plates shall haveround holes at 300 mm. c/c. of required diameter on one side of joint through which screws shall be fixedinto the concrete. On the other side, slotted holes at 300 mm. c/c shall be provided so that when screwed, these shall render smooth movement of plates during expansion/contraction. The plates shall be fixed correctly to required level, line, plumb etc. and as directed by the Engineer-in-charge.

In case of plates fixed on floors, they shall be fixed when floor mortar screed is laid to required level over the expansion joint duly filled up with sealing compound.

In case of roof, the expansion joint in beams placed vertically, shall be extended upwards, when RC/Brick masonry curbing is laid to the desired height (approximate 450 mm.) over which horizontal flat board islaid to the extent of 150 mm. or so as shown in drawing as per procedure laid down here- in- before.

63.5 MODE OF MEASUREMENT

Unless otherwise mentioned, all the vertical and horizontal expansion joints(Filler Board) in columns and beams shall be measured in a net area in sqm. actually laid at site. The length and breadth shall be measured correct upto half centimeter.

The aluminium plates/sheets shall be measured in running metres correct upto half centimeter, the widthbeing specified in the item.

The sealant as specified shall be measured in running metre and paid for accordingly.

The rate shall include the cost of all materials, labour, transport, making holes in plates, grouting makinggood the surface etc. all operations required to complete the job.

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64. RAILING, BALUSTERS AND NEWELS

64.1 SCOPE OF WORK AND GENERAL

The item refers to supplying and fixing in position composite hand railing for staircase, open area, balcony, corridor etc. at different floors, levels and locations.

64.2 MATERIALS

The class and quality of wood to be used for hand railing and workmanship shall comply with the requirements specified in wood work. M.S. balusters, grills, M.S. flat frame work and runners to be used in hand railing, their quality, workmanship etc. shall comply with requirements specified in manufacture of M.S. grills, and standard practice adopted in fabrication of structural steel work and also comply with
I.S. specification.

64.3 SAMPLES

Before taking up fabrication and erection on mass scale, the sample of railing materials being used etc. shall be got approved by the Engineer-in-charge.

64.4 FABRICATION

The fabrication of wooden hand rail shall follow the standard specification for wood work. Thewooden handrail shall be in single piece per flight panel, moulded, shaped and finished to required dimensions as shown in drawing and as directed by the Engineer-in-charge. The hand railing shall be secured perfectly to line, slope and level to M.S. flat runners, balusters, newels and posts. M.S. grill, balusters, M.S. flat frame work fabricated as per the drawing and shall be strictly according to the specifications specified in manufacturing of M.S. grills and structural steel work. M.S. balusters, newels,
M.S. flat frame work and horizontal runners etc. as the case may be, shall be fabricated in a workman like manner as shown in drawing.

64.5 FIXING/ERECTION

M.S. Balusters, newels, posts, M.S. flat frame work manufactured as per drawing and as per approved sample, shall be firmly fixed in the pockets left for fixing of balusters or weld to main steel of waist slab or landing slab or weld to the inserts left for fixing of balusters, posts etc. as shown in the drawing. Necessary cover plates at the base of the balusters shall be provided after grouting the balusters duly kept in position. The hand railing shall follow the inclination of stair in case of stair-case and shall be perfectly in line, level and plumb for all other railings. Any damage caused to treads/risers while fixing ofbalusters, posts, railings etc., the damaged tread and riser shall be removed and replaced by new ones at no extra cost. Railing shall be joined in lengths with plain butt joints, dowelled and held together by hand rails, bolts, clamps and M.S. frame work.

64.6 MODE OF MEASUREMENT

Hand railing shall be measured for payment in running meters. The length shall be measured along the top centre line of the hand rail and shall be measured between ends of balusters, newels posts as the case may be, upto two places of a decimal. Rate to include fabrication, leaving suitable pockets, grouting the same, fixing, all labour, materials, transporting, painting, polishing, finishing, scaffolding if necessary and as described in the schedule of quantities.

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65. FLEXIBLE P.V.C. WATER STOPS

65.1 GENERAL

PVC water stop shall be Ribbed with Centre bulb shape of specified width and of approved manufacture and shall satisfy all the normal tests such as tensile strength, elongation etc.

65.2 SAMPLE

A sample of PVC water stops shall be got approved from the Engineer-in-charge before procurement of bulk quantity.

65.3 PLACING IN POSITION

The water stops shall be provided in available maximum length and as far as possible, jointing shall be avoided. All the joints when unavoidable, shall be field jointed for water tightness as per manufacturers specifications.

PVC waterstops shall be securely positioned to prevent deflection or misalignment during concrete placement. This is achieved by tying off the outer edge of the waterstop to adjacent reinforcing steel. The exposed surfaces of water stops revealed after first concreting shall be cleaned thoroughly of all thedroppings, mortar splashing, timber scantlings sticking etc. before the next pour of concrete is taken up in hand. Any damage caused to water stops shall be made good by the contractor at his own cost.

65.4 MODE OF MEASUREMENT

The mode of measurements shall be in running meter, of water stop actually laid without any allowance for laps, wastage etc., measured correct to one centimetre.

65.5 RATE

Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc. all as described above.

65.6 FLEXIBLE ADHESIVE STRIP WATERSTOP

65.6.1 **Material:** Flexible Adhesive Strip Water-bar is composed of synthetic butyl rubber, pigments &fillers, adhesion promoters & many additives. The preformed construction joint sealant is of two types

(1) Swellable & (2) Non-swellable grades.

It is used to seal cold construction joints in RCC structure which are in constant touch with water which are susceptible to water leakages and in horizontal, vertical, inclined and curved profiles because it is highlyadhesive, flexible, swellable, controlled expansion & withstanding ability to hydrostatic & hydraulic waterpressure.

Swellable water bar is used when the construction joint in dry condition. After laying the waterbar, concreting is to be done as early as possible for maximum effectiveness. No dust or debris should fall onthe waterbar. Rain or curing water will start the special swelling process of the waterbar. Hence concreting should be carried out as early as possible.

Non-swellable type water bar is used when the construction joint(s) is submerged in water or under wet condition. In this type there is no need to apply the primer.

Generally primer is used to maintain the waterbar in the right position while concreting and preventing itfrom being dislodged. Primer if specified is to be applied as per manufacturers specification.

65.6.2 Method Of Application

65.6.2.1 Horizontal Joints

- Clean the construction joint of loose mortar and dust.
- Primer if specified shall be applied using brush in width equal to width of water bar strip.
- Wait for about half an hour until the primer dries a little and becomes "sticky". Unroll the water bar coil slowly and carefully on the joint without pulling and stretching it. Press it to ensure that it sticks to the concrete surface and hugs the profile of the concrete surface.
- Remove the protective wrap and pour the concrete.

65.6.2.2 Vertical Joints

- Clean the construction joint of loose mortar and dust.
- Primer if specified shall be applied using brush in width equal to width of water bar strip.
- Wait for about half an hour until the primer dries a little and becomes "sticky". Unroll the waterbarcoil slowly and carefully on the joint without pulling and stretching it. Press it to ensure that it sticks to the concrete surface and hugs the profile of the concrete surface.
- If primer cannot be applied for some reason, Water bars should be hung from the top by bendingover about 150 mm of the waterbar horizontally on the top of the retaining wall. If this is not possible, tie the end of the waterbar with binding wire or string to any available projecting rebar and hang the waterbar vertically in position.
- Pour concrete

65.6.3 Precautions

- Joints shall be properly cleaned and clear of all loose concrete, debris, dust, loose mortar, etc.
- Waterbar should not be stretched or pulled to make it longer than its existing length.
- Vibrator needle should not be pushed into the waterbar. The tip of the vibrator should be keptabout 200 mm away from the waterbar.
- Minimum cover of concrete for Swellable waterbar is 50 mm. Minimum cover of concrete for non-swellable waterbar is 25 mm.
- The ends can be joined by overlapping about 50 mm. It should be ensured that the joint is pressed, so that there is no gap under the place where it is joined together.

65.6.4 **Mode of Measurement :** The mode of measurements shall be in running meter, of water stopactually laid without any allowance for laps, wastage etc., measured correct to one centimetre.

65.6.5 **Rate**: Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc.all as described above.

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66. DISMANTLING AND DEMOLITION

66.1 SCOPE OF WORK

The work envisaged under the sub-head "dismantling and demolition" relates to building only and includes structural and general finishes items such as reinforced/plain cement concrete works ,structural steel, masonry work in cement/lime mortar, plastering/cladding ,removing wooden/steel doors and windows etc.

66.2 GENERAL

The term "Dismantling" implies carefully separating the parts without damage and removing. This shall consist of dismantling one or more parts of the building as specified or shown on the drawings.

The term "Demolition" implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on drawings.

66.3 PRECAUTIONS

Necessary propping, shoring and/or underpinning shall be provided to ensure safety of the adjoining work or property before dismantling / demolishing is taken up and the work shall be carried out in such a way that no

damage is caused to the adjoining work or property.

Wherever required, temporary enclosures or partitions and necessary scaffolding/double scaffolding shall also be provided as directed by Engineer-in Charge. Screen shall be placed where necessary to preventinjuries due to falling pieces.

Necessary precautions shall be taken to keep noise and dust nuisance down to the minimum. Safety accessories such as helmets, goggle, safety belts should be used whenever required.

Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roofs, masonry etc., shall be carefully dismantled first. The dismantled articles shall be passed by hand where necessary and lowered to the ground and not thrown.The materials then be properly stacked as directed by the Engineer-in-charge.

All materials obtained from dismantling or demolition shall be the property of the Government unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-Charge.

Any serviceable material, obtained during dismantling or demolition shall be separated out and stacked properly as indicated by the Engineer-in-charge within a lead of 150 m. or as specified in the item. All unserviceable materials, rubbish etc. shall be disposed off as directed by the Engineer-in-Charge.

66.4 RECOMMENDATIONS FOR DEMOLITION OF REINFORCED CONCRETE STRUCTURAL ELEMENTS

Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.

Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.

Demolition should be commenced by removing partitions and external non-load bearing cladding. It Should be noted that in some buildings the frame may rely on the panel walls for stability.

Where hard demolition methods are to be used, the following procedures should be used.

66.4.1 **Reinforced Concrete Beams:** For beams, a supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed.The reinforcement should then be cut in such a way as to allow the beam to be lowered under control tothe floor.

66.4.2 **Reinforced Concrete Columns:** For columns, the reinforcement should be exposed at the baseafter restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control.

66.4.3 **Reinforced Concrete Walls:** Reinforced concrete walls should be cut into strips and demolished as for columns.

66.5 HYDRODEMOLITION (HIGH- PRESSURE WATER JET CUTTING)

High-pressure water jetting can be used for a wide range of concrete applications such as demolition of reinforced cement concrete, controlled cutting of concrete, controlled removal of unsound/ distressed portion of concrete etc.

A high flow high pressure water jet can cut through concrete by eroding the cement, whereas a high pressure with a lower flow, water can actually remove coatings/loose and unsound concrete, laitance without damaging the sound concrete below.

The impact of concrete breakers and jackhammers is not limited to deteriorated concrete. It can damage rebar and produce vibration that generates microfractures in sound concrete. It also generates noise and the dust.

High-pressure water jets attack fissures in faulty concrete, preserving sound concrete and leaving it with an excellent

texture for new bonding. **They won't damage rebar, instead removing old concrete and scale**, and washing away entrained chlorides leaving a good bonding surface for new concrete in case of carrying structural repair.

66.5.1 System: High-pressure water-jet abrasive cutting systems operates at pressures of up to 40,000psi, they can quickly and efficiently cut concrete and rebar, or inspection and service openings in petrochemical tanks. Systems use automated adjustable nozzle angles and tracking speed to control themovement of the cutting head. Cutting with abrasive water-jet systems eliminate heat build-up, which can cause thermal distortion and a change in metallurgy. Water-jet cutting also leaves a smooth edge, has aminimal kerf loss, reduces the need for secondary finishing and is fast, clean and dust-free. The high pressure water-jetting system for green cutting of concrete shall be suitably selected and shall be used with prior approval of Engineer-in Charge.

Note: The Item of R.C.C demolition shall mention if „Hydro demolition(water jet cutting)" method is to beadopted for R.C.C.work. Otherwise, convention hard method of demolition shall be adopted as mentioned above.

66.6 TREATMENT

All the dismantled area shall be rendered clean off all debris, dust etc. The sides of jambs, sills, soffits etc. of the openings if any, after taking out doors and window frames, unless and otherwise to be closed, shall be plastered in C.M. 1:3 with proper finish to render true sides, corners, edges etc.

66.7 MODE OF MEASUREMENT

All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits,unless otherwise stated hereinafter.

(a) Dimensions shall be measured correct to a cm.
(b) Areas shall be worked out in sqm correct to two places of decimal.
(c) Cubical contents shall be worked out to the nearest 0.01 cum.

66.7.1 **Brick Masonry & R.C.C. Works :** The measurement of brick masonry with or without plaster/painting shall be taken correct to a centimeter before start of work and volume calculated in cubic metres upto two places of decimal. Similarly the measurement of concrete with or without plaster shall be taken correct to a centimeter before start of work and volume calculated in cubic metres upto two places of decimal.

66.7.2 **Doors and Windows :** Dismantling of doors and windows (wooden or steel) shall be enumerated. Removal of chowkhats (frame works) shall include (unless otherwise separately mentioned for removing shutters only) the removal of shutters along with architraves, beadings, fittings and fastenings along with frames.

66.7.3 **Roof Terracing :** Dismantling of roof waterproofing treatment shall be measured on area basis in sqM upto two decimal places Length and breadth shall be measured correct to a centimeter between parapets. No separate measurement shall be taken for gola and khurrah etc.

66.7.4 **Wood Work:** All wood work including karries average 40 sq cm or over in section, shall be measured in cubic metres, while that under 40 sq cm in section, in running metres. Ballies shall be measured in running metres.

Boarding including wooden chajjas and sun shades along with supports shall be measured in square metres in its plane.

66.7.5 Steel and Iron Work

(i) All steel and iron work shall be measured in quintals. The weight shall be computed from standard tables unless the actual weight can readily be determined.
(ii) Riveted work, where rivets are required to be cut, shall be measured separately.
(iii) Marking of structural steel required to be re-erected shall be measured separately.
(iv) In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately

66.7.6 Road Work

(i) Different types of road surfaces shall be measured separately.

(ii) Road surfaces metalling or soling (base) shall be measured in square metres.(iii)Concrete paving shall be measured same as in 54.7.1 in cubic metres.

66.8 RATES

The rate shall include cost of all such operations mentioned above including necessary labour, materials,transport, scaffolding, stacking the serviceable materials, disposing the unserviceable materials within the lead specified, all as directed by the Engineer-in-charge.

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67. ROAD AND PAVEMENTS

67.1 SCOPE OF WORK

The work contemplated under these specifications refers to Earth work in Excavation, Forming Embankments, WBM sub-base Soling, W.B.M., Bituminous Macadam, Wearing Course/Sealing Coat etc. for road and pavement works.

In addition, Specifications for Surface Dressing with hot bitumen, Premix carpet with hot bitumen, Bituminous penetration macadam, Bitumen mastic wearing courses, Dense bituminous macadam etc. as per guidelines of MORTH (Ministry of Road Transport and Highways) have been included.

Table 67.1: Approximate quantities of materials for Road Works (Only for Reference)

S.No	MATERIAL	DESCRIPTION	CONSUMPTION
i)	Soling stone	a) for 230 mm. thick consolidated thickness	2.65 cum./10 sqm
		b) for 150 mm. thick consolidated thickness	1.725 cum./10 sqm.
ii)	Stone aggregate 50 mm. nominal size	for 75 mm. thick consolidated W.B.M.	0.975 cum./10 sqm.
iii)	Murrum	for 75 mm. thick consolidated W.B.M	0.305 cum./10 sqm
iv)	Bituminous macadam	i) for premix carpets for 38 mm. consolidated thickness ii) for premix carpets for 50 mm. consolidated thickness	11 sqm./MT. 8.36 sqm./MT.
v)	Seal coat (Bituminous concrete for wearing course)	i) for 12 mm. consolidated thickness ii) for 25 mm. consolidated thickness	33 sqm./MT. 15.84 sqm./MT

67.2 EARTH WORK IN EXCAVATION

The specifications for "Earth work" under chapter - 1, specified here-in-before shall hold good as far as they are applicable.

67.3 FORMING EMBANKMENT

The work shall include preliminaries of clearing site, setting out and preparing the ground and there afterforming embankment for the roads, paths etc. with approved material available from excavations under this contract (excavation paid separately under respective items) or elsewhere, spreading in layers, watering and compacting to the required density and lines, curves, grades, camber and cross section and dimensions shown in the plan or as directed by the Engineer-in-Charge. When the embankment is to be laid on hill sides or slopes, the existing slopes are to be ploughed deeply. If the cross slopes are steeper than 1 in 3, steps with reverse slope shall be cut into the slopes to give proper hold and seating to the bank as directed by the Engineer-in-Charge. The top 15 cm. of soil shall be scarified and watered if directed and compacted to the same density as specified for the embankment before any material is laid for the embankment work.

Only the approved excavated earth shall be placed in the embankments in successive horizontal layers not exceeding 200 mm. extending to the full width of the embankment including the slopes at the level of theparticular layer and 30 cm. more on both sides to allow compaction of the full specified section. The extra loose stuff at the edges shall be

trimmed later after completion of the bank work without extra cost leaving the correct section fully compacted.

Keeping the width of the bank initially less and widening it later by dumping loose earth on the slopes shall not be permitted as the additional width and slopes will remain loose and uncompacted. Similar procedure to extend the embankment by dumping the material longitudinally shall also not be allowed. Each layer of the embankment shall be watered, levelled and compacted as specified here-in-after, before the succeeding layers are placed. The surface of the embankment shall at all times during construction, be maintained in such a manner so as to prevent ponding. Water to be used shall be free from all harmful elements which may cause efflorescence etc. and approved by the Engineer-in-Charge.

If the material for embankment contains moisture less than the optimum moisture, water shall be added in the 100 mm. layers of the embankment to bring moisture uniformly upto requirement. If the excavatedmaterial contain more than required moisture, it shall be allowed to dry until the moisture is reduced to required extent. If due to the wetness, the moisture content of the soil cannot be reduced to the appropriate amount by exposure, embankment work shall be suspended till suitable conditions prevail at no extra claim/compensation.

When loose layer is levelled manually or mechanically and moistened or dried to a uniform moisture content suitable for maximum compaction, it shall be compacted by 8 to 10 tonne power roller or sheep foot rollers or heavy hauling or dozing equipment to give the specified 90% of the proctor density. If on testing, the density is found to be less than 90% of the proctor density, the contractor shall do additional compaction necessary to get the specified density after adding water if required. If the density cannot be improved by such reasonable efforts, the work may be accepted as substandard work by the Engineer-in-Charge, if he thinks it is not harmful for the purpose and paid for at a reduced rate. Test shall be made to determine the maximum density of the material to be used by the proctor method before starting the work. Density test shall be carried out for the embankment work during the progressof the work. One set of three core samples for every 1000 sqm. (about 1000 sq.yd.) area of each layer of embankment work shall be taken and tested. The average density shall not be less than 90% of the proctor density, obtained in the laboratory.

Arrangement for obtaining the samples and transporting the same to laboratory, shall be made by the contractor at his own cost.

Embankment not accessible to rollers, such as those adjoining bridges, culverts and other works shall be carried out independently of the main embankments and shall have the layers placed in 150 mm. to 200 mm. height and each layer shall be moistened and thoroughly compacted with mechanical

or manual tamper. Before placing the next layer, the surface of the under layer shall be moistened and scarified so as to provide a satisfactory bond with the next layer.

The embankment shall be finished and dressed smooth and even, in conformity with the alignment levels and cross sections and dimensions shown on the drawing. On curves, section shall be providedwith super elevation and increased width, as shown on the plans as directed by the Engineer-in-Charge.

Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5.

The contractor shall be responsible for maintaining the embankment work in satisfactory conditions at his own cost till finally accepted including making good any damage.

67.4 MEASUREMENT AND RATE

The contract rate shall be per cubic metre of the finished embankment or as specified. Measurementsshall normally be taken by taking cross sections at suitable intervals. The measurements of the sectionshall be limited to the dimensions shown on the drawing or those ordered by the Engineer-in-Charge inwriting. The sectional area shall be worked out correct upto two places of decimal of square metre andthe quantity worked out to two places of decimal of cubic metre on lines similar to those specified for earth work here-in-before.

67.5 DRY STONE PITCHING

67.5.1 **Stones:** These shall be clean, hard stones, free from decay and weathering. They shall be in block and

hammer dressed on all sides. The size of the pitching stones shall be approximately 22.5 cm.in depth and not less than 15 cm. in any other direction.

67.5.2 **Preparation of surface:** The sides and bottom of earth work to be pitched shall be brought to therequired slope and gradient and shall be compacted to a firm and even surface.

67.5.3 **Pitching:** Pitching shall be of 22.5 depth unless specified otherwise. Profiles shall be put up by means of pegs and strings or by placing stones, at intervals of not more than 15 cm. Stones shall then belaid closely in position in between the profile and firmly embedded with joints staggered and with exposed faces true to line, gradient and in uniform slope throughout.

Cross bands of approximately 22.5 cm width through bond stones equal to the full depth of pitching shallbe provided at an interval of approximately 3 metres centre to centre both longitudinally and transversely.

The interstices between adjacent stones shall be filled in with stones of proper size, well driven in with crow bars to ensure tight packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind. Final wedging shall be done with the largest sized chip practicable, each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

67.5.4 **Measurements:** The measurements shall be taken in sqm. The area of pitching for drains shall be calculated by multiplying the perimeter (bed width plus side slopes) by the length of the pitching. The length, width and side slope shall be measured correct to a cm.

67.5.5 **Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above, except pitching stone, if specified, shall be paid for separately.

67.6 SUB GRADE

67.6.1 **Preparation of Sub-Grade :** The surface of the formation for a width of sub-base, which shall beas per drawing shall first be cut to a depth equal to the combine depth of sub-base and surface coursesbelow the proposed finished level (due allowance being made for consolidation). It shall then be cleaned

of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to finished profile.

67.6.2 **Consolidation :** The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as anelastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All undulations in the surfacethat develop due to rolling shall be made good with fresh material or quarry spoils as the case may be andthe sub-grade is rerolled.

67.6.3 **Surface Regularity:** The finished surface shall be uniform and conform to the lines, grades and typical cross sections shown in the drawings. When tested with the template and straight edge, the variation shall be within the tolerances specified in the Table below:

Table 67.2: Permissible Tolerances Of Surface Regularity

Longitudinal profile	Cross profile
Maximum permissible undulation when measured with a 3 metre straight edge template.	Maximum permissible variation from specified profile when measured with a camber-
24mm	15mm

Where the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shallbe liable to rectify these with fresh material or quarry spoils as the case may be, and the sub grade rerolled to the satisfaction of the Engineer-in-charge.

67.6.4 **Measurement & Rate :** The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal. The rate shall include the cost of materialsand labour required for all the operations mentioned above, unless specified otherwise.

67.7 SUB-BASES

67.7.1 **Lime Fly Ash Stabilised Soil Sub Base:** The thickness of lime flyash soil layer for use as sub base should be designed in accordance with IRC 37. The minimum thickness shall not be less than 15 cm.

67.7.1.1 **Soil** Granular soils free from high concentration of organic matter or deleterious salts and sandwith fine silts produce better mixes than fine grained soil with high clay content. Clay, silts and low plastic clays with plasticity index between 5 and 20 and liquid limit less than 25 are however, suitable the minimum proportion of particles smaller than 425 micron should be between 15 and 25 percent by dry weight of the soil lime flyash mixture. Selection of material and their gradation should be such as would be conducive to compaction to high density.

67.7.1.2 **Lime** Should be commercial dry lime slaked at site or pre-slaked and delivered in airtight sacks. Suitable approved lime should have purity (Cao content) of not less than 50 percent. Only hydrated highcalcium and mono hydration dolomitic limes are to be used. Quick lime is not recommended for use. Where in exceptional circumstances, when lime with 50% purity is not available, the deficiency can be compensated by using larger proportion of lime.

67.7.1.3 **Flyash** Shall conform to IS 3812. If it is partially set due to long storage, it should be pulverised and dry sieved before mixing, to conform to following grading:

Table 67.3: Grading for Flyash

Sieve Size (mm)	Percent passing
12.5	100
9.5	95(min)
2.0	75(min)

Flyash should be fine enough to have a specific surface are of 3200 sq.cm/gm or 320 sqm/kg. It should be ensured before its use, that flyash possesses lime relativity of not less than 35 kg/sq.cm. Flyash should be stored in covered area safe from moisture.

67.7.2 Mix Proportioning

The mix proportion shall be determined in conformity with IRC-88 through laboratory tests for meeting the strength requirements. A typical mix proportion of soil lime, flyash is given below :

- Soil 85 parts by weight
- Lime 3 parts by weight
- (based on 80% purity of lime)
- Flyash 12 parts by weight

The quantity of water shall be as per the O.M.C. requirements determined on soil lime flyash mixture byproctor density method.

67.7.3 Construction Operation

Mixing shall preferably be done by mechanical plant either of the single pass or multiple pass type, where such plant is not available, manual method may be adopted with rigorous control over quality of construction. In the manual method, the soil shall be pulverised by means of crowbars, pick axes, bullock drawn ploughs etc. and deposited on the road bed in stacks of suitable size, about 30 cm in height. Water in requisite quantities shall be sprinkled on the soil for aiding pulverisation.On the pulverised soil stacks,lime and flyash in a thoroughly mixed form and in the requisite quantities shall be spread uniformly and mixed by cutting with spade till the whole mass is uniform. The mixed soil shall then be spread over the prepared sub-grade to the required thickness and rolled. Before rolling, the moisture content shall be adjusted to be within + 1% and -2% of the O.M.C.

67.7.4 **Rolling:** Rolling shall be done with a 8-10 tonne roller. Rolling is continued till the required density (100% of Lab. Proctor density as per IS 2720 Pt.VII) and a smooth surface obtained without leaving any roller marks on the surface. During rolling surface should be checked for grade and camber and irregularities corrected.

67.7.5 **Curing:**The compacted surface shall be cured for a minimum period of 7 days before the next layer is

placed. Curing is done by sprinkling water over the surface five or six times a day. The surface shall not be allowed to dry during the curing period. Curing by ponding shall not be adopted.

67.7.6 **Measurements:**The length and breadth shall be taken to the nearest centimeter and the thicknessto the nearest half centimeter. The consolidated cubical contents shall be calculated in cubic metres, correct to two places of decimal.

67.7.7 **Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

67.8 WATER BOUND MACADAM SUB-BASE WITH STONE AGGREGATE

The scope of work involves providing WBM rubble soiling of 230mm consolidated thickness in two layers of compacted thickness of 115mm each as a sub base to WBM road using Stone aggregate of Grading-Iwith size range 90 mm to 45 mm. This consists of clean crushed coarse aggregate mechanically interlocked by rolling using power road roller of 8 to 10 tonnes and voids thereof filled with screening and blinding material with the assistance of water, laid on a prepared sub-grade/sub-base.

67.8.1 Specifications for Laying

67.8.2 **Quantities of Materials:** Approximate quantities of coarse aggregate, screening & blinding material required to be stacked for 100 mm compacted thickness of WBM sub-base course for 10 Sqm. shall be as per table given below:

Table 67.4: Approximate quantities of coarse aggregate, screening & blinding material required tobe stacked for 100 mm compacted thickness of WBM sub-base course for 10 Sqm

Coarse Aggregate			Stone Screenings		Blinding materials
Classification	Size Range	Net Qty.	Grading/ Classification and size	Net Qty	
Grading - I	90mm to 45mm	1.2 Cum. to 1.28 Cum	Type A 13.2 mm	0.27 Cum. to 0.30 Cum	0.08 Cum. to 0.10 Cum.

NOTE: Net Quantity = Loose Quantity measured in stack minus 7.5%

67.8.3 **Preparation of Foundation :** In the case of an existing unsurfaced road, where new materials is to be laid, the surface shall be scarified and reshaped to the required grade, camber and shape as necessary. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for W.B.M.

67.8.4 **Spreading Aggregate :** The coarse aggregate shall be spread uniformly and evenly upon the prepared base in required quantities with a twisting motion to avoid segregation. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. The aggregates shall be spread uniformly to proper profile by using templates placed across the road six metres apart. Where specified, approved mechanical devices maybe used to spread the aggregates uniformly. The levels along the longitudinal direction upon which the metal shall be laid, shall be first obtained at site to the satisfaction of Engineer-in-charge and these shall be adhered to.

The surface of the aggregate spread shall be carefully trued up and all high or low spots remedied by removing or adding aggregate as may be required.

The W.B.M. sub-base shall be normally constructed in layers. Each spread loose layer of 150mm.thick shall be compacted to consolidated thickness of 115 mm each. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall normally not be spread in lengths exceeding three days average work aheadof the rolling and blending of the proceeding section.

67.8.5 **Rolling :** Immediately following the spreading of the coarse aggregate, it shall be compacted to the full width

by rolling with either a three-wheel power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller. Initially, light rolling is to be done which shall be discontinued when the aggregate is partially compacted with sufficient void space in them to permit application of screenings.

The rolling shall begin from the edges with the roller running forward and backward and adding the screenings simultaneously until the edges have been firmly compacted. The roller shall then progress gradually from the edges to the centre, parallel to the centre line of the road and overlapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. Rolling shall continue until the road metal is thoroughly keyed with no creeping of metal ahead of the roller. Only slight sprinkling of water may be done during rolling, if required. On super elevated curves, the rolling shall proceed from the lower edge and progress gradually continuing towards the upper edge of the pavement.
Rolling shall not be done when the sub-grade is soft or yielding or when the rolling causes a wave like motion in the sub-base or sub-grade. When rolling develops irregularities that exceed 12 mm when tested with a three metre straight edge, the irregular surface shall be loosened and then aggregate added to orremoved from it as required and the area rolled until it gives a uniform surface conforming to the desiredcross-section and grade. The surface shall also be checked transversely by template for camber and any

irregularities corrected in the manner described above. In no case shall the use of screenings to make up depressions be permitted.

67.8.6 **Application of Screenings :** After the coarse aggregate has been lightly rolled to the required true surface, screenings shall be applied gradually over the surface to completely fill the interstices. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller causes them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles on the coarse aggregate but shall be spread uniformly in successive thin layers either by the spreading motion of the hand, shovels or a mechanical spreader.

The screenings shall be applied at a slow rate (in three or more applications) so as to ensure filling of allvoids. Rolling and brooming shall continue with the spreading of the screenings. Either mechanical brooms or hand brooms or both may be used. In no case shall the screenings be applied, so fast and thick as to form cakes, ridges on the surface making the filling of voids difficult, or to prevent the direct bearingof the roller on the coarse aggregates. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day"s operation and shall continue until no more screenings can be forced into the voids of the coarse aggregate. Damp and wet screenings shall not beused under any circumstances.

67.8.7 **Sprinkling and Grouting :** After spreading the screening and rolling, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well bonded and firmly set for the entire depth and until a grout has been formed of screenings and water that will fill all voids and form a wave of grout ahead of the wheels of the roller. The quantity of water to be used during the construction shall not be excessive so as to cause damage to the sub-base or sub-grade.

67.8.8 **Application of Blinding Material :** After the application of screenings and rolling, a suitable blinding material shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of blinding material, the surface shall be copiously sprinkled with water and the resulting slurry swept-in with hand brooms or mechanical brooms or both so as to fill the voids properly. The surface shall then be rolled by a 8-10 tonne roller, water being applied to the wheels in order to wash down the blinding material that may get stuck to the wheels. The spreading of blinding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry that is formed well, after filling the voids form a wave ahead of wheels of the moving roller.

67.8.9 **Setting and Drying :** After final compaction of the course, the road shall be allowed to cure overnight. Next morning defective spots shall be filled with screenings or blinding material, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed till the macadam sets.

67.8.10 **Surface Evenness :** The surface evenness of completed W.B.M. sub-base in the longitudinal and transverse directions shall be as specified in the table given below:

Table 67.5: surface evenness of completed W.B.M. sub-base

Size of coarse aggregates	Longitudinal profile	Cross profile
	Max. permissible undulation when measured with a 3 M straight edge	Max. permissible undulation when measured with a camber template
45-90 mm	15 mm	12 mm

The longitudinal profile shall be checked with a 3 M long straight edge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 M.

67.8.11 **Rectification of Defective Construction :** Where the surface irregularity of the WBM sub-base course exceeds the tolerances specified in the table given above or where the course is otherwise defective due to sub-grade soil mixing with the aggregates, the layer to its full thickness shall be scarifiedover the affected area, reshaped with added material or removed and replaced with fresh material as applicable, and re-compacted. The area treated in the aforesaid manner shall not be less than 10 Sqm. In no case shall depressions be filled up with screenings and blinding material.

67.8.12 **Measurements & Rate:** The length and breadth shall be taken to the nearest centimetre and thickness to the nearest half centimetre. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimals. The rate shall include the cost of all labour and materials involved in all the operations described above.

67.9 WATER BOUND MACADAM ROAD

67.9.1 Metal : Metal required for water bound macadam surfacing shall be broken from the first sort rubble. The rubble shall be broken to required size by the contractor at his own cost. However, the metal required for water bound macadam shall conform to I.R.C. specification in all respects. It shall be hard, sound, trap stone metal free from decay and weathering and obtained from approved quarries, and shall be of 50 mm. nominal size.

67.9.2 Collection of metal : Metal shall be of first sort black trap stone and shall be collected in stackson level ground and stacked on the sides of the road as directed. The metal shall be free from all earth, rubbish and vegetable matter and graded before stacking and closely packed in stacks. The metal supplied by the contractor shall be arranged in stacks for measurement. No deductions will be made forvoids. The size of stack shall be 1 m. wide at top, 2.2 m. wide at bottom and 60 cm. high. The length shall be as directed by the Engineer-in-Charge. The contractor shall provide the templates required to ensure, compliance with size of stack stipulated.

67.9.3 Supply of Murrum : The contractor shall be permitted to excavate in the selected areas in the township/site of work, as approved by the Engineer-in-Charge, for collection of murrum. The excavation shall be done by the contractor to correct line and level, transport and stack the same at site of work as directed by the Engineer-in-Charge. Alternately, the contractor will be permitted to bring from outside, approved graded hard murrum 10 mm. down to dust (but not silt) as directed by the Engineer-in-Chargeand shall also be collected in stacks on level ground along side of the road.

The stacks shall be measured in cubic metre for payment before using it for blinding. No deduction shall be made for voids.

67.9.1 Laying and preparation of water bound macadam surface

i) After preparation of the existing surface as specified above, 50 mm size metal collected in stacks shall be spread to uniform thickness over the prepared surface and consolidated to 75 mm thickness as specified here-in-after.

ii) Templates properly made of full width and gauge or templates fitted with central plumb toeach edge fixed with it must be used. The depth of the plank forming the gauge shall be the thickness of the metal layer in loose state so that when the metal has been properly spread, thegauges are buried just flush with the surface. The intermediate work shall be tested with cord stretched between the gauge. Three templates shall be provided and used with a distance of about 7.5 Metres between each but not exceeding 15 Metres. A spirit level shall invariably

be used with the templates to ensure that the edges of metalling are truly levelled. The metal shall bespread and rolled with 8 to 10 tonne power roller until well compacted and there is no appreciable movement (in the metal) when walked upon, or no appreciable wave in front of theadvancing roller. Rolling shall be done by roller perfectly, by a 8 to 10 tonne power roller, till proper

internal packing of adjacent pieces of stones has been achieved. Excessive dry rolling shall beavoided.

iii) Rolling shall commence from the edge to the centre of the road. In case of super elevated curve, rolling shall commence from the inside edge of the centre and progress towards the outside edge. Where the gradient is steeper than 1 in 60, the roller shall run up grade, i.e. rolling shall be started from lower level to upward direction for the 1St. rolling.

iv) While rolling the surface in two or more parts, a strip of about 230 mm. to 300 mm. along the predetermined cross section shall be left unrolled while consolidating the first half. This shall be properly jointed when the metal is being spread on the second half and consolidated with it. Care must be taken to avoid the occurrence of a continuous longitudinal furrow along cross section ofthe road. Full width of road will be rolled at a time.

v) The metalling shall be moderately kept saturated and rolling continued until consolidation is completed. Just enough watering shall be done so as to flush the metal slurry into the interstices. Care shall be taken to avoid excess water softening the subsoil. The full consolidation stage shall be tested by (a) putting a piece of metal about the size of wal-nut on the surface and roller passed over it. If it is crushed the surface shall be deemed as well consolidated (b) there shall be no creeping of stone ahead of the roller.

vi) Until the above conditions are satisfied, no blinding or surfacing materials shall be put on the surface. No rolling shall be done where signs of metal crushing are noticed or rolling causes wave like motions in the base course of sub-grade. Over rolling shall not be done. About 20 to 30 trips of the roller shall normally suffice to make the surface well compacted. Before starting rolling, the metal shall be dressed accurately to camber. No fresh metal shall be added once dry consolidation has commenced. The part of the road must be fully raked up so that the metal is thoroughly incorporated into the body of road.

67.9.2 **Binding Course :** When the required consolidation has been completed, the binding material of approved graded murrum/stone grit and dust (unscreened) as specified shall be spread over the surface and brushed backwards and forwards to fill in the surface voids and rolling and watering continued to such an extent that the binding materials are formed into a slurry and is grouted into the interstices. After the road has been fully consolidated, the surface shall be covered with 12 mm layer of murrum/stone grit and dust (unscreened) and road opened to traffic after 4 days. The road shall be kept watered for 14 days orsuch other period as specified by the Engineer-in-charge. Where tracks are likely to be formed by the traffic on the road, barriers such as tree branches etc. shall be put to divert the traffic. After 15 days, light watering and rolling shall be done. For joints across the road, the end of each layer shall be given a flatslope and well consolidated together and hump formation must be avoided.

67.9.3 **Damages to the Department‘s Property :** Any damage to the Deptt‟s property due to negligence of the contractor while executing the work shall be made good to the original condition at his own cost.

67.9.4 **Mode of Measurement:** The areas of water bound macadam road surfaces of required thicknessactually completed as per above specifications limiting to the areas as per drawing shall be measured insquare metre upto two places of decimal,for payment.

The item includes laying, spreading, watering, consolidation, blinding etc. but excluding the cost of 50 mm size I.R.C. metal and graded murrum which will be paid under relevant item. However Murrum obtainedfrom excavation work under this contract and used as blinding material as above on instructions/approval of the Engineer-in-charge shall not be paid.

67.10 BITUMINOUS MACADAM & BITUMINOUS CONCRETE SURFACING FOR ROAD (GENERAL)

67.10.1 GENERAL TERMINOLOGY: (FOR BITUMINOUS BINDER)

Bitumen: A noncrystalline solid or viscous material, having adhesive properties derived from petroleum either by natural or refinery processes and substantially soluble in carbon disulphide. This shall be straight- run bitumen of specified penetration value conforming to IS 73 (Latest revision) for hot mix application.

Bitumen-Cutback: Bitumen, the viscosity of which has been reduced by a volatile dilutent when blended with kerosene or naphtha type dilutent or fuel oil, is called, medium or rapid or slow curing cut backs respectively. The binder bitumen-cutback shall be of specified penetration grade conforming to IS 217 or454 as specified and generally used as cold application for repair and maintenance work of road under dry condition.

Bitumen-Emulsion: A liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium containing an emulsifier and stabiliser. The emulsion is termed „Anionic" when the bitumen particles are negatively charged and the aqueous phase is alkaline. The emulsion is termed „cationic" when the particles are positively charged and the aqueous phase is acidic. Binder bitumen emulsion shall conform to RS grade IS 8837 and is used for urgent repairs under damp surface condition.

67.10.2 SCOPE OF WORK

The work covered hereunder provides for hot mix bituminous treatment for roads consisting of providing 38 mm or specified thick bituminous macadam and 12 mm or specified thick seal coat or bituminous concrete of thickness as specified in item in the schedule of quantities.

The contractor shall make at his own cost, all the arrangements for controlling the traffic during the execution of the work. All arrangements such as proper barricading of road, diversion of road if necessary, red and green flags during the day, red lights at nights shall be made by the contractor at hisown cost to control and safeguard the traffic.

67.11 BITUMINOUS MACADAM OVER WATER BOUND MACADAM

67.11.1 **Preparation of Existing Water Bound Macadam Surface :** The existing water bound macadam surface shall be brushed, cleaned properly with wire brushes and coir brooms, so as to free from all loose materials, murrum, earth, silt and caked mud etc. The surface shall then be dusted clean with gunny bags etc. If during the process of cleaning the sub grade (water abound macadam), soft spots and pockets, hollows etc. are found, such spots/pockets will be filled with approved precoated bituminous chips, consolidated and finished to proper level, rolled with power roller if necessary. The pot holes shall be excavated properly in a rectangular or rhomboidal shape with vertical edges. The bottom and sidesshall be cleaned as stated above. The sides and bottom shall then be thoroughly painted with heated 60/70 penetration or VG 30 grade bitumen. The pot holes shall thereafter be filled with premixed bituminous chips so that after thorough tamping and rolling, the surface is flush with surrounding road surface all as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to ensure that the subgrade is even and is finished to camber and slope as shown on the drawings or as directed by the Engineer-in-Charge.

The surface of the subgrade shall be checked for its trueness by means of the scratch template resting on side forms having scratch points placed at not less than 200 mm. apart and set to the exact profile of thebase course. The template shall be drawn along the forms at right angles to the road.

Unevenness of the surfaces as indicated by the scratch points shall not exceed 10 mm. in 30 m. The area of depression shall then be painted or sprayed with 60/70 penetration or VG 30 grade bitumen at the rate of 0.75 kg. persqm. and the leveling course applied by hand or machine to grade and camber and rolled. If the depressions are deeper than 50 mm., the levelling course shall be applied in two or more layers and rolled as directed by the Engineer-in-Charge.

The prepared surface shall be closed to traffic and maintained fully clean and no asphalting work shall be started unless this prepared surface is approved by the Engineer-in-Charge.

67.11.2 **Materials:** Representative samples of materials proposed to be used shall be submitted to the Engineer-in-Charge and got approved. No material shall be used unless it is approved by the Engineer-in- Charge.

67.11.3 Hot Mixed Hot Laid Bituminous Macadam

67.11.3.1 **Coarse Aggregate:** It shall consist of crushed hard trap stone metal, free from coatings of clay, silt and any objectionable material. Metal brought by contractor for different items of work shall strictly conform to latest relevant I.R.C. specifications in all respects. The aggregate shall be obtained by crushing approved stones of specified type in mechanical crusher and shall be hard, close grained, sound trap stone metal, free from decay and weathering and obtained from approved quarries.

Metal shall be collected in stacks on level ground and neatly stacked at site of mixing. The metal shall be free from all earth, rubbish, vegetation and other foreign matter and graded before stacking and closely packed in stacks.

Tests considered necessary shall be carried out in an approved laboratory when the Engineer-in-Charge considers the quality to be doubtful or there is a dispute about the quality. The cost of testing shall be borne by the contractor.

Aggregate Grading : The requirements of base course shall be as under:

Table 67.6: **Composite of Bituminous Macadam**

Mix Designation	Grading 2
Nominal maximum aggregate size*	19 mm
Layer Thickness	50-75 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing
26.5	100
19	90-100
13.2	56-88
4.75	16-36
2.36	4-19
0.3	2-10
0.075	0-8
Bitumen content** percent by mass to total mix	3.7 or as specified in the item
Bitumen grade	As specified in item or directed otherwise

* Nominal maximum aggregate size is the largest specified sieve size upon which any of the aggregate material is retained.

** Corresponds to specific gravity of the Aggregate being 2.7. In case aggregates have specific gravity more than 2.7, bitumen content can be reduced proportionately. Further, for regions where highest daily mean air temperature is 30º C or lower and lowest daily mean air temperature is - 10º C or lower, the bitumen content may be increased by 0.5 percent.

The aggregate/chips shall be entirely dry at the time of mixing.

67.11.3.2 **Bitumen:** The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, or as otherwise specified in the item. The type and grade of bitumen to be used shall be specified in the Contract. The type and grade of bitumen to be used would depend upon the climatic conditions and the traffic. Guidelines for selection of bitumen are given in Table below

able 67.7: Selection Criteria for Viscosity-Graded (VG) Paving Bitumen Based On Climatic Conditions

Lowest Daily Mean Air Temperature ºC	Highest Daily Mean Air Temperature, ºC		
	Less than 20ºC	20 to 30ºC	More than 30ºC
More than -10ºC	VG-10	VG-20	VG-30
-10ºC or lower	VG-10	VG-10	VG-20

The contractor on demand by the Engineer, obtain and furnish a laboratory test certificate to the effect that the material conforming to the requirement of the specified grade, to the satisfaction of the Engineer-in- Charge. Bitumen content 3.7 % to 4.7% (as specified) by weight of the total mix, shall be used in the mixture.

67.11.3.3 **Tack Coat :** Bitumen of the same grade as that used for premix shall be heated to a temperature of 163°C to 177°C in a bitumen boiler and the hot bitumen shall be applied evenly to thethoroughly cleaned and prepared road surface (as specified here-in-before) @ 7.5 kg. per 10 sqm. leaving no part of the surface unpainted. Application shall be done by a mechanical pressure sprayer or if permitted, by perforated pouring cans. The tack coat shall be applied just before the macadam is laid. Application of tack coat shall be only slightly in advance of laying premixed chips.

In case of surface already asphalted, application of tack coat is not necessary.

67.11.3.3 **Mixing and Transportation of the Mixture :** Pre-mixed bituminous materials, shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table of these Specifications; the difference in temperature between the binder and aggregate should at no time exceed 14ºC. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time. The essential features of the hot mix plants are given in Annex. A of IRC:27.

If a continuous type mixing plant is used, the Contractor must demonstrate by laboratory analysis that the cold feed combined grading is within the grading limits specified for that bituminous bound material. In the case of a designed job mix, the bitumen and filler content shall be derived using this combined grading.

Bituminous materials shall be transported in clean insulated vehicles, and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

Table 67.8: Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree Celsius)

Bitumen Viscosity Grade	Bitumen Temperature	Aggregate Temperature	Mixed Material Temperature	Laying Temperature	*Rolling Temperature
VG-40	160-170	160-175	160-170	150 Min.	100 Min.
VG-30	150-165	150-170	150-165	140 Min.	90 Min.
VG-20	145-165	145-170	145-165	135 Min.	85 Min.
VG-10	140-160	140-165	140-160	130 Min.	80 Min.

* Rolling must be completed before the mat cools to these minimum temperatures.

67.11.3.4 **Cleaning of Surface:** The surface on which the bituminous work is to be laid shall be cleaned of all loose and extraneous matter by means of a mechanical broom and air jet. or any other approved equipment/ method as specified in the contract. The use of a high pressure air jet from a compressor to remove dust or loose matter shall be available full time on the site, unless otherwise specified in the Contract.

67.11.3.5 **Spreading:** Prior to spreading the mix, the base shall be prepared by carrying out the required operation. Except in areas where a mechanical paver cannot get access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine equipped with an electronic sensing device. The essential features of the paver finisher shall conform to Annex A of IRC:27. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver, and its method of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and leveled with suitable hand tools by experienced staff, and compacted to the satisfaction of the Engineer-in-charge.

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300 mm short of the joint. The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145ºC, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer-in-charge.

67.11.3.6 **Rolling / Compaction:** Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectionally cambered portions, it shall progress from the lower to the upper edge parallel to the center line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8 – 10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8 – 10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sqcm or 0.56 MPa. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers. Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller.

Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300 mm.

In portions with super elevated and unidirectional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.

Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

67.11.3.7 **Joints :** Where joints are made, the material shall be fully compacted and the joint made flush in one of the following ways:

(a) All joints shall be cut vertical to the full thickness of the previously laid mix. All loosened material shall be discarded and the vertical face coated with a suitable viscosity grade hot bitumen, or cold applied emulsified bitumen. While spreading the material along the joint the material spread shall overlap 25 mm to 50 mm on the previously laid mix beyond the vertical face of the joint. The thickness of the loose overlap material should be approximately a quarter more than the final compacted thickness. The overlapped mix shall be dragged back to the hot lane so that the roller can press the small excess into the hot side of the joint to obtain a high joint density.

(b) By using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling

All longitudinal joints shall be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer-in-charge. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate. Longitudinal joints shall not be situated in wheel track zones.

67.11.3.8 Opening to Traffic : The newly laid surface shall not be open to traffic for at least 24 hours after laying the completion of compaction, without the approval of the Engineer-in-Charge in writing.

67.11.3.9 Surface Finish and Quality Control of Work : The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH Specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH Specifications.

67.11.3.10 Arrangement for Traffic : During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of the Engineer- in-charge.

67.11.4 Measurement : Bituminous Macadam shall be measured as finished work in cubic meters correct to two places of decimal.

67.11.4 **Rate :** The rate includes the cost of all material, labour, machineries and equipments in all the operations described above.

67.12 HOT MIXED HOT LAID BITUMINOUS CONCRETE WEARING COURSE (SEAL COAT)

67.12.1 **Bituminous concrete:** shall consist of mixture of mineral aggregate, sand and filler, graded to fill the voids, mixed with bitumen binder to obtain the maximum stability and durability. It shall be spread and compacted on a prepared bituminous macadam base in conformity with lines, grades and cross section shown in the drawings. The aggregate shall be preheated the temperature specified for the bitumen and the mixture shall be prepared and laid hot.

67.12.2 **Coarse Aggregate :** The coarse aggregate brought by contractor shall be I.R.C. hard black trap, crushed in mechanical crushers and shall be clean, strong, tough, dense, close grained, angular but not flaky, and free from

soft, decayed, weathered portion, coating of dust, dirt or other objectionable matter. Stone chips shall be of 6.7 mm size defined as 100 per cent passing through 11.2 mm sieve andretained on 2.36 mm sieve. Maximum size of the aggregate shall be suitable for the thickness of the sealcoat (12mm./25mm. or as specified). The upper limit for water absorption value for stone chips shall be 1per cent.

The aggregate grading composition and characteristics of surface (wearing course mix) shall conform tostandard code of practice. The mix shall satisfy the following requirements:

Table 67.9: Grading Composition and Characteristics

Bitumen contentment percentage by weight of total mix	5% to 7% (as specified)
Voids of air in total mix :	2% by weight of mix and 4% by volume.
Specific gravity	Not less than 2.3.
Marshall stability :	453.6 kg (1000 lb.) minimum
Flow :	1020.
Water absorption :	0.50%

67.12.3 **Fine Aggregate :** The aggregate shall be sand or grit and shall consist of clean, hard durable, uncoated dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36 mm sieve and be retained on 180 micron sieve. Stones or fine aggregate shall be used as specified in item. The fine aggregate shall be clean, natural, river bank or pit sand or quarry sand produced in a crushing plant and satisfying the requirement of the grading of aggregate for the bituminous concrete as stated above or as determined by the preliminary tests.

67.12.4 **Filler :** The filler shall be dry and clean lime stone powder hydrated lime having calcium oxide content of not less than 60% both passing B.S. sieve No.8. It shall be free from lumps and loosely bonded aggregation. When tested by laboratory sieves, 100% shall pass through B.S. sieve No.14, 80%shall pass through B.S. sieve No.8. Fillers shall be added to the aggregate to give the above grading determined by preliminary tests.

67.12.5 **Bitumen :** Bitumen shall be of specified viscosity grade or penetration grade as specified in item and shall conform to I.S. 73 (Latest Revision).

The tenderer shall submit the mix design with grading and quality requirements of individual ingredients, bitumen content, voids, specific gravity etc. to meet the requirements set out in Table 55.7 for bituminousconcrete for approval of Engineer in Charge.

67.12.6 **Preparation of Base :** Dirt, dust and other foreign materials if accumulated shall be cleared offleaving the surface entirely clean. The prepared surface shall be closed to traffic and so maintained fullyclean till the seal coat is applied.

67.12.7 **Mixing and Laying Wearing Course:** Grade 60/70 or VG30 bitumen shall be heated to a temperature of 163° C to 177° C (325° F to 350° F) in a boiler. The aggregate of the suitable approved grading or as decided by preliminary tests, shall be dried and heated in an aggregate drier to a temperature of 149° C to 177° C (300° F to 350° F) and fed into a twin shaft peddle type mixer at a temperature not less than 149° C (300° F). The bitumen, the aggregate and the filler shall be measured separately and accurately to the proportions in which they are to be mixed and mixed intimately till all the particles are completely coated with bitumen. The quantities of aggregate, bitumen and the filler shall be such as to obtain the percentage of each as specified above or decided after tests. Continues batching and mixing plant shall be used. Asphalt/bituminous mixing plant proposed to be used by the contractor for the preparation of asphalt/bituminous mixes shall conform to all of the requirements of the job, which shall produce uniform mixtures of the required quality.

The temperature of bituminous concrete when leaving the mixer shall not be less than 138° C (280° F) and it shall not be less than 121° C (250° F) at the time of laying.

The bituminous concrete shall be transported to the site of work in suitable tipping vehicles properly insulated

and covered with canvas or other suitable materials to protect the mixture from weather conditions and to retain the heat.

The mixture shall be spread with mechanical self powered spreader. The bituminous concrete shall be laid to the specified line, curve, grade and camber. Any irregularities shall be corrected immediately before rolling is started. Before laying the mixture, the faces of the joints shall be painted with a uniform coating of hot bitumen. The bituminous concrete shall be laid to such loose depth as to give a compacted layer of specified thickness as per item in the schedule of quantities.

67.12.8 **Compaction:** The bituminous concrete layers shall then be allowed to cool sufficiently such that it does not spread under wheel load of 10/12 tonne power roller. The compaction shall be done by the roller till no wheel mark are left on the surface and no further compaction is possible. The road shall be openedto traffic on cooling of the concrete to the atmospheric temperature or after a lapse of 24 to 40 hr. after laying.

67.13 GENERAL REQUIREMENTS FOR BITUMEN MACADAM & SEAL COAT

67.13.1 **Testing :** The contractor shall have a well equipped testing laboratory with a competent laboratory staff. Daily tests (not less than two specimen per day) shall be made by them on the bituminous mixture produced to ensure compliance with these specification and copy of the test results duly signed by the competent authority shall be submitted to Engineer-in-Charge for record. Tests shall include water absorption, stability, filler content etc.

The contractor shall give all facilities at all times to the Engineer-in-Charge or his representative to inspect the work or testing done by him.

67.13.2 **Weighing:** Each lorry leaving the plant must be weighed on a weigh bridge in the presence of the representative of the Department and a challan must be issued along with the lorry in duplicate showing the weight of the material loaded in the lorry. As and when required, the said lorries shall also be weighed at the Departments weigh bridge or any other weigh bridge approved by the Engineer-in-Charge to check the tonnage of the material stated on the challans. In case of short fall, the same shall be made good by the contractor without extra cost.

67.13.3 **Testing Surface :** The completed surface when ready for acceptance shall be thoroughly compacted, smooth, true to line, grade, camber and free from irregularities when tested by means of a straight edge of 3 m. long, laid on the finished surface parallel with the centre line of the road, the surface shall in no place vary more than 6mm. from the working edge.

67.14 MODE OF MEASUREMENT

i) Measurement for bituminous macadam over newly prepared surfaces shall be paid by weight measuredin metric tonne used on the job, completed satisfactorily, measured upto second place of decimal including preparing surface, applying tack coat and compacting by roller etc. complete as specified. Actual consumption shall be reassessed with consumption co-efficient for specified thickness of compacted bitumen macadam. It should be within (plus side only) permissible limit specified for wastages etc.

ii) Measurement for bituminous concrete (seal coat) shall be paid by weight in Metric tonne measured upto second place of decimal used on the job. Actual consumption shall be reassessed with consumption co-efficient for specified thickness of compacted sealcoat. It should be within (plus side only) permissiblelimit specified for wastages etc.

Note: For new road work, payment of any excess consumption over theoretical consumption, if justified and approved by Engineer-in Charge shall be restricted to specified limit of wastage only.

67.15 SURFACE DRESSING ON NEW SURFACE WITH HOT BITUMEN - ONE COAT

This type of treatment shall consist of cleaning the existing water bound macadam, kankar or gravel surfaces, and applying one coat of hot bitumen on the prepared base, blinding it with stone chippings of

12.5 mm nominal size and consolidation with a road roller. This type of treatment is normally done for a road with light density rubber tyred traffic and roads for temporary construction. This treatment is also done on existing water bound macadam before applying the final surface treatment. In the latter case, after applying a coat of

painting the road is thrown open to traffic till the road is consolidated. The final treatmentis then given after making good the undulations etc. in the road surface.

Preparation of surface (Repairs and Cleaning) shall be as specified in preceding sections.

Applying binder, blinding, consolidation, surface finishing, measurements and rates shall be as specified,except that binder shall be applied at the rate of 2.25 kg per sqm and stone chippings of size 13.2 mm at
1.65 cum per 100 sqm unless otherwise specified.

67.16 SURFACE DRESSING ON NEW SURFACE USING HOT BITUMEN - TWO COATS

This consists of the application of two coats of surface dressing each coat consisting of a layer of bituminous binder sprayed on a base prepared previously, followed by a cover of stone chippings properly rolled to form a wearing course. The existing water-bound macadam surface shall be cleaned thoroughlybefore application of bituminous binder. The work shall be carried out only when the atmospheric temperature in shade is 16 deg C or above. No bituminous material shall normally be applied when the road surface or material is damp, when the weather is foggy or rainy, or during dust storms.

67.16.1 Materials: Binder shall be of specified grade conforming to IS 73 and rate of application shall be as per table and stone chippings shall conform to grading as per the below Table. Unless otherwise specified or directed by the Engineer-in-Charge the quantities of materials shall be as specified in Table. A proper record will be kept to ensure that the daily out-turn of work is co-related with the quantity of bitumen used.

Table 67.10: Rate of Application of Binder

	Stone Chipping			Bitumen Quantity
	Nominal Size	Specification	Quanity	
First Coat	13.2mm	100 percent passing through IS sieve 22.4 mm square mesh and retained on IS Sieve 11.2 mm square mesh	1.5 cum/100 sqm	1.8 kg persqm
Second Coat	11.2mm	100 percent passing through IS sieve 13.2 mmsquare mesh and retained on IS Sieve 5.6 mm square mesh	1.0 cum/100 sqm	1.1 kg persqm

67.16.2 First Coat

(a) Preparation of Existing Sub-base WBM Surface (same as described under preceding sections)

(b) Applying Binder (Hot Bitumen)

The binder shall be heated in a boiler to a temperature 163^0C to 177^0C and maintained at the same temperature. The binder shall be applied evenly to the clean dry surface by means of a pressure sprayer at the rate specified. The binder shall be applied longitudinally along the length of the road and never across it. The edges of the binder surface shall be defined by wire or a rope stretched in position. Heating in cutout drums and pouring from perforated tins, cans and such other methods shall not be permitted. Except inthe case of petty works and repairs with the specific approval of the Engineer-in-Charge.

Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

(c) Blinding or Spreading Stone Chippings

Immediately after the binder is applied and while it is still hot, stone chippings free from dust and in a dryand clean state shall be spread evenly over the surface at the rate specified above. Spreading shall be done preferably by means of a mechanical gritter, otherwise manually with a twisting motion to avoid segregation which otherwise shall have to be removed by brushing the excess stone chippings over the

surface into hungry spots to obtain a uniform surface, free from waviness, depressions and other irregularities. The surface shall be checked by means of a camber board laid across the road and a three metre straight edge laid parallel to the centre line of the road, and undulations if any shall be corrected by addition or removal of blindage till a surface free from undulation is obtained. If a uniform surface is assured at this stage, the completed surface should be normally free from undulations and unevenness.

(d) Consolidation of Blindage

Immediately following the application of the stone chippings and light brooming, the road surface shall be compacted by a power roller of 6 to 8 tonnes, starting at edges and working towards the centre (or to theoutside edge in case of super elevated curve). Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller shall be worked or started and stopped without jerks and shall not be stopped or reversed each time at the same location to cause displacement of stone and other irregularities. Consolidation shall be considered complete when the stone chippings arefirmly embedded.

Generally five to six trips shall be made for thorough compaction of the surface or as may be specified by the Engineer-in-Charge. Along kerbs, manholes and all places not accessible to the roller, compaction shall be secured by means of steel rammers or hand rollers.

67.16.3 Second Coat

(a) Cleaning the Road Surface : The surface shall be examined and any loose material and foreign matter shall be removed by brooming or blowing off by faning with gunny bags, care being taken not to loosen the blindage already set.

(b) Applying Binder (Hot Bitumen) : The second coat of binder shall be applied immediately after the blinding has been set and the surface has been cleaned. The binder shall be applied at the specified rate in the manner specified for the first coat.

(c) Blinding or Spreading Stone Chippings: Immediately after the second application of binder, the stone chippings shall be spread at the specified rate.

(d) Consolidation of Blindage: The specifications described shall apply. Further the prepared finished surface shall be protected from traffic for 24 hours or such period as may be specified by the Engineer-in- Charge.

67.16.4 Surface Finishing

The finished surface shall be uniform and conform to the lines, grades and typical cross-sections shown in the drawings.

The finished surface shall be thrown open to traffic on the following day. Controlling traffic shall be done by suitable methods like barricading posting of watchman etc.

67.16.5 Measurements: The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal. For record purposes, the measurement for binder and stone chippings shall be taken as specified before they are actually used on the work. Pre measurements of materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment.

67.16.6 Rate: The rate shall include the cost of materials and labour involved in all the operations described above.

67.17 TACK COAT OF HOT STRAIGHT RUN BITUMEN

67.17.1 General: The bitumen binders shall be of specified grade and conforming to relevant IS codes.

The rate of application of tack coat be as below

(a) 0.75 kg/sqm on W.B.M. surface.

(b) 0.50 kg/sqm on existing black topped surface.

67.17.2 Materials

Bitumen: This shall be straight-run bitumen of penetration value 80/100 conforming to IS 73 specifications.

67.17.3 Preparation of Surface (same as described under preceding sections)

67.17.4 Application of Tack Coat

Heating: Bitumen shall be heated in a boiler to a temperature of 165 deg. C to 175 deg. C and maintained at that temperature. Temperature shall be checked at regular intervals with the help of a thermometer.

Application of Bitumen: Hot bitumen shall be applied evenly to the clean, dry surface by means of a pressure sprayer at specified rate. Even and uniform distribution of bitumen shall be ensured. Bitumen shall be applied longitudinally along the length of the pavement and never across it. Excessive deposits of bitumen caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably rectified.

67.17.5 Measurements (If not included in bituminous macadam item): Length and breadth shall bemeasured correct to a cm, along the surface of pavement. Area shall be worked out in sqm correct to two places of decimal.

67.17.6 Rate: Rate shall include the cost of all materials and labour involved in all the operations described above.

67.18 PREMIX CARPET WITH HOT BITUMEN

67.18.1 General: This type of treatment is normally applied on roads where the motor traffic is of medium intensity. This treatment is suitable for district roads and for internal and service road in colonies. The consolidated thickness of this type of treatment shall generally be 2 cm or 2.5 cm as specified.

This treatment consists of applying a tack coat on the prepared base followed immediately by spreading aggregates pre-coated with specified binder to camber and consolidated. Premix carpet shall not be laidduring rainy weather or when the base course is damp or wet or, when the atmospheric temperature in the shade is not more than 16^0 C.

67.18.2 Preparation of Surface: This shall be done as described in preceding sections.

67.18.3 Materials: Grading of stone chipping shall be as per Table. Binder shall be as specified. Quantities of materials shall be as given in Table below.

Table 67.11: Grading of Stone Chipping

Consolidated thickness of premix carpet	Binder Hot Bitumen	Stone Chippings (in CuM/ 100 SqM)	
		13.2mm Size	11.2mm size
2.00 cm	52 Kg/CuM of 13.2 mm size and 56 Kg/cuM 11.2 mm	1.80	0.90
2.5 cm	-do-	2.25	1.12

A proper record shall be kept to ensure that the daily out turn of work is correlated with the quantity of bitumen used as per proforma given below.

Table 67.12: Format for Bitumen Record

BITUMEN REGISTER								
Name of Work:								
Name of Contarctor:								
Receipts			Issues					
Date of Receipt	Quantity Received	Progressive Total	Date of Issue	Quantity of Bitumen issued	Total Issue	Daily balance in hand	Contractors signature	Department Engineers Signature
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

Table 67.13: Daily Comparison of Issues with Requirement

Item of work for which issued	Approx. quantity of work done on each day	Theoretical requirement of bitumen for work done on each day	Department Engineers Signature
(10)	(11)	(12)	(13)

67.18.4 Tack Coat: The rate of application of tack coat be as (a) 0.75 kg/sqm on W.B.M. surface and (b) 0.50 kg/sqm

on existing black topped surface. Tack coat shall be applied as described in preceding sections.

67.18.5 Preparation of Premix: The aggregate shall be dry and suitably heated to temperature as directed by Engineer-in-Charge before these are placed in the mixer to facilitate mixing with the binder. Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer-in-Charge, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by Engineer-in-Charge before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be cleaned and be covered over in transit if so directed.

67.18.6 Spreading and Rolling: The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid, rolling shall commence with 8 to 10 tonne power rollers, preferably of smooth wheel tandon type. Rolling shall begin at the edges and progress towards the centre longitudinally. Except on the super elevated portions rolling shall progress from the lower to upper edge, parallel to the centre line of the pavement. The consolidated thickness shall not at any place be less than the specified thickness by more than 25%. However, the average thickness shall not be less than that specified in the item.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may get deformed thereby.

The edges along and transverse of the carpet, laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

Further, the prepared finished surface shall be protected from traffic for 24 hours or such period as may be directed by the Engineer-in-Charge.

67.18.7 Surface Finishing: The surface regularity both in longitudinal and transverse directions shall be within the tolerances specified in Table below

Table 67.14: Tolerance For Surface Regularity Both In Longitudinal And Transverse Directions

Longitudinal Profile Max. permissible undulation when measured with 3 m straight edge	Cross profile Max. permissible variation from specified profile when measured with camber template
10 mm	6 mm

.The longitudinal profile shall be checked during rolling with a three metres long straight edge and graduated wedge at the middle of each traffic lane along the road. Similarly the transverse profile shall be checked with adjustable templates at intervals of 10 metres.

67.18.8 Rectification: Where the surface irregularity fall outside the specified tolerances the contractor shall be liable to rectify it to the satisfaction of Engineer-in-Charge by adding fresh material and re- compacting to specifications where the surface is low. Where the surface is high the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

67.18.9 : Measurements: The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

For record purposes, the measurement for binder and stone chippings shall be taken as specified before they are actually used on the work. Pre-measurements of the materials taken for recordpurposes shall simply serve as a guide and shall not form the basis for payment.

67.18.10 Rate: The rate shall include the cost of materials and labour involved in all the operations described above for the particular item.

67.19 BITUMINOUS PENETRATION MACADAM

67.19.1 Scope: The work shall consist of construction of one or more layers of compacted crushed coarse aggregates with alternate applications or bituminous binder and key aggregates in accordance with the requirements of these specifications to be used as a base course on roads, subject to the requirements of the overall pavement design, in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-Charge. Thickness of an individual course shall be 50 mm or 75 mm or otherwise as specified.

67.19.2 Materials

67.19.2.1Bitumen : The binder shall be paving bitumen of specified penetration grade conforming to IS 73 or approved cutback satisfying the requirement of IS 217 or 454 as specified in item. The actual grade ofbitumen or cutback to be used shall be as specified in item or as directed by the Engineer-in-charge.

67.19.2.2Aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm IS sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where the contractors selected source of aggregate have poor affinity for bitumen, as a condition for approval of the source, the bitumen shall be treated with approved anti-stripping agents, as per the manufacturers recommendations, without additional payment. Before approval of the source the aggregate shall be tested for stripping. The coarse aggregate shall conforming to the table as given under the item "Seal Coat". The coarse and key aggregates shall conform to the grading given in Table 55.12.

67.19.2.3Quantities of Material : The quantities of materials used for this work shall be as specified in Table 55.12 or as specified in item.

67.19.3 Construction Operations

67.19.3.1 Weather and Seasonal Limitations: Laying shall be suspended while free standing water ispresent on the surface to be covered, or during rains, fog and dust storm. After rain, the bituminous surface, tack coat shall be blown off with a high pressure of air jet to remove excess moisture, or the surface left to dry before laying shall start. Laying of bituminous mixture shall not be carried out when theair temperature at the surface on which it is to be laid is below 10°C.

67.19.3.2 Equipment : A mechanical broom, compressor, self propelled or trailed bitumen heater/distributor, mechanical aggregate spreader and 8 to 10 tonne smooth steel wheel roller or vibrating roller are required for the preparation of Penetration Macadam.

67.19.3.3 Preparation of the Base : The preparation of base on which the Penetration Macadam Course shall generally same as described in preceding sections. A prime coat, where specified shall be applied over the base as directed by the Engineer-in-charge.

67.19.3.4 Spreading Coarse Aggregate : The coarse aggregate shall be dry and clean and free from dust, and shall be spread uniformly and evenly at the rate specified in Table 55.12 or as specified. It shall be spread by a self-propelled or tripper tail mounted aggregate spreader capable of spreading aggregate uniformly at the specified rates over the required widths. The surface of the layer shall be carefully checked with camber templates to ensure correct line and level and cross fall. The spreading shall be carried outsuch that the rolling and penetrating operations can be completed on the same day. Segregated aggregates or aggregates contaminated with foreign material shall be removed and replaced.

Table 67.15: Composition of Penetration Macadam

	Cumulative Percent by Weight of Total Aggregate Passing			
	For 50mm compacted thickness		For 75mm compacted thickness	
IS Sieve Designation (mm)	Coarse Aggregate	Key Aggregate	Coarse Aggregate	Key Aggregate
(1)	(2)	(3)	(4)	(5)
63	-	-	100	-
45	100	-	58-82	-
26.5	37-72	-	-	100
22.4	-	100	05-27	50-75
13.2	02-20	50-75	-	-
11.2	-	-	-	05-25
5.6	-	05-25	-	-
2.8	00-05	00-05	00-05	00-05
Approx. Loose aggregate quantities cm/m^2	00.06	0.015	0.09	0.018
Binding Quantity (Penetration Grade), Kg/m^2	As Specified in Item		As Specified in Item	
Note: (1) If cutback bitumen is used, adjust binder quantity such that the residual bitumen is equal to the values in this table.				

67.19.3.5Compaction : After the spreading of course aggregates, dry rolling shall be carried out with an 8 -10 tonne smooth steel wheel roller. After initial dry rolling the surface shall be checked with a crown and 3 metre straight edge. The surface shall not vary more than 10 mm from the template or straight edge. All surface irregularities exceeding the above limit shall be corrected by removing or adding aggregate as required the rolling shall continue until the compacted coarse aggregate has a firm surface, true to cross-section shown on the plans and has a texture that will allow free and uniform penetration of the bitumen material.

Compaction shall be done as per following procedure.

Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surfacelevel, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weighthaving nine wheels, with a type pressure of at least 5.6 kg/cm^2. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

Where compaction is to be determined by density of cores the requirements to prove the performance ofrollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level ofcompaction and finish at temperature above the minimum specified rolling temperature.

Laying trials shall then demonstrate the acceptability of the plant and method used. Bituminus materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pnueumatic-tyred roller, at least the nominal width

of 300 mm.

In portions with super-elevated and uni-directional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge. Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter onthe pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moistwith water and the spray system provided with the machined shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels ofrollers and the mixture should be used. Surplus water shall not be allowd to stand on the partially compacted pavement. After initial dry rolling, the surface shall be checked with a crown template and a 3metre straightedge. The surface shall not vary more than 10mm from the template or straight-edge. All surface irregularity exceeding the above limit shall be corrected by removing or adding aggregates as required. The rolling shall continue until the compacted coarse aggregate has a firm surface true to the cross section shown on the plans and has a texture that will allow free and uniform penetration of the bitumen material.

67.19.3.6 Application of Bituminous Material : After the coarse aggregate has been rolled and checked, the bituminous binder shall be applied at the rate given in Table 55.12 or as specified, at a temperature directed by Engineer-in-Charge.

At the time of applying the binder, the aggregates shall be surface dry for the full depth of the layer. In certain circumstances, depending on the type and size of aggregate used, the Engineer-in-Charge maydirect the placing of a bed of clean sand or quarry fines, not exceeding 10 mm in thickness, on the prepared foundation before placing the coarse aggregate. The sand or fine material shall be slightly wetted, just sufficient for it to slurry up during the compaction process. Where cut back is used, if flooding of the binder occurs it should be applied in two operations, or as directed by the Engineer-in-charge.

67.19.3.7 Application of Key Aggregates: Immediately after the first application of bitumen, the key aggregates, which shall be clean, dry and free from dust shall be spread uniformly over the surface by means of an approved mechanical spreader or by approved manual methods at the rate specified in 55.12 or as specified.

Where directed by the Engineer-in-charge, the surface shall be swept and the quantity of key aggregateadjusted to ensure uniform application, with all the surface voids in the coarse aggregate being filled without excess. The entire surface shall then be rolled with a 8- 10 tonnes smooth steel wheel roller (or vibrating roller operating in non-vibratory mode) in accordance with the procedure as specified in preceding sections.

67.19.3.8 Surface Finish and Quality Control: The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH specifications.

67.19.3.9 Surfacing: The penetration Macadam shall be provided with a surfacing (binder/wearing course) within a maximum of forty-eight hours. If there is to be any delay, the penetration macadam shall be covered by a seal coat as specified and directed by Engineer-in-charge. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

67.19.4 Arrangements for Traffic: During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of Engineer-in-Charge.

67.19.5 Measurement for Payment: Penetration Macadam base course shall be measured as finishedwork in square metres.

67.19.6 Rate: The rate includes the cost of all materials, labours and equipment involved in all the operations described above.

67.20 SEAL COAT

67.20.1 Scope: This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

67.20.2 Seal coat shall be of either of the two types specified below:

(A) Liquid seal coat comprising of an application of all layer of bituminous binder followed by a cover of stone chips.

(B) Premixed seal coat comprising of a thin application of the aggregate premixed with bituminous binder.

67.20.3 Materials

67.20.3.1 Binder : The binder shall be of specified grade and its quantity/ content shall be as specified in the item.

67.20.3.2 Stone Chips: Stone chips shall be as specified. The stone chips shall consist of angular frangments of clean, hard, tough and durable rock of uniform quality throughout. They should be free ofsoft or disintegrated stone, organic or other deleterious matter. Stone chips shall be of 6.7 mm size defined as 100 per cent passing through 11.2 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 100 square metre area. The stone chips shall satisfy the qualityrequirements in Table 55.13 bituminous except that the upper limit for water absorption value shall be 1 per cent.

Table 67.17: Quality Requirement of Stone Chips

S.No	I.S.Sieve (mm)	Cumulative % passing by weight of total aggregate
1	0.60	100
2	0.30	95-100
3	0.075	85-100

Table 67.16: Quality Requirement of Stone Chips

S.No	Name of Test	I.S.Code	Acceptance Criteria
1	Grain Size Analysis	IS 2386 Part 1	Max 5% passing IS sieve 75 micron
2	Flakiness and Elongation Index	IS 2386 - Part 4	Max 30 %
3	Los Angeles Abrasion Value	IS 2386 - Part 4	Max 30 %
4	Polished stone value	B.S. 812 (part 114)	Min 55%
5	Soundness (a) Sodium Sulphate (b) Magnesium sulphate	IS 2386 - Part 5	 Max 12 % Max 18 %
6	Water Absorption	IS 2386 - Part 3	Max 2 %
7	Coating and stripping of Bitumen Aggregate Mixture	IS 6241	Min. retained coating 95 %
8	Water Sensitivity retained tensile strength	AASHTOT 283	Min 80%

67.20.3.4 Fine Aggregate : The aggregate shall be sand or grit and shall consist of clean, hard durable,uncoated dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metres per 100 square metres area. Stones or fine aggregate shall be used as specified in item.

67.20.4 Construction Operations

67.20.4.1 Weather and Seasonal Limitations: As described in preceding sections.

67.20.4.2 Preparation of Surface : The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned.

67.20.4.3 Construction of Seal Coat with Stone Chips : Bitumen shall be heated to 163^{O}C - 177^{O}C and sprayed at the rate specified on the dry surface in a uniform manner with a self-propelled mechanical sprayer Immediately after the application of binder, stone chips which shall be clean and dry, shall be spread uniformly at the rate specified on the surface preferably by means of a self -propelled or towed mechanical grit spreader so as to cover the surface completely. If necessary, the surface shall be brushedto ensure uniform spread of chips.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled steel roller, 8-10 tonne static weight vibratory roller, or other equipment approved by theEngineer after laying trials if required. Rolling shall commence at the edges and progress towards the centre except in super-elevated and unidirectional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one third of the track made in the proceeding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particlesare firmly embedded in the binder and present a uniform closed surface.

67.20.4.4 Construction of Seal Coat with Premixed Fine Aggregate: A mixer of appropriate capacity and type approved by the Engineer-in-charge shall be used for preparation of the mixed material. The plan shall have separate dryer arrangements for heating aggregate. The binder shall be heated in boilers of suitable design, approved by the Engineer-in-Charge to the temperature appropriate to the grade of bitumen or as directed by the Engineer-in-Charge. The aggregates shall be dry and suitably heated to atemperature between 150^{O}C and 165^{O}C or as directed by the Engineer-in-charge before these components are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued until the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as a sufficient length has been covered with the premixed material, the surface shall be rolled with an 8-10 tonne smooth-wheeled roller. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

67.20.4.5 Opening to Traffic: In the case of seal coat with premixed fine aggregate traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. In the case of seal coat with stone chips traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer-in-charge may open the road to traffic immediately after rolling, but in such case traffic speed shall be rigorously limited to 16 km. per hour untilthe following day

67.20.5 Measurement for Payment: Seal coat, for both items shall be measured as finished work over the area specified to be covered, in square metres at the thickness specified in the item.

67.20.6 Rate: The rate for seal coat shall be cost of all materials, labour and equipment involved in operation described above.

67.21 ROAD MARKINGS STRIPS

The colour width and layout of road makings shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35, and as specified in the drawings or as directed by the Engineer-in-Charge.

67.21.1 Materials: Road markings shall be of ordinary road marking paint (retro-reflective) or hot applied thermoplastic compound as specified in the item.

67.21.2 Hot Applied Thermoplastic Road Marking: The thermoplastic material shall be homogenously composed of aggregate, pigment, resins and glass reflectorizing beads and shall conform to ASTM D36/BS-3262-(Part I). The thermoplastic compound shall be screeded/ extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic

67.21.3 Sampling and Testing: The thermoplastic material shall be sampled and tested in accordancewith the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer-in-Charge a copy ofcertified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

67.21.4 Application: Marking shall be done by fully /semi automatic paint applicator machine fitted withprofile shoe, glass beads dispenser, propane tank heater and profile shoe heater, driven by experiencedoperator as specified in item. For locations where painting cannot be done by machine, approved manual methods shall be used

with prior approval of the Engineer-in-charge. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer tothe laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer or otherwise directed by the Engineer-in-Charge for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint. Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. The minimum thickness specified is exclusive of surface applied glass beads. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed.

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

67.21.5 Measurements for Payment: The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any) correct upto the two places of decimal. The rate include the cost of all materials, labour and equipments required in all the above.

67.22 GRANULAR SUB-BASE (GSB)

67.22.1 Scope:

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-charge.

67.22.2 Materials:

The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the grading given in Table below and physical requirement given in Table below Gradings III and IV shall preferably be used in lower sub-base. Grading V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

If the water absorption of the aggregate determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the aggregate shall be tested for Wet Aggregate Impact Value (AIV) (IS: 5640). Soft aggregates like Kankar, Brick ballast and laterite shall also be tested for Wet AIV (IS: 5640).

Table 67.18: GRADING FOR GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	--	--	--	100	--
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	--	--	35-65	55-75

4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	--	--	10-20	10-25
0.85 mm	--	--	--	--	2-10	--
0.425 mm	10-15	10-15	--	--	0-5	0-8
0.075 mm	<5	<5	<5	<5	--	0-3

Table 67.19: PHYSICAL REQUIREMENTS FOR MATERIALS FOR GRANULAR SUB-BASE

Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 Maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

67.22.3 Construction Operations

67.22.3.1 Preparation of Sub-Grade:

The surface of the sub grade to receive the Granular Sub-base shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80 – 100 kN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for GSB. Where the existing surface over which the sub base of GSB is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the GSB is laid.

67.22.3.2 Spreading and compacting:

The sub-base material of grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720 (Part 8). The mix shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer-in-charge. Moisture content of the mix shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 per cent below the optimum moisture content (OMC).

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall or on super elevation. For carriageway having crossfall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS : 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

67.22.4Measurements

Granular sub-base shall be measured as finished work in position in cubic metres. The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

67.22.5 Rate

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including all labour, tools, equipments, machinery and incidentals to complete the work to the specifications as described above.

67.23 WET MIX MACADAM (WMM) SUB-BASE/BASE

67.23.1 Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer-in-charge.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub- base course may be increased to 200 mm upon approval of the Engineer-in-charge.

67.23.2 Materials: - Aggregates: Physical requirements

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table below. If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS:2386(Part-5).

Table 67.20: PHYSICAL REQUIRMENTS OF COARSE AGGREGATES FOR SUB-BASE/BASE COURSES

	Test	Test Method	Requirement
1.	Los Angeles	IS:2386 (Part-4)	40 per cent (Max.)

2.	Abrasion value or Aggregate impact value Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-4) or IS:5640 IS:2386 (Part-1)	30 per cent (Max.) 35 per cent (Max.)*

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

Grading requirements: The aggregates shall conform to the grading given in Table **below**.

Table 67.21 GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per cent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	---
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-5

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6. The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

67.23.3 Construction Operations

Preparation of base : The surface of the sub grade / sub base / base to receive the Wet Mix Macadam shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80-100 kN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for WMM. Where the existing surface over which the sub base of WMM is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the WMM is laid.

Provision of lateral confinement of aggregates: While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer.

Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled, addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers. Optimum moisture for mixing shall be determined in accordance with IS:2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed

limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix : Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.
The mix may be spread either by a paver finisher.
The paver finisher shall be self-propelled of adequate capacity with the following features:

(i) Loading hoppers and suitable distribution system. So as to provide a smooth uninterrupted material flow for different layer thickness from the tipper to the screed.

(ii) Hydraulically operated telescopic screed for paving width upto 8.5 metre and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.

(iii) Automatic leveling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure. In exceptional cases where it is not possible for the paver to be utilized mechanical means like motor grader may be used with the prior approval of the Engineer-in-charge. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine panicles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

The Engineer-in-charge may permit manual mixing and / or laying of Wet Mix Macadam, where small quantity of WMM is to be executed. Manual mixing / layhing in inaccessible / remote locations and in situations where use of machinery is not feasible can also be permitted. Were manual mixing / laying is intended to be used, the same shall be done with the approval of the Engineer-in-charge.

67.23.4 Compaction: After the mix has seen laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN with an arrangement for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one-third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8)

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

67.23.5 Setting and drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

67.23.6 Opening to Traffic

No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

67.23.7 Surface Evenness

All work perform shall confirm to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer-in-charge, subject to the permitted tolerances described herein after.

67.23.8 Horizontal Alignment

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriage way as constructed shall be correct within a tolerance of ± 10 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 25 mm.

67.23.9 Surface Levels

The levels of the Sub-base / base course as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer-in-charge beyond the tolerances mentioned as below:

TOLERANCES IN SURFACE LEVELS OF WMM

Sub-base

(a) Flexible pavement ± 10 mm
(b) Concrete pavement ± 06 mm

Base course flexible pavement

(a) Bituminous Base / Binder Course ± 06 mm
(b) Granular

(i) Machine laid± 10 mm
(ii) Manually laid ± 15 mm

For checking compliance with the above requirement for sub-base / base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely.

The longitudinal profile shall be checked with a 3 metre long straight edge / moving straight-edge as desired by the Engineer-in-charge at the middle of each traffic lane along a line parallel to the centre line of the road.

67.23.10 Measurements

Wet Mix Macadam shall be measured as finished work in position in cubic metres. The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer- in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

67.23.11 Rates

The contract unit rate for Wet Mix Macadam shall be payment in full for carrying out the required operations including all labour, tools, equipments machinery and incidentals to complete the work to the specification as described above.

Note: - For construction of new bituminous road the latest version of relevant IRC codes shall be followed. The CBR value of the soil subgrade shall be determined as per IS 2720(Part 16) and IRC :37 (latest version) and based on the CBR value the appropriate cross section details of various layers of road as per standard drawing issued by department shall be followed.

67.24. PRIME COAT OVER GRANULAR BASE

67.24.1Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

67.24.2Materials

67.24.2.1 Primer: - The primer shall be cationic bitumen emulsion SS1 grade conforming to IS:8887 or medium curing cutback bitumen conforming to IS:217 or as specified in the contract.

67.24.2.2 Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as given in Table 67.22 or as specified in the item of contract.

Table 67.22: Quantity of Bitumen Emulsion for various types of Granular Surfaces

Type of Surface	Rate of Spray (kg/sqm)
WMM/WBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9-1.2

67.24.2.3 Cutback for primer shall not be prepared at the site. Type and quantity of cutback bitumen for various types of granular surface shall be as given in the Table 67.23.

Table 67.23 Type and Quantity of Cutback Bitumen for various types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (kg/sq.m)
WMM/WBM	MC 30	0.6-0.9
Stabilized soil bases/Crusher Run Macadam	MC 70	0.9-1.2

67.24.2.4 The correct quantity of primer shall be decided by the Engineer-in-Charge and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10mm.

67.24.3Construction

67.24.3.1 Equipment

The primer shall be applied by a self propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer-in-Charge.

67.24.3.2 Preparation of Road Surface

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/moorum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

67.24.3.3 Application of Bituminous Primer

After preparation of the road surface the primer shall be sprayed uniformity at the specified rate as per item of contract. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively though the jets of the spray and to cover the surface uniformity.

67.24.3.4 Curing of Primer and Opening to Traffic

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

67.24.4Measurement for Payment

Prime coat shall be measured in terms of surface area of application in square metres.

67.24.5 Rate

The contract unit rate for prime coat shall be payment in full for carrying out the required

operations i/c all equipments, labour and machinery as described above.

67.25 TACK COAT WITH BITUMEN - EMULSION/ HOT BITUMEN OF GRADE VG- 10

67.25.1Scope

The work shall consist of the application of single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, as specified in the contractor or as instructed by the Engineer-in-Charge and applied as specified in the nomenclature of item.

67.25.2Materials

The binder used for tack coat shall be either cationic bitumen emulsion (RS1) complying with IS:8887 or suitable low viscosity paving bitumen of VG 10 grade conforming to IS:73. The use of cutback bitumen RC:70 as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer-in-Charge. The type and grade of binder for tack coat shall be as specified in the contract or as directed by the Engineer-in-Charge.

67.25.3Construction

67.25.3.1 Equipment

The tack shall be applied by a self propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer-in-Charge.

67.25.3.2 Preparation of Base

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material, and be otherwise prepared in accordance with the requirements. The granular or stabilized surfaces shall be primed as per Para 16.65 clause (priming coat) immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer-in-Charge.

67.25.3.3 Application of Tack Coat

The application of tack coat shall be at the rate specified in Table 16.17A and it shall be applied uniformity. If rate of application of tack coat is not specified in the contract, then it shall be the rate specified in Table given below. No dilution or heating at site RS1 bitumen emulsion shall be permitted. Paving bitumen if use for tack coat shall be heated to appropriate temperature in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20 C to 70 C and for cutback, 50 C to 80 C. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed or forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Table 67.24:

Type of Surface	Rate of Spray of Binder in Kg per sq.m
Bituminous surfaces	0.20-0.30
Granular surfaces treated with primer	0.25-0.30

Cement concrete pavement	0.30-0.35

67.25.3.4 Curing of Tack Coat

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

67.25.4 Measurement of Payment

Tack coat shall be measured in terms of surface area of application in square metres.

67.25.5 Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components i.e. labour, equipments and machinery as described above.

67.26 DENSE GRADED BITUMINOUS MACADAM (DBM)

DBM have a void content of 3 to 5% whereas the void content in bituminous macadam is 20 to 25% higher than DBM.

67.26.1 Scope

Dense Bituminous Macadam (DBM) for use mainly but not exclusively, for in base/binder and profile corrective courses. DBM is also used as road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

67.26.2 Material

67.26.2.1 Bitumen : The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, or as otherwise specified in the item. The type and grade of bitumen to be used shall be specified in the item of Contract. Where modified bitumen is specified, it shall conform to the requirements of IRC:SP:53 and IS:15462.

Section criteria for viscosity grade bitumen, based on highest and lowest daily mean temperatures at a particular site are given in Table 67.7

Selection criteria for modified bitumen shall be in accordance with IRC:SP53.

67.26.2.2 Coarse Aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm IS Sieve. They shall be clean, hard, durable, or cubical shape, free from dust and soft or friable matter, organic or other deleterious substance. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the physical requirements specified in Table 67.25, for dense bituminous macadam.

Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm IS Sieve shall have at least two fractured faces.

67.26.2.3 Fine Aggregates: Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm IS Sieve and retained on the 75 micron sieve. These shall be clean, hard, durable, dry and free from dust and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the fine aggregate may be allowed in base

courses.

The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirements of IS 2720 (Part 37).

The plasticity index of the fraction passing the 0.425 mm IS Sieve shall not exceed 4, when tested in accordance with IS 2720 (Part 5).

TABLE 67.25

Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size anlysis7	Max 5% passing 0.075mm sieve.	IS:2386 Part 1
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS:2386 Part 1
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS:2386 Part 4
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part 5
Water Absorption	Water Absorption	Max 2%	IS:2386 Part 3
Stripping	Coating and stripping of Bitumen aggregate Mix	Minimum retained coating 95%	IS:6241
Water sensitivity	Retained Tensile Strength**	Min 80%	AASHTO 283

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.
** If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

67.26.2.4 Filler : Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer-in-Charge. The filler shall be graded within the limits indicated in Table 67.26.

TABLE 67.26
Grading Requirements for Mineral Filler

Is Sieve (mm)	Cumulative per cent passing by weight of total aggregate
0.6	100
0.3	95-100
0.075	85-100

The filler shall be free from organic impurities and have a plasticity index not greater than 4. The Plasticity Index requirements shall not apply if filler is cement or lime. Where the

aggregates fail to meet the requirements of the water sensitivity test in Table 16.35, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly.

67.26.2.5 Aggregate Grading and Binder Content: When tested in accordance with IS 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 67.27 for dense bituminous macadam. To avoid gap grading the combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

TABLE 67.27 Composition of Dense Graded Bituminous Macadam Pavement Layers

Mix Designation	Grading 2
Nominal aggregate size*	26.5 mm
Layer Thickness	50-75 mm
IS Sieve[1] (mm)	Cumulative % by weight of total aggregate passing
37.5	100
26.5	90-100
19	71-95
13.2	56-80
4.75	38-54
2.36	28-42
0.3	7-21
0.075	2-8
Bitumen content percent by mass of total mix (Marshal method)	Min 4.5** or as specified in the item / As per Mix Design
Bitumen grade	As specified in item or directed otherwise.

* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.
** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30º C or lower and lowest daily air temperature is – 10 º C or lower, the bitumen content may be increased by 0.5 percent.

67.26.3Construction Operations

67.26.3.1 Preparation of Base : The base on which DBM is to be laid shall be prepared, shaped and compacted to the required profile as appropriate or as directed by the Engineer-in-charge. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air, in locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer-in-charge.

67.26.3.2 Tack Coat : Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied as specified, in accordance with the provisions of para 67.25, or as directed by the Engineer-in-Charge.

67.26.3.3 Mixing and Transportation of the Mixture : The provisions are as specified in the para 67.11.3.4 shall apply. Table 67.8 gives the mixing laying and rolling temperature for dense mixes using viscosity grade bitumen. In case of modified bitumen, the temperature of mixing and compaction shall be higher than the mix with viscosity grade bitumen. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per the recommendations of the manufacturer. In order to have uniform quality, the plant shall be

calibrated from time to time.

67.26.3.4 Spreading : The provisions are as specified in the para 16.47.3.5 shall apply. The paver finisher shall be fitted with electronic sensor device.

67.26.3.5 Rolling / Compaction & Joints : The provisions are as specified in the relevant para shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer-in-charge in writing.

67.26.4Opening to Traffic : The newly laid surface shall not be open to traffic for at least 24 hours after laying the completion of compaction, without the approval of the Engineer-in-Charge in writing, on the surface until the DBM layer has cooled to the ambient temperature.

67.26.5 Surface Finish and Quality Control of Work : The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH Specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH Specifications.

67.26.6 Arrangement for Traffic : During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of the Engineer-in- charge.

67.26.7 Measurement

Dense Bituminous Macadam shall be measured as finished work in cubic meters, correct to two places of decimal.

67.26.8 Rate

The rate includes the cost of all material, labour, machineries and equipments in all the operations described above.

67.27 DENSE BITUMINOUS CONCRETE

67.27.1Scope

Dense Bituminous Concrete (DBC), is used in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer in a single layer shall be 30 mm / 40 mm / 50 mm thick or as specified in item.

67.27.2 Materials

67.27.2.1 Bitumen: The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, or as otherwise specified in the item. The type and grade of bitumen to be used shall be specified in the item of Contract. Where modified bitumen is specified, it shall conform to the requirements of IRC:SP:53 and IS:15462.

Section criteria for viscosity grade bitumen, based on highest and lowest daily mean temperatures at a particular site are given in 67.11.3.2 Selection criteria for modified bitumen shall be in accordance with IRC:SP53.

67.27.2.2 Coarse Aggregates : Same as specified in para 67.26.2.2 excepting strength which shall be max 30% for Los Angeles Abrasion Value and Aggregate Impact Value of max

24%. Where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

67.27.2.3 Fine Aggregates : The fine aggregates shall be all as specified in para 67.26.2.3.

67.27.2.4 Filler : Filler shall be generally as specified in para 67.26.2.4.

67.27.2.5 Aggregate Grading and Binder Content : When tested in accordance with IS 2386 part 1 (wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table 67.28 for grading 1 or 2 specified in the contract.

TABLE 67.28
Composition of Bituminous Concrete Pavement Layers

Grading	1	2
Nominal aggregate size*	19 mm	13.2 mm
Layer Thickness	50 mm	30-40 mm
IS Sieve[1] (mm)	Cumulative % by weight of total aggregate passing	
45	-	-
37.5	-	-
26.5	100	-
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min. 5.2* or as specified in the item	Min. 5.4** or as specified in the item
Bitumen grade	Specified in item or directed otherwise	Specified in item or directed otherwise

*

The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30º C or lower and lowest daily air temperature is – 10 º C or lower, the bitumen content may be increased by 0.5 percent.

67.27.3 Construction Operations

67.27.3.1 Preparation of Base : The base on which DBC is to be laid shall be prepared, shaped and compacted to the required profile as appropriate or as directed by the Engineer-in-charge. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air, in locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer-in-charge.

67.27.3.2 Tack Coat : Where the material on which the bituminous macadam is to be placed is bitumen bound surface, a tack coat shall be applied as specified, in accordance with Para

16.29, or as directed by the Engineer-in-Charge..

67.27.3.3 Mixing and Transportation of the Mixture : The provisions are same as specified in Para 16.47.3.3 shall apply.

67.27.3.4 Spreading : The provisions are same as specified in Para 16.47.3.5 shall apply.

67.27.3.5 Rolling / Compaction : The provisions are same as specified in Para 16.47.3.6 shall apply.

67.27.4 Opening to Traffic : The newly laid surface shall not be open to traffic for at least 24 hours after laying the completion of compaction, without the approval of the Engineer-in-Charge in writing.

67.27.5 Surface Finish and Quality Control of Work : The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH Specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH Specifications

67.27.6 Arrangement for Traffic : During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of the Engineer-in-charge.

67.27.7 Measurement

Dense Bituminous Concrete shall be measured as finished work in cubic meters, correct to two places of decimal.

67.27.8 Rate

The rate includes the cost of all material, labour, machineries and equipments in all the operations described above.

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68 FENCING WORK WITH BARBED WIRE, CHAIN LINK AND CONCERTINA

The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer-in-Charge.

68.1 M.S. POSTS AND STRUTS

All the M.S. posts/struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and struts shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and struts shall be of sizes and lengths as specified in the tender schedule and drawing. The posts and struts shall have split ends for proper fixing and shall be embedded in the cement concrete of mix. 1:2:4 or as specified in the schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

68.2 R.C.C. POSTS AND STRUTS

All the posts and struts shall be of standard size as specified in schedule. These shall be casted on suitable places/platforms in cement concrete 1:1.5:3 (1 cement : 1.5 coarse sand : 3 graded stone aggregate 12.5 mm. nominal size) as per relevant specifications stipulated here-in-before. The reinforcement shall be provided as shown in the drawings, as directed by Engineer-in-Charge and specified here-in-before under relevant sections.

The posts and struts shall be free from honeycombing, cracks and other defects.
After casting, the posts/struts shall be left at the same place and cured for a minimum period of 7 days. After 7 days curing the same shall be shifted to a levelled ground and stacked for further curing for 14 days. After 21 days of curing only, the posts/struts shall be transported to work site without any damage, for fixing in position.

68.3 SPACING OF THE POSTS AND STRUTS

The spacing of posts shall be 3 m. centre to centre unless otherwise specified or as directed by the Engineer-in Charge, to suit the dimensions of the area to be fenced. Every 10th posts, last but one end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer-in-Charge. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

68.4 FIXING OF M.S./R.C.C. POSTS AND STRUTS

Pits of size 45 x 45 x 45 cm. deep or of sizes mentioned in the drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of struts, thepits shall be so excavated, as to receive minimum 15 cm. concrete cover at any point of the struts to suit its inclination or as shown in the drawing.

The pits shall be filled with a layer of 15 cm. thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix. shall then be filled-in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for atleast 7 days to ensure proper curing.

68.5 G.I. BARBED WIRE

The barbed wire shall be of G.I. as specified and it shall generally conform to I.S. 278-2009.
The base metal of the line and point wire shall be of good commercial quality mild steel conforming to IS:280-2006. The line and point wire shall be circular in section, free from scales and other defects and shall be uniformly galvanised if specified.

The line wire shall be in continuous lengths and shall generally be free from signs of welds. It shall be able to withstand Wrapping and unwrapping 8 turns round its diameter.

The barbed wire shall consist of two splices per reel. The barbed wire shall be formed by twisting two lines wires one containing the barbs.

Table 68.1: The barbed wire and its weight

Type	Nominal diameter of wire		Nominaldistance between two barbs in mm	Mass of complete barbed wire (in gm./m.)
	line wire (in mm.)	point wire (in mm.)		
1.	2.50 (12G)	2.50 (12G)	75	146 (136-155)
2.	2.50	2.50	150	114 (108-120)
3.	2.50	2.00 (14G)	75	117 (108-125)
4.	2.50	2.00	150	96 (89-103)
5.	2.24 (13G)	2.00	75	102 (97-106)
6.	2.24	2.00	150	82 (78- 85)

The barbs shall carry four points and shall be formed by twisting two point wires, each two turns, tightly round one line wire, making altogether 4 (four) complete turns. The barbs shall be so finished that the four points are set and locked at right angles to each other.

The barbs shall have a length of not less than 13 mm. and not more than 18 mm. The points shall be sharp and well pointed. Barbs spacing shall be as given in the above table. Wherever required for every 50 reels or part

thereof, samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

Table 56.2: Tensile Properties

Size of line wire Nominaldia (in mm)	Breaking load of line wire		Min. breaking load of complete barbed wire (in Kg.)
	Min. (in Kg.)	Max. (in Kg.)	
2.50 (12G)	216	302	444
2.24 (13G)	128	179	263

On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded as the case may be.

68.5.1 **Fixing of Barbed Wire:** The barbed wire shall be stretched and fixed in number of rows and two diagonals as specified. The bottom row shall be 140 mm. above ground and the rest at 125 mm orat given spacing as per drawing. The diagonals shall be stretched between adjacent posts from top wire

of one post to the bottom wire of the 2nd post. The diagonal wires will be interwoven with horizontal wiresby fixing the odd rows of wires, then the diagonal cross wires and lastly the even rows of wires. The jointing of the barbed wire in between the posts shall not be permitted.

Necessary holes should be tapped in the post and the barbed wire shall be fixed in position by means of'U' clamps or bolts and nuts as specified in drawings. In case of fixing with 'U' clamps, the legs of the 'U' clamps passing through the 10 mm. dia. hole in the R.C.C. post to hold barbed wire shall be turned upand down to get an over-lap of 25 mm. on the face of RCC post. Turn buckles and straining bolts shall be used at the end posts if specified.

68.5.2 **Mode of Measurement:** The work shall be measured in running metre length of fencing correct to a centimetre for the finished work, from centre to centre of the posts.

The rate shall include the cost of labour and materials involved in all the operations described aboveincluding the cost of barbed wire, turn buckle, straining bolts, bolts and the nuts/U clamps including excavation and foundation concrete or as specified in item description for the work.

68.6 CHAIN LINK

The chain link shall be of approved manufacture and of correct size, gauge etc. It shall be of M.S. or G.I. as specified of approved manufacture and of required size, gauge etc. The base materials of the wire shall be of good commercial quality mild steel conforming to IS:280-2006. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanised if specified.

68.6.1 Fixing of the Chain Link Fencing to M.S. or R.C.C post

The chain link of specified height of fencing shall be fixed first to the end post with necessary G.I. approved type U clamps threaded at both the ends and G.I. nut, bolts, washers etc. and with 6 mm.dia. full height M.S./G.I. anchor bar. After fixing the chain link at the end post, it shall be stretched tightlyand fixed to next post one after the other by the above mentioned clamps and bars etc. leaving 50 mm. clearance from the ground and 20 mm. clearance in the case of concrete coping at bottom to avoid rusting. The point at the change in level of the fencing top/bottom, necessary links shall be adjusted suitably as per the manufacturers specification or as directed by the Engineer-in-Charge. The entire chain link fence shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer or as specified in the item/drawing.

68.6.2 **Measurement:** The work shall be measured in running metre length of fencing correct to a centimetre for the finished work from centre to centre of the posts.

The rate shall include the cost of labour and material involved in all the operation described above including the

cost of barbed wire, turn buckle, straining bolts and bolts and the nuts/U clamps, 6 mm. dia.M.S./G.I. anchor bar etc. including excavation and foundation concrete or as specified in item descriptionfor the work.

68.7 CONCERTINA COIL FENCING

68.7.1 Material

i) Angle iron post & strut shall be as specified in item.

ii) Punched tape Concertina coils shall be manufactured using central core of High Tensile G.I. Spring steel core wire of 2.60 mm dia. around which a tape of razor sharp blades(Low carbon G.Istrip)of thickness 0.52mm, is machine crimped. Concertina coil fencing shall be of specified diameter such as 450mm,600mm,750mm,900mm, having 10 to 8 turns(loops) per running metre length of coil and shall be of approved manufacturer.

68.7.2 **Spacing of Posts & Struts**: The spacing of posts shall be 2.4 m or 3.00 m apart centre to centre, unless otherwise specified or as per Engineer-in-Charge to suit the dimension of the area to be fenced. Every 15th last but one end posts and corner posts shall be strutted on both sides and end posts on one side only.

68.7.3 **Fixing of Posts and Struts:** As per drawing and as specified in the item.

68.7.4 **Fixing concertina coil fencing:** Concertina coil fencing shall be fixed on angle iron y-shaped with 9 horizontal reinforced barbed tape (RBT) stud tied with GI staples and GI clips to retain horizontal including necessary bolts or GI barbed wire tied to angle iron all complete as per directions of Engineer-in- Charge with reinforced barbed tape.

68.7.5 **Measurements:** The length of Concertina coil fencing shall be measured correct to a cm forfinished work. Angle iron post & strut shall be paid separately under relevant item.

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69 M. S. CRIMPNET GATE

69.1 MATERIALS

All steel work, pipe frame work and crimp net shall be of sizes and sections as specified and as shown in drawings. They shall generally conform to relevant I.S. specifications. The G.I crimp net shall conform to IS4948-2002.The crimpnet mesh unless otherwise specified, shall be of size 25 x 25 mm.x10 g. and of approved manufacturer.

69.2 INSTALLATION

For each leaf of the gate, the crimp net shall be fixed tightly to internal angle iron frame of required size by means of suitable welding. This internal angle iron frame is then fixed to outer frame of 50 mm. dia. seamless pipes by means of 65 mm. long angle iron lugs welded together. Suitable cleats for the locking arrangement are welded at the height as shown in drawing. Both the leaves of the gates thus be fixed over suitable hinges provided on the side M.S. channel posts of specified sizes. The side post which shall be erected prior to fixing the gates shall be welded with m.s. plates 250 x 150 x 5 mm. at bottom. These posts shall be properly embedded in cement concrete foundations of specified sizes and allowed to set properly. All the assembly mentioned above shall be properly erected correct to line, level, plumb and render easyand proper movement of shutters.

The shutters, channel posts and all other steel parts shall be thoroughly cleaned and painted with red oxide primer of approved make and shade. Final painting with two coats of flat oil/synthetic enamel paints of approved shade and make shall be done as directed by the Engineer-in-Charge and as per specifications.

69.3 MODE OF MEASUREMENT

The length of the gate shall be measured clear in between the side m.s. channel posts and height between the extreme ends of pipes, correct to half centimeter and area worked out in sqm. correct to two places of decimals.

The rate shall include the cost of all materials mentioned above viz. crimpnets, M.S. angles, G.I.pipes,guide plates, channels, base plates, hinges, locking arrangement and other accessories as also necessary excavation in pits, embedding cement concrete, painting etc. all complete. The rates shall bevalid for areas in variance by about (±) 10% in the overall size of the gate.

70 DRAINAGE WORK WITH NP2 CLASS RCC HUME PIPES

70.1 R.C.C. SPUN PIPES

The pipes shall be R.C.C. spun pipes NP2 class, conforming to I.S. 458-2003 and shall be approved by the Engineer-in-Charge for soundness before incorporation in the work

70.2 LAYING R.C.C. SPUN PIPES

The work consist of providing, laying, jointing and testing R.C.C. spun pipe storm water drain of required diameter as mentioned in the schedule to discharge storm water to the main nallah as shown in the drawing.
After the cement concrete cradle has been laid properly, if specified or as directed by the Engineer-in- Charge, the pipes shall be lowered gradually into the trenches over the concrete cradle or bed. Necessary working space/gap for collars shall be made at every joint. Laying of pipe shall proceed upgrade of a slope. The collars shall be slipped-on before the next pipe is laid.

The pipe drain shall rest on the bed at every point through its length. To ensure this the space between the underside of the pipe on the invert of the cradle shall be carefully grouted solid with cement slurry consisting of one part of cement to one part of clean washed sand in such a manner that no void is left. Itshall be ensured that the load of the pipes and the super imposed load of the earth filling is evenly distributed on the cradle or bed.

The contractor shall take precautions to see that no dirt, earth or other foreign matter is allowed on the surface of the cradle or bed of the pipe resting there-on, all to the full satisfaction of the Engineer-in- Charge. After the alignment and grading of the pipes is checked by the authorised representative of the Department, the grouting shall be done with specified stiff mix of cement mortar.

The cradle of concrete shall be allowed to set at least for three days before any pipe is placed on it and the contractor shall take due care in setting the pipe in the cradle so that no damage is occur to the cradle. If any damage to the cradle occurs, it shall be rectified to the satisfaction of Engineer-in-Charge and in any particular case where damage to the cradle is beyond repair in the opinion of the Engineer-in- Charge, the contractor shall cut out the damaged section of the cradle and re do the same at his own expenses to the complete satisfaction of the Engineer-in-Charge.

No pipe shall be laid or placed till the alignment of the pipe drain and its levels and gradient have been carefully checked and found correct/approved by the Engineer-in-Charge.

70.3 JOINTS

The joints for the pipes shall be made by loose collars and the connecting space shall be as minimum as possible. The collars shall be specifically roughened inside to provide a better grip.

The two adjacent pipes will be so designed and manufactured that when butted together concentrically, a dowel is left between the two ends. In this dowel, cement mortar of (1:1) proportion or mix. as specified in the schedule be filled and then between the ends a paste of cement mortar of the same proportions will be placed. The space remaining between the pipe ends and the collar being then caulked with cement mortar of (1:1) or other specified proportion so that an even space appears all round the external diameter of the pipes. All the joints shall be finished off smooth at an angle of 45^0 with the longitudinal axis of the pipe on either side of the collars.

The interior of the pipe drains shall be cleaned off all dirt, cement mortar and superfluous materials andjoints shall be cured for atleast 7 days.

70.4 TESTING OF R.C.C. SPUN PIPES

After sufficient interval has been allowed for the joints to set, the pipe drains will be tested under a water head of at

least 1.2 m. and in no case under a head greater than 1.8 m. of water above the top of the pipes. In addition, the pipe drains shall be examined for leaks of land/sub-soil water making its way through the joints. The contractor shall make the pipe drains water tight against the entrance of land/sub-soil water from outside and also against the leakages of water from the inside of the pipe drains at the test heads specified above to the full satisfaction of the Engineer-in-Charge.

All defective or leaking pipes or joints shall be cut out and replaced and made good by the contractor at his own cost. In case of the joints that may be defective and cannot be made good, shall be entirely embedded/surrounded externally with cement concrete of 1:2:4 proportion to render the joint (s) water tight and this shall be allowed to set before encasing or back filling is done. A strong colour shall be added to the water used for testing of the pipes, in order to detect any leakage easily. The cost of testing of the pipe drain shall be borne by the contractor and is deemed to be included in the rates quoted by the contractor.

70.5 ENGINEER-IN-CHARGE MAY ORDER CONCRETE TO BE INCREASED OR DIMINISHED

The Engineer-in-Charge may increase or decrease the concrete on the pipe drains as to the quantity and quality or to omit the same entirely according to the nature of the ground that may be revealed when the storm water drain trenches are excavated.

70.6 BACK FILLING/FILLING TRENCHES

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 20 cm. watered, rammed and consolidated, taking care that no damage is caused to the pipe below. In case of excavation of trenches in rock, the filling upto a depth of 30 cm. above the crown of pipe or barrel shall be done with fine material such as earth, murrum or pulverised decomposed rock according to the availability at site. The remaining filling shall be done with rock filling or boulders of size not exceeding 15 cm. mixed with fine material as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30 cm.

70.7 MODE OF MEASUREMENT

The length of pipes shall be measured in running metre nearest to a centimetre along the centre line of the pipes over all fittings such as collars, bends, junctions etc. Fittings/specials shall not be measured separately.

The rate shall include the cost of materials and labour including jointing, grouting, cutting of pipes to the required lengths, wastages etc. involved in all the operations described above.

Excavation, back filling, shoring and timbering in trenches and cement concreting wherever required shall be measured separately under relevant items of work.

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71 ROUGH / NATURAL FACED SHAHABAD STONE PAVEMENT

71.1 MATERIALS

Hand cut rough/natural faced shahabad stone shall be of the best quality and of the specified thickness, size etc. and shall be got approved by the Engineer-in-Charge. The sizes given in schedule of quantities are tentative and can vary only slightly as per the availability in the market. At its thinnest, no stone shall be thinner than specified thickness. The stone shall be hard, sound, durable, tough, free from flaws, cracks, decay & weathering. The edges shall be hand cut and dressed true and squares. The evenness of surfaces and edges of the slabs shall not be marred by careless dressing or handling and no patching up shall be allowed for the slab. The edges shall be reasonably straight. The under face may be left as required or rough dressed. Before taking up the work, samples of stone slabs to be used and their dressing shall be got approved by the Engineer-in-Charge. The work shall be carried out strictly in accordance with the approved samples.

71.2 BEDDING/BACKING COAT

In case of plinth protection or other pavements over concrete sub base, the mortar bedding shall be of cement mortar of thickness and mix specified in the item of tender schedule.
In case of pavement work for footpaths, approaches and other similar works, to be laid directly over levelled and consolidated ground, the bedding shall be of 150 mm. thick quarry spoil and 60 mm. thick stone grit or as specified/directed by the Engineer-in-Charge.

71.3 LAYING AND FIXING THE STONE SLABS/ TILES

The specifications for Kotah stone flooring/skirting/facia described here-in-before shall hold good as far as it is applicable except that the joints shall be pointed with C.M. 1:3 or with other specified mix, finished flush/with grooves as specified/directed. The joints shall be raked out uniformly to a depth of not less than 12 mm. before grouting and pointing the same.

71.4 CURING

The pavement work shall be kept well wetted for atleast seven days.

71.5 CLEANING

When the bedding and joints have completed, set and attained required strength, the surface shall be thoroughly cleaned and handed over free from any mortar stains, dust, dirt etc.

71.6 MODE OF MEASUREMENT

The above pavement work shall be measured in square metre correct to two places of decimal. The length and breadth shall be measured net correct to a centimetre. The pavement under skirting/dado/wall plaster, if any, shall not be measured for payment.

No deduction shall be made nor extra paid for any opening of area up to 0.10 sqm. Nothing extra shall be paid for use of cut tiles/slabs nor for laying the pavement at different levels.

NOTE : Wastage in obtaining the required sizes as specified from the commercial sizes available in market is deemed to be taken in to consideration by the contractor while quoting the rate. The workshall be measured as above and no extra claim on this account will be entertained.

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72 FACTORY MADE CEMENT CONCRETE INTERLOCKING PAVER BLOCK

72.1 INTERLOCKING PAVER BLOCK

Precast Concrete Blocks for paving shall be conforming to IS 15658 (Latest Revision). Factory made precast cement concrete interlocking paver blocks of specified thickness and specified concrete grade are to be used. Paver blocks of approved size and design are made by block making machine with strong vibratory and pneumatic compaction. Paver block shall be of specified thickness, colour, design and pattern of approved manufacturer. Concrete paver shall conform to the concrete strength as prescribed for the grade specified and shall be free from any defects. For road work the thickness of paver block shall be minimum 80mm and of higher strength (M-40) for footpath or internal road the thickness shall be 60mm and of minimum grade of M30. The paver blocks shall be tested as per the requirements of IS 15658 for different technical parameters in the Government / NABL approved Lab.

72.2 SUB-BASE

Same as described earlier under **55.8** of Specification for road and pavement or as specified in items of work.

72.3 LAYING

Interlocking paver block shall be laid on the compacted bed of 50 mm or specified thick coarse sand of approved specification. Proposed pavement area shall be confined by fixing kerbs, bricks on edge etc. on peripheral edges. The same shall be paid separately. The joints of paver block shall be filled by spreading sand over the laid surface, surface brooming and light tapping for proper interlocking. Area around

peripheral edge should be finished with matching cement mortar. If specified, an anti-moss/anti-algae treatment with water repellent, penetrative waterproofing chemical spray of approved manufacturer shallbe applied on top surface of paver block as per manufacturer\"s specification.

72.4 MEASUREMENT & RATES

Area provided with paver block shall be measured in sqm. correct upto two places of decimal. The rate includes the cost of materials, labour, tools etc. required in all the operations described above. Sub baseshall be paid under relevant items.

73.0 KERB STONE (PRECAST)

73.1 **Laying:** Trenches shall first be made along the edge of the wearing course of the road to receivethe kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion. The kerb stones with top 12.5cm wide or as specified shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the water channel (of concrete or natural stone) and shall project about 12.5 cm. above the latter. The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer-in-Charge for connecting to storm water drains.

73.2 Finishing: Berms and road edges shall be restored and all surplus earth including rubbish etc.disposed off as directed by the Engineer-in-charge. Nothing extra shall be paid for this.

73.3 Measurements: Kerb stone shall be measured in running meters with Length of the finished work(for specified width and height of stone) along the edge of the road correct to a cm.

73.4 Rate: The rate shall include the cost of all the materials and labour involved in all the operationsdescribed above.

74. STRUCTURAL AUDITING OF BUILDINGS

74.1 General: The structural condition and performance of any civil engineering structure deteriorates gradually over the period of time as the structure becomes old. The causes of deterioration are attributed to many factors like quality of raw materials used at the time of construction, workmanship exercised at the time of construction, Environmental exposure conditions, misuse and overloading of the structure, additions and alterations done in the structure, so and so forth. But whatever may be the reasons, it is very important to prevent the structures from getting deteriorated by assessing the reasons and carrying out the necessary preventive measures as required in a time bound manner.

Structural health assessment of any civil engineering structure is done through Structural Auditing of the said structure. It is a detailed technical survey carried out to assess the overall structural health and performance of an old structure by a qualified and certified structural Engineer.

As per the Clause No. 77 of Co-operative Housing Society Bye-Laws and BMC Bye laws clause No. 353B , structural auditing is mandatory as follows:

For buildings aging between 15 to 30 years---- Once in every 5 Years

For buildings aging more than 30 years---- Once in every 3 Years

After structural auditing, necessary structural repairing/retrofitting work as recommended in the structural audit report need to be carried out.

74.2 Stages of Structural Audit:

74.2.1 Visual Inspection:

74.2.1.1 Study of available Architectural drawings:

i) To get general information about the type of structure like residential, commercial, institutional etc, structural lay-out, No. of floors, stilt/ground floor, basements if any, location and no. of staircases and lifts, fire escape areas, water tanks etc.

ii) To get information about different type of occupancies in the building as per the original plan and compare with the actual present use

iii) To assess the additions and alterations done

iv) To know about location of internal partition walls and other features

If Architectural drawings are not available, then representative architectural floor plans are to be prepared for the purpose of structural auditing.

74.2.1.2 Study of available Structural drawings:

i) To get information about different types of structural materials used such as grade of Concrete, Grade of reinforcement steel, Grade of structural steel etc.

ii) To get datails of type of foundation adopted and depth of foundation etc

iii) Reinforcement details for various structural elements

iv) Cover provided to different structural elements

v) Information regarding overall design criteria of the building like important codes followed for design, whether the structure is designed for earthquake resistance or not, exposure condition considered in the design etc

74.2.1.3 Collecting Information and record of maintenance works carried out in the past :

i) Internal and external structural repairing done

ii) Additions and/or alterations done in the existing structure

iii) Repairing of the terrace waterproofing work

iv) Maintenance history of the structure, Materials used in the past repairing works and their performance etc

74.2.1.4 Site visit and Inspection

A detailed site inspection is to be carried out to get the following information about the structure.

i) Name and address of the building/structure.

ii) Any settlement in the foundation and ground floor

iii) Plinth level of the structure w.r.t. the surrounding road level and high flood level if available

iv) Cracks in non-structural elements like external and internal wall, chajjas, fins, facia drops etc.

v) Cracks in structural elements like Columns, Beams, Slabs etc.

vi) Type of cracks like hair cracks, shrinkage cracks, minor/major cracks

vii) Level of corrosion in reinforcement steels

viii) Delamination of plasters or cover concrete from various RCC elements exposing the reinforcement steels.

ix) Buckling of exposed reinforcement bars in columns

x) Deflection of horizontal structural and non-structural members like beams, slabs and lintels etc

xi) Leakage, seepage or dampness at various locations from external source and internal wet areas.

xii) Growth of vegetation on walls, terrace and chajja tops etc

xiii) Condition and type of terrace waterproofing work existing

xiv) Whether water ponding is seen on terrace.

xv) Whether proper slope is there on terrace waterproofing

xvi) Performance of the past repairing works if any

74.2.2 Evaluation by NDT and Lab. Tests:

74.2.2.1 Non-destructive tests

The purpose of non-destructive test (NDT) is to determine the quality and integrity of materials, elements of the structure or the structure as a whole without affecting the ability of the structure to perform its intended purpose. There are various non-destructive tests conducted on Civil Engineering structures as per the requirement. But in view of the limitations of the NDTs and the various factors which affect the results of each NDT, it is very essential and also recommended by relevant IS codes that the results of one method of NDT shall be complemented by other tests and each method shall be adopted carefully. As a guideline the following general notes shall be adopted for all structural auditing works;

(i) Consultants / Firms are advised to visit the site of work at their own cost and quote the rates accordingly.

(ii)All Structural Audit work must be carried out in conformity with latest relevant Indian Standard Codes for Plain and Reinforced concrete (IS 456-2000), Method of test for Strength of concrete (IS 516), Properties of Hardened concrete other than strength (IS 516: part 2: sec 1: 2018), Sampling, preparing and testing of concrete cores (IS 516: part 4: 2018), Ultrasonic pulse velocity testing of hardened concrete (IS 516: part 5: sec 1: 2018), Half-cell potentials of uncoated reinforcing steel in concrete (IS 516: part 5: sec 2: 2021), Carbonation depth test in Hardened concrete (IS 516: part 5: sec 3 - 2021), Rebound hammer test of hardened concrete (IS 516: part 5: sec 4: 2020), Determination of water soluble and acid soluble chlorides in hardened mortar and concrete (IS 516: part 12, if published, otherwise IS 14959: part 2: 2001), Methods of sampling and analysis of concrete (IS 1199), Standard test method for Pull-out strength of Hardened concrete (ASTM C900-19), Determination of chloride and sulfate in hardened concrete and aggregates (AS 1012.20.1:2016) and various other standard specifications for Sampling, tests and recommendations.

(iii) Structural Audit Agency shall ensure that all testing equipments / instruments are properly calibrated before commencement of work. Agency shall arrange calibration of instruments at NABL approved lab in presence of department representative & test report shall be submitted to Engineer-in-charge for record. All necessary cost on account of same shall be borne by agency.

(iv) All the Laboratory tests are to be conducted in approved NABL laboratory in presence of departmental representatives.

(v) For co-relation purpose, Rebound Hammer test and USPV test must be done at all locations from where core samples are collected or pull-out test is conducted and the results should be presented in tabular form.

(vi) Debris generated during the removal of concrete / plaster etc. shall be disposed of within the colony at the designated place or as directed by Engineer-in-charge with all leads, loading, unloading etc. all complete without any extra cost to the Department.

(vii) Filling, plastering & painting of all the removed surfaces or drilled holes shall be done by contractor after conducting various tests to bring member / structure to original condition as directed by Engineer-in-charge and all the expenses including tools & equipments, material, labour etc. all complete shall be borne by contractor.

(viii) The rates quoted by the Consultant shall be inclusive of all scaffolding, hoists, tools, equipments, instruments, material, labour etc., required for the smooth execution and completion of the work. No extra amount will be paid for Mobilisation of equipments, personnel, materials required for work including dismantling / removal / demobilisation of same after completion of all field work etc. Also, no extra charges will be paid for lead / lift, loading / unloading, handling/ stacking of materials etc. at site.

(ix) The entire operation of core drilling / cutting and other tests shall be carried out in highly professional manner at locations shown by the Engineer-in-charge. Safety procedures are to be followed strictly while carrying out the on-site tests. Existing re-bars should not be cut in the process of core cutting. Rebar locator shall be used to locate and avoid cutting of rebars.

(x) Three Hard copies along with soft copy in Pendrive of Final Structural Audit report shall be submitted for each building in a phased manner as the work progresses and get completed in some buildings. The report shall clearly describe the brief history of building, observations during visual inspection with coloured photographs, test procedure, reference codes (IS, ASTM, BS, AS etc.) or literature, tests location and results along with calculations, , remedial measures, conclusion etc.and to make necessary recommendations in addition to the routine report of the field work, laboratory work, maintaining field books and to be submitted at the end of work to the department.

74.2.2.2 Additional Notes: - Structural Audit report should include:

(i) Building having different blocks (such as A, B, C, D etc.) shall have one combined Audit report only.

(ii)Hard copy of Draft Structural Audit report shall be submitted for scrutiny and approval by the department and necessary changes shall be incorporated as required before submitting the Final Structural Audit report.

(iii) Layout plan at various floor levels and side elevations of each building showing location of tests, distressed members etc., properly drawn to scale and dimensioned.

(iv) Findings from detailed Visual inspection.

(v) Non-destructive test & Core test results including observations and analysis.

(vi) Suggested remedial measures.

(vii) Clear conclusion stating whether building is habitable / livable or need minor structural repairs or need major structural repairs / retrofitting or to be evacuated.

(viii) Photos of distressed location / members.

(ix) Structural Audit report shall be signed by empanelled Structural Engineer / Structural consultant of BMC / Government agencies / PWD or The Institution of Engineers (India) and copy of registration / empanelment shall be submitted to Engineer-in-charge for record.

(x) All the necessary tools, equipments, instruments, material, labour etc. required for completion of audit shall be part of the scope of work.

(xi) Location of all tests including some additional points for each test will be marked at site as per the test guidelines and standard practice in consultation with EIC as per the feasibility of site and testing.

(xii) Out of all the identified locations, EIC shall approve the required number of each tests as per BOQ for further arrangement of testing.

(xiii) All Core samples shall be clearly labelled indicating date of sampling, test no. etc. and shall be suitably packed / stored before transporting to the laboratory for testing.

74.2.2.3 Detailed chronological record of various tests including core drilling, sampling and other site operations shall be maintained in the field log and should be submitted to Engineer-in-charge after completion of site work. Field log should contain at least the following information: -

(i) Reference information like test no., type of test, location, level, member etc.

(ii) Readings of various field tests like USPV test, rebound hammer test, Half-cell potential test, Carbonation depth test, Cover meter test, Pull-out test etc.

(iii) Core sample diameter and length including complete visual description in "as retrieved state"

(iv) Date and time of all operations and delays with reasons.

(v) Carry out Laboratory tests on samples collected to determine concrete properties as directed by the Engineer-in-charge.

(vi) Carry out Chemical analysis on samples of concrete to determine Chloride content, Sulphate content, pH value including assessing their effect on concrete and indicate corrective measures.

(vii) Audit agency shall give complete calculations showing the basis of the recommendations on field and laboratory tests. For all recommendations, formulas in Indian Standards shall be used or any established literature can be consulted.

(viii) DCSEM reserves the right to ask for clarification and additional information without paying additional charges.

(ix) Structural audit is to be carried out in occupied buildings, therefore, work shall be done in phased manner with least disturbance to residents / occupants. For carrying out tests located inside the flats, the Agency has to co-ordinate with the allottee and carryout the test as per the convenience of the allottee. If the allottee does not co-operate, same shall be brought to the notice of EIC and if required test locations may be changed.

(x) The arrangement of water, electricity, lighting, etc. required for the work should be done as per the conditions of contract. Necessary permission from statutory authority if any shall be obtained by the contractor.

(xi) Contractor shall strictly abide by the local statutory regulations imposed by the Department / Police authorities regarding any equipment, operation, drainage, security, etc., wherever applicable.

74.2.3 Rebound Hammer Test:

Rebound hammer method of NDT can be used for assessing uniformity of concrete quality and the likely compressive strength of the concrete with the help of suitable correlation developed between the rebound hammer number and the compressive strength as per the provisions of the relevant IS codes. In absence of the correlation, the correlation charts provided by the manufacturer of the rebound hammer can be used. For carrying out the rebound hammer test on any structural element, first the existing plaster on the structural element is to be removed over an area of about 150mmx150mm size by carefully cutting and chiseling it without damaging the concrete surface below the plaster. Then the concrete surface so obtained is to be neatly cleaned and smoothened by grinding the surface undulations if any. For taking measurements, the rebound hammer should be held at right angles to the concrete surface and the test is to be conducted as per the standard procedure. Total ten readings are to be taken on each point of observation and then the lower two readings and upper two readings are to be ignored and average of other six readings is to be recorded as rebound hammer number of that point of test.

Because of various limitations of this test and various factors affecting the result of the test, it is recommended to use the result of this test along with result of other NDT like USPV for proper interpretation of the quality and strength of the concrete.

If the USPV is more than 3.5 Km/sec for grades lower than M25 and more than 3.75 Km/Sec for grades higher than M25, then the strength assessed by rebound hammer test is valid otherwise it is invalid and no such assessment shall be made.

For measurement purpose tests carried out at one point shall be considered as one test.

74.2.4 Ultrasonic Pulse Velocity (USPV) Test:

This test is conducted on the structural elements to determine the velocity of the ultrasonic waves in the concrete which is co-related with the quality of the concrete. This test can also be used to check the presence of any cracks, voids or any honeycombing in the concrete. There are three different methods for carrying out this test at site dep ending upon the accessibility of test surfaces of the said structural member. Where the two opposite faces of the structural member is accessible, then direct method is to be adopted. Where two adjacent faces of the structural member is accessible, then semi-direct method is to be adopted. Where only one face of the structural element is accessible, then indirect method is adopted. Direct transmission method is preferable over others.

At the points of testing, the existing plaster/coating etc are to be removed preferably over an area of 150mmx150mm size by cutting and chiseling the plaster carefully without damaging the concrete surface. The surface so obtained is to be neatly cleaned, levelled by grinding the undulations if any. Then petroleum jelly or grease is to be applied on the area of test where transducers and receivers are to be placed to avoid any air gap between the probes and the concrete surface. Then the test is conducted as per the standard procedure of latest relevant IS codes. The reading is recorded when there is no fluctuation in the reading value or the fluctuation is minimum. The result of USPV shall be reported in tabular for with the details of location, method of test, speed in Km/hr and the corresponding quality grading of concrete.

74.2.5 Core Test:

Since this test is semi-destructive in nature, locations of core tests are to first marked at site by the agency as per the general guidelines of NDT and feasibility of extraction of cores considering the accessibility and other aspects. Then out of those locations, structural design section will finalize and approve the location of required number of cores as per BOQ. Dia. of cores should be preferably more than three times of Maximum size of aggregates used in the concrete. Height of the core should be preferably two times of the dia. and should never be less than dia. of core. Existing plaster or repaired micro-concrete layer if any is to be removed prior to preparation of cores for testing. If during core extraction, the core breaks, then separate core is to be taken from other location. Before locating the exact position of core, it should be ensured that no reinforcement is cut in core extraction. After extraction of core, the hole is to be immediately filled up/repaired using micro-concrete. Minimum six specimens of core is to be tested for any individual building. Testing and reporting of the core test is to be done by latest relevant IS codes.

74.2.6 Half-Cell Potential Difference Test:

The objective of this test is to assess the risk of corrosion of the embedded reinforcement in the structural elements. This test is not to be conducted at locations where the reinforcement is exposed due to corrosion and subsequent cracking and spalling. At the proposed location of test, the reinforcement is to be accessed by making a hole in the concrete surface for connecting the positive terminal of the volt meter. Other terminal of the voltmeter is connected to the copper sulphate half cell. The potential difference is measured at three different locations and average is reported with corresponding level/risk of corrosion as per IS 516.

74.2.7: Cover meter test:

This test is conducted to assess the approximate depth of cover existing at different locations of any structural element. This test also identifies the presence of reinforcement and approximate dia. of reinforcement present. This test result is more reliable when the depth of cover is less and the reinforcements are widely spaced. In case of heavy and/or double layered reinforced sections, it is not recommended to use this test for locating the position and dia. of re-bars.

74.2.8 : Pull out Test:

The pull out test is conducted on RCC members to assess the compressive strength of the existing concrete. Test points for pull out test is to be approved by SDS and these tests are to be conducted at locations other than the core testing points. This pull out test shall be conducted as per the latest relevant ASTM/BS codes. The result is to be presented in the form of compressive strength of the existing concrete.

74.2.9 : Lab. Tests:

Sufficient numbers of samples as per the BOQ shall be collected and tested at NABL approved labs for different chemical tests as follows as per the latest relevant IS codes.

i) Chloride Content:

ii) Sulphate Contest:

iii) Ph value

iv) Carbonation depth

Minimum six numbers of specimens are to be tested for each of the above tests for every building. The samples required for these chemical tests may be collected from the core samples taken.

75. REPAIRS TO BUILDING

75.1 REPAIRS TO PLASTER

The work includes cutting the patch and preparing the wall surface. Patches of 2.50 square metres and less in area shall be measured under item of „Repairs to Plaster" under this sub-head. Plastering in patches over 2.5 square metres in area shall be paid for at the rate as applicable to new work under sub head "Finishing".

75.2 SCAFFOLDING

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safelywith the ladder or jhoola these will be permitted in place of scaffolding. Double bamboo scaffolding using minimum 50 to 75 mm dia. good quality bamboos tied with coir ropes with horizontal and vertical spacing not more than 900mm may be used for low rise buildings(height less than 15 mts). The scaffolding is to be tied to the structure at every alternate floors and at the top at terrace level for overall safety and stability of the scaffolding. If the height of building is more than 15 mts, then double steel tubular scaffolding using H frames and cross bracings confirming to the latest relevant IS code has to be used.

75.3 CUTTING

The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow when gentlytapped on the surface, shall be removed. The patch shall be cut out to a square or rectangular shape atposition marked on the wall as directed by the Engineer-in-Charge or his authorized representative. Theedges shall be slightly under cut to provide a neat joint.

75.4 PREPARATION OF SURFACE

The masonry joints which become exposed after removal of old plaster shall be raked out to a minimumdepth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and not with a basuli, and loose mortar dusted off. The surface shall thenbe thoroughly washed with water, and kept wet till plastering is commenced.

In case of concrete surfaces, the same shall be thoroughly scrubbed and roughened with wire brushes after the loose plaster had been removed. The surface shall then be thoroughly washed with water, andkept wet till plastering is commenced.

75.5 APPLICATION OF PLASTER

Mortar of specified mix with the specified sand shall be used. The method of application shall be as described for single coat plaster work of the specified mix and under relevant Chapter. The surface shall be finished even and flush and matching with the old surrounding plaster. All roundings necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified under „Plastering".

All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

75.6 PROTECTIVE MEASURE

Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

75.7 CURING

Curing shall be done as per plaster work with special reference to the particular type of plaster mix as described under sub-head "plastering".

75.8 FINISHING

After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suitthe existing finishing as required unless specified.

75.9 MEASUREMENTS

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment.
Pre-measurements of the patches to be plastered shall be recorded after the old plaster has been cut andwall surface prepared.

75.10 RATE

The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled plaster /material.

75.11 MAKING OPENING IN THE MASONRY CONSTRUCTION AND FIXING CHOWKHATS FOR DOORS, WINDOWS AND CLERESTORY WINDOWS

Before making opening it is necessary to examine that the wall exclusive of opening is adequate to takethe load coming on the structure. All the structural members supported on the walls which have direct bearing over the area in which opening is to be made, shall be properly supported with props to relieve the load from masonry wall till the lintel over the opening is strong enough to take the load. Care should alsobe taken not to disturb the adjoining masonry.

All precautions as explained in Chapter (Demolition and Dismantling) should be followed in case of dismantling the external walls. The portion to be dismantled may be clearly marked on both sides of thewall. Dismantling shall be carried out from top to bottom within the marked area. The sides of the opening shall be as far as possible, parallel and perpendicular to the plane of wall.

75.11.2 Making Opening: The openings for fixing door/window frames shall be to the extent ofaccommodating the hold fast. The hold fasts shall be fixed in cement concrete 1:2:4 (1 cement : 2 coarsesand : 4 stone aggregate 20 mm nominal size) or in masonry as specified. Where only opening is to be made in the masonry, the width of the opening shall be such that the sides of the masonry can be built true to line and plumb and such masonry built shall conform to the specifications of the particular type of masonry in which the opening is made with particular reference to size of corner stones etc. In order to get continuity with old masonry, proper key shall be provided. The height of the opening shall be such that itcan accommodate the required depth of the RCC lintel also.

The sides of opening in masonry shall be cleaned of all dust, mortar, brick bats/loose stones chips etc. and the surface left rough and thoroughly wetted.

The lintel shall be invariably cast first in the opening made for the purpose. One side of the shuttering shall be kept open in the beginning till the concrete is laid. The shuttering shall then be fixed for half of the opening and concreting completed. Curing of lintel casted shall be done for a minimum period of 7 days.Precast RCC lintel or R.S. Joist may also be used if directed by the Engineer-in-Charge.

75.11.3 Fixing Chowkhats:. The sides of chowkhats of door, window or clerestory window abutting against or to

be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The chowkhats shall than be inserted in position with their hold-fasts bolted tight. The chowkhats shall than be adjusted to proper line and plumb and secured in position by temporary bracing which shallnot be disturbed or removed until the hold fasts are embedded in the masonry and the concrete block hasset. The concrete to be used for embedding hold-fasts shall be cement concrete 1:3:6 mix (1 cement : 3coarse sand : 6 graded stone aggregate 20 mm nominal size).

The minimum size of concrete block in which the hold-fasts will be embedded shall be 30 x 10 x 15 cm for 35 cm long holdfasts. The concrete of the block shall completely fill the hole made in the masonry for thepurpose. The chase cut in the floor shall be cut square and construction joint shall be provided filled in with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and rendered smooth at the top and finished to match the existing type of floor.

75.11.4 Finishing: After the surface of the sides of masonry opening and lintel are sufficiently dry and set, it shall be cleaned free of dust, loose mortar etc. and wetted thoroughly. It shall then be plastered or pointed as required flush with the surrounding masonry work. Any other portion of the wall if damaged shall be finished in similar manner. After the cement plaster/pointing has been thoroughly cured and have dried the surface shall be either white or colour washed/painted as required. The surface of the wall which is spoiled due to splashing of mortar shall be cleaned forthwith.

75.11.5 Measurements: The openings made for doors, windows, clerestory windows shall be measured correct to cms and area shall be calculated in square metres correct to two places of decimal.

75.11.6 Rate: The rate shall apply per sqm of opening. The rate is inclusive of labour and material involved in all the operations described above. Cost of Chowkhats, cost of CC blocks, cost of supplying the hold-fasts bolts, cost of R.C.C lintel or R.S. Joist which shall be paid for separately or as specified in item of work.

75.12 PAINTING OLD SURFACE

75.12.1 White wash with lime

Preparation of Surface: In case of old work, all loose particles and scales shall be scrapped off and holes in plaster as well as patches of less than 50 cm area shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer-in-Charge, the entire surface of old white wash shall be thoroughly removed by scrapping and this shall be paid for separately. Where efflorescence is observed the deposits may be brushed clean and washed. The surface shall then be allowed to dry for at least 48 hours beforewhite washing is done

Application: For old work, after the surface has been prepared as described in preceding Para above acoat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patches do not appear. The washing on ceiling should be done prior to that on walls.

All other details such as scaffolding, preparation of lime wash, protective measures and mode of measurements shall be same as described under relevant Chapter of Painting.

75.12.2 Oil Emulsion (Oil Bound) Washable DistemperingPaint Materials: Same as described earlier under painting.

Preparation of the Surface: In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc. Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming coat: For old work no primer coat is necessary.

Distemper Coat: For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

Other Details: The specifications in respect of scaffolding, protective measures and measurements shall be same as described under Chapter „painting".

Rate: The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat, if any) described above.
Generally same specification with respect to preparation of surface, application of paint and other detailsfor old surface shall hold good for painting with interior grade acrylic/plastic emulsion and other type of internal paint.

75.12.3 Varnishing on Old SurfacePreparation of Surface

If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped cleanwith a soft cloth. Knots, holes and cracks shall be stopped with glazier"s putty.The surface shall then begiven a coat of wood filler made by mixing whiting in methylated spirit @1.5kg of whiting per litre of spirit. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish using suitable paint remover and such removal shall be paid for separately outside the rate for varnishing. Further the varnishing itself will have to be done like new work and will be paid for as such.

Application : The specification shall be same as described for new surface as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

Other details shall be as specified earlier as far as they are applicable.

75.12.4 Removing old paint

75.12.4.1 **With Patent Paint Remover:** Patent Paint removers shall consist of volatile organic liquids thickened with waxes and other ingredients to retard the evaporation of the liquid and to enable a substantial layer of remover to be applied to the surface. The Paint remover shall be of a brand and manufacture approved by the Engineer-in-Charge. It shall be free from alkaline matter and non-caustic so that it can be handled by workmen without injury. It shall be of non inflammable quality as far as possible.

75.12.4.2 **Application :** Paint remover shall be used where burning off with blow lamp is not suitable. ThePaint remover shall be applied liberally with a brush and allowed to remain on the surface for a period depending on the particular brand of remover used and on the thickness of the Paint coating to be removed. When the Paint film lifts and wrinkles under the action of the remover it shall be stripped with asharp instrument. If the film is not thoroughly removed a second coat of remover may be applied if necessary over such patches and then the film thoroughly scrapped.

After the surface has been stripped, it shall be washed down with mineral turpentine to remove all traces of paraffin wax, which forms one of the ingredients of patent Paint remover and which if left in place will prevent the Paint from drying.

The cleaned surface shall be suitably prepared for application of Paint or other finish.

75.12.4.3 Precautions : Where the Paint remover used is of the inflammable type, suitable precaution against risk of fire shall be taken. Neighbouring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

75.12.4.4 With Caustic Soda Solution

Application : Caustic soda dissolved with 48 times its volume of water shall be applied to the old Paint with a brush and when the Paint film lifts and wrinkles it shall be thoroughly scrapped of in the same wayas described

in 61.3.4.2. After the surface has been stripped thoroughly, it shall be rinsed with several chances of clean water to remove all traces of alkali, which if allowed to remain are liable to spoil the new Paint applied over it. A little acetic acid or vinegar added to the final change of rinsing water helps to neutralize any remaining alkali.

Precautions : Caustic soda as its name implies is a corrosive liquid and care should be taken to see that no liquid spills over the skin or clothing.

75.12.4.5With Blow Lamp:
The Paint shall be removed either with a blow lamp or with an air acetylene equipment. The flame shall be allowed to play upon the Paint just enough to soften it without charring either the Paint or the background. The softened Paint shall then be removed with a stripping knife following the flame as it is moved up thesurface.
Burning off shall begin at the bottom of the vertical surface and shall proceed upwards.

Precautions : Removal with blow lamp shall not be done on narrow or carved undercut surfaces or where there is risk of damage to neighbouring materials such as panes in glazed windows. Neighbouring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

Other Detail: Preparation of surface, scaffolding, measurements shall be as described under painting.

Rate : Rate shall include the cost of all labour and materials involved in all operations described above.

75.12.5 Structural Repairs to Building

75.12.5.1 **General:** Polymer based chemicals are widely being used in structural repair of buildings withstanding harsh condition of coastal regions. These polymers are polymeric formulations that strengthen and modify the microstructures of cement based hydrated products by forming a polymeric

spatial network in its voids, complimenting the cement paste characteristics. Polymer modified co-matrix of cement mortar/concrete has exhibited significantly improved properties with respect to carbonation resistance, flexural and tensile strengths and durability and they are compatible with the concrete elements to be treated for structural repair.

75.12.5.2 Materials: (a) Polymers used for structural repairs are generally of following types
i) Acrylic based cement mortar modifier (Polyalk EP),
ii) Elastomeric Acrylic Crack Filler (Polyfill AR),
iii) SFMC---Grout Powder for Super-flow micro concrete (Polycrete),
iv) Rust remover and Passivator (Rusticide).
v) Polymermodified readymix dry mortar

In addition, there are many other construction chemicals which can also be used for specific structural requirements as specified in item.

These polymer chemicals shall be of standard approved and shall be brought to site in standard sealed condition of manufacturer. The Acrylic polymer used for structural repairing shall confirm to the following technical requirements:

Appearance: Milky white

Ph Value: 9 to 10

Specific Gravity: 1.055+/- 0.005

Solid content % by weight: 44+/-1

Viscosity at 25 degree centigrade temperature (in secs) : 15 to 20 seconds.

These chemicals shall be tested at NABL approved labs. at the cost of Contractor for all the technical parameters as per instruction of Engineer-in-Charge before being used in work. Sampling of the polymer shall be minimum one sample (three specimens) for each batch of procurement.

(b) Silica sand conforming to zone-II of IS.

(c) Marble chips (4.75mm and below)

75.12.5.3 Treatment

A. Polymer Modified Mortar for repairing of Structural Elements:

i) Structural RCC element (beams, columns, slabs, etc) on which treatment is to be carried out, should be adequately supported all around with steel props and ties for overall stability of structure as per instructionof Engineer-in-Charge. For repairing of columns, all the beams getting supported on the said column shall be provided with props/ channel sections of adequate size as per site condition/requirement as instructed by EIC. All such props will be provided with bearing plates of size 150mmx150mm both at top and bottom of the props.

ii) The distressed portion of concrete shall be carefully removed till sound concrete is met. The exposed reinforcement bar condition shall be assessed and on extent of corrosion if need be the same shall be suitably replaced as per structural requirement. The exposed concrete surface shall be free from dirt, loose particles, oil grease etc.

iii) Any rust on reinforcement shall be removed by wire brushing, light hammering etc. Using cottonwaste swab, chemical for rust remover and passivator such as rusticide of approved manufacture shall be applied on affected surface and left for 24 hrs. Afterwards freed loose rust particles shall be removed by brushing. Treated bars shall appear as original colour of bar. If the reinforcement is severely corroded, then additional reinforcement of same dia. or more as per the structural drawing issued for the said repairing/retrofitting work shall be provided and the ends of the new reinforcement shall be welded to the intact sections of the existing reinforcement. If the stirrups of the beams or the columns are severely corroded, then additional stirrups shall be provided, if full shaped stirrups cannot be provided as per site condition, then half stirrups shall be provided and ends of the open stirrups shall be welded to the intact sections of the existing stirrups.

iv) Applying bond coat of polymer- cement slurry: Cement slurry is made by mixing cement and acrylic polymer in proportion of 1:1 by weight. Slurry of such consistency should be easilyapplicable by brush over the prepared RCC surface as bond coat. Consumption of polymer for bond coat should not be less than 0.37 lits/Sqm/layer of application.

v) After application of bond coat polymer modified mortar in specified proportion as mentioned below isapplied (wet on wet application) to build the original section of structural element. Building up of the structural elements shall be done in layers not exceeding 20mm thick at a time. Each successive layer shall be provided with bond coat for proper bonding of the successive layers. Total thickness should not exceed 70 mm.
Polymer modified mortar proportion:
Acrylic polymer: 1.0 litreCement : 5.0kg.
Silica sand :12.5kg (As specified)

Water : Added in quantity to attain dough like consistency for hand packing or trowel application.

Curing: Curing should start after 24 hrs. of application by a fine spray of water for minimum 7 days. Approved chemical curing compounds may also be used which need to be brush applied on the repaired and finished surface. Water curing is preferred over the chemical curing.

Mode of Measurement: Treatment with Polymer modified mortar is measured on the basis of consumption in litre of polymer chemicals(Polyalk EP/SBR) only used in repair involving all the steps described above.

Rate: Rate shall include cost of all materials, labours, staging and support (if not specified separately) involved in all the operations described above.

B. Polymer modified micro-concrete and ready mix micro-concrete:

Where the structural elements are damaged to such an extent in general more than 70mm deep,

there the built up and repairing of the members are supposed to be done using micro concrete.

i) Steps (i) to (iv) shall, in general, be same as described above except for the form work which should be tightly fixed with properly sealed gap to prevent leakage with small opening for pouring of micro-concrete.

ii) Super flow micro-concrete is made using polymer modified cement in powder form (Polycrete or Equivalent) andmarble chips of sizes 4.75mm down as aggregate mixed in water in proportion mentioned below:

Polycrete/Polymer modified grout Powder: 1.0kg.Marble chips(4.75mm and down) :1.5kgWater : 12.5%

iii) The above mix should be thoroughly mixed in a bucket using mechanical stirrer (2 to 3minutes) until it forms a mix of uniform and flowable consistency. The mix quantity shall be such that the same can be consumed within 30 minutes.

iv) Readily available micro concrete dry mix of different approved manufacturers can also be used for repairing of structural elements like columns, beams and slabs etc.

Curing: Curing for all practical purpose should start as soon as de-shuttering is done with props in place incase of flexural member, and should continue for 7days.

Mode of Measurement: Repairs using microcrete shall be measured on weight basis of Polycrete/Grout Powder consumed in all the stages of repair described above.

Rate: Rate shall include all materials, formwork, staging (if not specified separately), labour involved in all the operations described above.

C. Polymer Bonded Mortar for repairing of Non-structural Elements:

Steps (i) to (iv) shall, in general, be same as described above. The mortar used for repairing of non-structural elements like chajjs, facia drops and fins etc is prepared using cement and silica sand in the ration of 1:2.5 with a hand applied consistency. This mortar is to be used for building up of the non-structural elements in layers of thickness not more than 20mm at a time in a day. Each layer shall be applied with bond coat prepared using cement and acrylic polymer in the ration of 1:1 by weight to the brush applied consistency. If the thickness is more than 35 mm, then chicken wire mesh of 22 gauge shall be provided between the layers beyond 35mm thickness. The chicken wire mesh shall be properly spread over the entire area of repairing and nailed @ 300 mm c/c for securing the wire mesh in position.

Curing: Curing of the of the repaired surface shall be as explained above.

Mode of Measurement: Repairs using polymer bonded mortar shall be measured on Sqm.for repairing thickness up to 35 mm and above 35 mm up to 70 mm separately under relevant items of work.

75.12.6 Cutting W.B.M Roads and Making Good

75.12.6.1 **Cutting:** All road crossings shall be cut in half the width at a time and repaired, unless otherwise permitted by the Engineer-in-Charge. Cutting shall be straight and uniform in width. Soling stone and aggregate obtained from cutting macadam shall be stacked separately, clear of the road surface. Aggregate shall be screened. Stones of size below 20 mm and with rounded edges shall be discarded and disposed.

75.12.6.2Making Good:

i) After the trenches have been filled in with excavated earth in layers of 15 cm thickness, watered, well consolidated with heavy iron rammers and brought to sub grade level, soling stone obtained from cuttingshall be laid as per existing soling and consolidated with heavy iron rammers. Where the earth consolidation is well done, no settlement need occur subsequently, for this excess watering should be avoided.

ii) New aggregate 50 mm nominal size or as required, shall be added to old aggregate and spread over to a depth of 7.5 cm as specified in 55.8.4. This shall then be consolidated with hand roller or heavy iron rammers, as directed, first with light sprinkling then with sufficient application of water till the aggregate has become adequately consolidated and does not get displaced. All undulations shall be loosened by handpicking, surplus aggregate

removed from high spots and depressions filled with surplus and new aggregate and the surface compacted again. When thoroughly consolidated, kankar moorum and red bajri, freshly collected shall be spread over it in 12 mm layer and consolidated with hand roller or heavy iron rammers,with sufficient application of sufficient water till a uniform surface is obtained.

The finished surface shall be in camber and left a little higher than the adjoining road surface to allow for any settlement on drying.

75.12.6.3 **Measurement :** Length and width of cutting shall be measured correct to a cm. The area shallbe calculated in square metre, correct to two places of decimal.

75.12.6.4 **Rate :** The rate shall include the cost of materials and labour involved in all the operations described above.

75.12.7 Cutting Bituminous Roads and Making Good

75.12.7.1 Cutting, making good and measurements shall be as specified above in 61.3.6 except the top bituminous surface shall be finished as per the existing surface or as directed by the Engineer-in-Charge. The item shall include cutting and restoration of W.B.M. portion as well as Bitumen portion.

75.12.7.2 **Rate** : The rate shall include the cost of materials and labour involved in all the operations described above.

75.12.8 SURFACE DRESSING ON OLD SURFACE WITH HOT BITUMEN-ONE COAT

75.12.8.1 This treatment consists of cleaning old painted surfaces and applying a coat of hot bitumen on the prepared base, blinding with stone chippings and consolidation with road roller.

75.12.8.2 **Materials**: Binder shall be as specified and conform to relevant IS, stone chipping shall conform to grading specified for 11.2 mm. Unless otherwise specified or directed by the Engineer-in-Charge stone Chippings of 11.2 mm nominal size shall be used @ 1.5 cum per 100 sqm area and bitumen @ 1.95 kg per square metre area. A proper record shall be kept to ensure that the daily turn out of work is correlated with the quantity of bitumen used.

75.12.8.3 Preparation of Surface (Repairs and cleaning) shall be as described below:

Repairs : Pot holes or patches and ruts in the water bound macadam base or surface course which is tobe surface treated, shall be repaired by removal of all loose and defective material by cutting in rectangular patches and replacement with suitable material. For the purpose of repairs the area of pot holes shall betaken upto 0.75 sqm and depth upto 5 cm. All pot holes, patches and ruts upto 2.5 cm deep shall be repaired and brought to level with premix and properly consolidated while those of depths greater than 2.5 cm shall be repaired with similar specifications as adopted originally.

Cleaning : Prior to the application of the binder, all dust, dirt, caked mud, animal dung, loose and foreignmaterial etc. shall be removed 30 cm on either side, beyond the full width to be treated, by means of mechanical sweepers and blowers, if available or otherwise with wire brushes, small picks,brooms etc. The material so removed shall be disposed off as directed by the Engineer-in-Charge.

For a water bound macadam surface, the interstices between the road metal shall be exposed upto a depth of about 10 mm by means of wire brushes. The surface shall then be brushed with soft brooms toremove all loose aggregate. Finally the traces of fine dust which get accumulated while brushing shall bethoroughly removed from the surface by blowing with gunny bags. The prepared surface shall be closed to traffic and maintained fully clean till the binder is applied.

75.12.8.4 **Applying Binder (Hot Bitumen):** The binder shall be heated in a boiler to a temperature as specified for surface dressing (163^0C to 177^0C) for the grade used and maintained at the temperature, theuse of a thermometer being essential. The binder shall be applied evenly to the clean dry surface by means of a pressure sprayer at the rate specified. The binder shall be applied longitudinally along the length of the road and never across it. The edges of the binder surface shall be defined by wire or a ropestretched in position. Heating in cut out drums and pouring from perforated tins, cans and such other methods shall not be permitted. Except in the case of petty

works and repairs with the specific approval of the Engineer-in-Charge.
Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

75.12.8.5 **Blinding or Spreading Stone Chippings:** Immediately after the binder is applied and while it is still hot, stone chippings free from dust and in a dry and clean state shall be spread evenly over the surface at the rate specified above. Spreading shall be done preferably by means of a mechanical gritter, otherwise manually with a twisting motion to avoid segregation which otherwise shall have to be removed by brushing the excess stone chippings over the surface into hungry spots to obtain a uniform surface, free from waviness, depressions and other irregularities. The surface shall be checked by means of a camber board laid across the road and a three metre straight edge laid parallel to the centre line of the road, andundulations if any shall be corrected by addition or removal of blindage till a surface free from undulation is obtained. If a uniform surface is assured at this stage, the completed surface should be normally free from undulations and unevenness.

75.12.8.6 **Consolidation of Blindage:** Immediately following the application of the stone chippings and light brooming, the road surface shall be compacted by a power roller of 6 to 8 tonnes, starting at edges and working towards the centre (or to the outside edge in case of super elevated curve). Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller shall be worked or started and stopped without jerks and shall not be stopped or reversed each time at the samelocation to cause displacement of stone and other irregularities. Consolidation shall be considered complete when the stone chippings are firmly embedded.

Generally five to six trips shall be made for thorough compaction of the surface or as may be specified by the Engineer-in-Charge.

Along kerbs, manholes and all places not accessible to the roller, compaction shall be secured by meansof steel rammers or hand rollers.

75.12.8.7 **Measurements**: The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal. For record purposes, the measurement for binder and stone chippings shall be taken as specified before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment.
75.12.8.8 **Rate:** The rate shall include the cost of materials and labour involved in all the operations described above. For repairs binder and chippings shall be applied at the rate specified above or as specified in item.

Note: The Specification also in general holds good for dressing/repair of old road with Pre-mix bituminous macadam and bituminous concrete (as seal coat) using specified grade of bitumen conforming to IS 73(Hot application) or bitumen cut-back(cold application)conforming to IS-217 or RS grade bitumen emulsion(cold application in damp condition) conforming to IS 8837.However, Payment shall be based on actual consumption of pre-mix on weight basis for which proper receipt and consumption records(date and location-wise records) shall be scrupulously maintained at site. For construction of new bituminous road the latest version of relevant IRC codes shall be followed. The CBR value of the soil subgrade shall be determined as per IS 2720(Part 16) and IRC :37 (latest version) and based on the CBR value the appropriate cross section details of various layers of road as per standard drawing issued by department shall be followed.

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76 HORTICULTURE AND LAND SCAPING

76.1 HORTICULTURE WORK

Horticultural operations shall be started on ground previously levelled and dressed to required formationlevels and slopes. In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth.

In the course of excavation or trenching during horticultural operations, any walls, foundations, etc.met with shall not be dismantled without pre-measurement and prior to the written permission of the EIC.

76.1.1 TRENCHING IN ORDINARY SOIL

Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regrassing, hedging and shrubbery.

Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for regrassing in good soil.

The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.

Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed offand paid.

76.1.2 Trenching: Trenching shall consist of the following operations:

a. The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge.

b. These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.

c. In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.

d. The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

76.1.3 Measurements: Length and breadth of the plot shall be taken correct to 0.1 m and depths correct to cm. Cubical contents shall be calculated in cubic meters, correct to two places of decimal. No deduction shall be made nor extra paid for removing stones, brick bats and other foreign matter met with during excavation upto initial lead of 50 m and stacking the same.

76.1.4 Rate: The rate shall include the cost of all labour and material involved in the operations described above, including cost of all precautionary measures to be taken for protections and supporting all services etc. met with during trenching. It does not include the cost of mixing of earth, sludge/manure.

76.2 GOOD EARTH

76.2.1 The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.

76.2.2 Measurements: Length, breadth and height of stacks shall be measured correct to a cm. The volume of the stacks shall be reduced by 20% for voids before payment, unless otherwise described.

76.2.3 Rate: The rate shall include the cost of excavating the earth from areas lying at distance not exceeding one km. from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

76.3 SUPPLY AND STACKING OF MANURE

76.3.1 Farmyard Manure: It shall be transported to the site in lorries with efficient arrangement to prevent spilling enroute. It shall be stacked at site. Each stack shall not be less than 50 cm height and volume not less than 3 cum.

76.3.2 Measurements: Length, breadth and depth of stacks shall be measured correct to a cm. The volume of the stack shall be reduced by 8% for looseness in stacking and to arrive at the net quantity forpayment

76.3.3 Rate : The rate shall include the cost of labour and material involved in all operations described above, including carriage up to one km. The rate shall also include royalty if payable.

76.4 ROUGH DRESSING OF THE TRENCHED GROUND

Rough dressing of the area shall include making kiaries for flooding. The trenched ground shall be levelled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannotbe so levelled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. Thesupply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at thesurface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

76.4.1 Measurements: Length, breadth of superficial area shall be measured correct to 0.1 metre. Thearea shall be calculated in sqm. correct to two places of decimal.

76.4.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

76.5 UPROOTING WEEDS FROM TRENCHED AREAS

After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

76.5.1 Measurements: Length, breadth of superficial area shall be measured correct to 0.1 meters. Superficial area of the weeded ground shall be measured for purpose of payments.

76.5.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

76.6 FINE DRESSING THE GROUND

Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the floodedground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

76.6.1 Measurements: Length, breadth and depth of stacks shall be measured correct to a cm. The area shall be calculated in sqm. correct to two places of decimal.

76.6.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

76.7 SPREADING GOOD EARTH

Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

76.7.1 Measurements: The quantity of good earth spread shall be determined by the difference in the volume of good earth in stacks before and after spreading duly reduced for looseness in stacking by 20% of good earth.

76.7.2 Rate: The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of the good earth which shall be paid for separately unless specifically described in the item.

76.8 SPREADING SLUDGE/MANURE

Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge. The mixing shall be spread as described in 62.7 to the thickness ordered by the Engineer-in-Charge.

76.8.1 Measurements: The quantity of good earth and sludge or manure mixed shall be determined by the

difference in the volume of good earth and sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

76.8.2 Rate: The rate shall include of all the labour and material involved in all the operations describedabove, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

76.9 MIXING OF GOOD EARTH AND SLUDGE/MANURE

The stacked earth shall, before mixing be broken down top particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-charge.

76.9.1 Measurements: The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth, sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

76.9.2 Rate: The rate shall include the cost of all labour and materials involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately,unless otherwise described in the item.

76.10 GRASSING WITH SELECT GRASS NO. 1

The area from where the grass roots are to be obtained shall be specified by the Engineer-in- Charge atthe time of execution of the work and no royalty shall be charged on this account from the Contractor. Grass is to be arranged by contractor (cost of grass to be paid separately)

The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in theitem. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and
material (grass shall be paid separately.)

During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

76.10.1 Measurements: Length, breadth of the lawn grassed shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

76.10.2 Rate: The rate shall include of all the labour and material involved in all the operations described above, excluding supply of the requisite quantity of good earth and grass so needed for properly maintaining the levels of the lawns. (payment of grass to be paid separately.)

76.11 RENOVATION OF LAWNS

The area shall be first weeded out of all undesirable growth. The entire grass shall be scrapped (cheeled) without damaging roots and level of the grounds. Slight irregularities in surface shall be levelled off and the area shall then be forked so as to aerate the roots of the grass without, however uprooting them.

Specified quantity of sludge or manure shall than be spread uniformly with wooden straight edge (phatti) as directed by the Engineer-in-charge. The area shall then be slightly sprinkled with water so as to facilitateproper integration of the manure or sludge with the soil and later flooded. The contractor shall be responsible for watering, proper maintenance and tending of the lawn for 30 days or till the grass forms a lawn fit for mowing, whichever is later.

During the above operations, all undesirable growths shall be constantly weeded out and all rubbish removed and disposed off as directed by the Engineer-in-Charge.

76.11.1 Measurements: Length, breadth of the lawn renovated shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

76.11.2 Rate: The rate shall include of all the labour and T&P (excluding RH pipe/grass) involved in all the operations described above, excluding the supply of the requisite quantity of good earth if so needed forproper maintenance of the levels of the lawns. The cost of the sludge or manure shall be measured andpaid for separately, unless its supply is specifically included in the description of the item.

76.12 UPROOTING RANK VEGETATION AND WEEDS AND PREPARING THE GROUND FOR PLANTING "SELECT GRASS NO. 1"

Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetarian with roots removedthereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described above for trenching. Clods of excavated earth shall then be broken upto the size not more than 75 mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully. The rubbish arising from the above operations shallbe removed and disposed off in a manner directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed as described under relevant item.

76.12.1 Measurements: Length, breadth of uprooted area shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

76.12.3 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

76.13 EXCAVATION AND TRENCHING FOR PREPARATION OF BEDS FOR HEDGE AND SHRUBBERY

Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters respectively.

Beds for hedges and shrubbery shall be prepared in the following manner:

The beds shall first be excavated to a depth of 60 cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in orderto loosen the soil, in the manner described under trenching. No flooding will be done at this stage but thetop surface shall be rough dressed and levelled. The excavated soil from the top 60 cm depth of the bedstacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8:1 by ratio or

other proportion described in the item. The mixed earth and manure shall be refilled over the trenched bed, leveled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed. The surface after full subsidence shall again be refilled with the earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50 mm to 75 mm below theadjoining ground or as directed by the Engineer-in-Charge. Surplus earth if any, shall be disposed off asdirected by the Engineer-in-charge. Any surplus earth if removed beyond initially lead shall be paid separately. Stones, bricks bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initially lead & lift, such material as is declared unserviceable by the Engineer- in-charge shall be disposed by spreading and levelling at places ordered by him. If disposed outside theinitial lead & lift, then the transport for the extra leads will be paid for separately. If a large proportion of material unsuitable for the hedging and shrubbery operations is met with and earth from outsides is required to be brought in for mixing with manure and filling, the supply and stacking of such earth will bepaid for separately.

76.13.1 Measurements: Length, breadth and depth of the pit excavated and trenched shall be measured correct to a cm. The cubical contents shall be calculated in cubic meter correct to two places of decimal.

76.13.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above. The rate shall not include the cost of supply & stacking of the manure unless the same is specifically included in the description of the item.

76.14 DIGGING HOLES FOR PLANTING TREES

In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside thehole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed.Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required toreplace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The tree holes shall be manured with powdered Neam/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profuselywatered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

76.14.1 Measurements: Holes shall be enumerated.

76.14.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, excluding the cost of supply and stacking the requisite quantity of manure/sludge and oil cake.

76.14.3 In Soil other than Ordinary Soil

i) Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and /or ordinary soil in any hole, thedifferent excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only.

ii) The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.

iii) Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately

iv) The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge. If such places are outside initially leads, carriage for the extra lead shall bepaid for separately.

v) The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 16 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

76.14.4 Measurements: The pit shall be enumerated. The volume of excavation in soil and other than aordinary soil shall be determined by reducing the stack volume of the relevant soil with respective percentage for voids specified in(ii) above.

76.14.5 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, including mixing refilling, watering, dressing etc. but shall not include (a) cost of manure over sludge (b) cost of supplying and stacking of good earth for replacement and (c) the cost of carriagebeyond initial lead for disposing off useless materials. The excavation other than that of ordinary soil shall be paid extra over and above the rate if excavation in ordinary soil.

76.15 M.S. FLAT IRON TREE GUARD

76.15.1 M.S. Iron Riveted Tree Guard: The tree guard shall be 600 mm in diameter and 2-meter-high above ground level and 25 cm in below ground level. The tree guard shall be framed of 4 nos. 25 x 6 m M.S. flat 2 meter long excluding displayed outward at lower and upto an extent 10 cm and 8 nos. 25 x 3mm vertical M.S. Flat Rivetted to 3 Nos. 25 x 6 mm Flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. bolts and nuts.The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved brand and manufacturer. The design of tree guards shall be shown in the drawing.

76.15.2 Measurement : The tree guard shall be enumerated.

76.15.3 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

76.16 FILLING MIXTURE OF EARTH & SLUDGE OVER MANURE

The separately specified earth and sludge shall be broken down to particles of size not exceeding 6 mm in any directions before mixing. Good earth shall be thoroughly mixed with sludge over manure in specifiedproportions as directed by Officer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and levelled.

76.15.1 Measurements: Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

76.15.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, but do not include the good earth, sludge or manure which will be paid separately.

76.17 EXCAVATION OF WATER BOUND MACADAM

All excavated operations shall include excavation, stacking of serviceable and unserviceable material. Excavation shall be straight and uniform in width. Soling stone and aggregate obtained from excavation of W.B.M. shall be stacked separately and unserviceable material disposed off with lead upto 50 meter andlift upto 1.50 meter and neatly dressed.

76.17.1 Measurements: Measurement shall be made in (Length, breadth and height of stacks) cubicmeter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

76.17.2 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

76.18 FLOODING THE GROUND WITH WATER AND MAKING KIARIES:

The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

76.18.1 Measurements: Measurement shall be made in sqm. of area.

62.18.2 Rate: The rate shall be for 100 sqm of area and include the cost of all the labour and material involved in all the operations described above.

76.19 CLEANING OF LAWN:

The Cleaning of Garden shall cover to proper sweeping work including removing litter, debris, picking of leaves, papers, plastic bottles etc. & disposal of collected waste in dustbin/designated place as decided by Engineer in charge.

76.19.1Measurements

Measurement shall be made in sqm. of area.

76.19.2RATE

The rate shall be for per sqm of area and include the cost of all the labour and material involved in all the operations described above.

76.20 REMOVAL OF GARDEN WASTE

Removal of garden waste by manual / mechanical means including loading/unloading and transportation and disposal at designated place as directed by Engineer in Charge or as per item description.

76.20.1 Measurements & Rate

Measurement & rate shall be made as per item description. Rate shall be inclusive of all labour and material involved in all the operation as described above.

76.21 PRUNING, TRIMMING, SHAPING OF TREES

Pruning, trimming, shaping of trees/shrubs (ht 15 feet and above) i/c removal of cut materials up to 50mt. lead and as per direction of Engineer in charge. (i/c necessary T&P shall be arrangedby the contractor. Pruning, trimming, shaping of trees/ shrubs shall be done as per direction of Engineer in charge.

76.21.1 Measurements: Measurement shall be made as per item description.

76.21.2 RATE: The rate shall be for per Tree/shrub basic and include the cost of all the labour and materials& involved in all the operations described above.

76.22 SPECIFICATIONS OF PLANTS

The plants should be as per following specification.

1. The plants should be full of fresh and healthy foliage.
2. The plants should be free from insect, pest and diseases.
3. Plant should be well developed and healthy.
4. The height of the plants will be measured from top of the pots.
5. The plants should be well settled and should not be newly shifted/Transplanted.
6. The plants should be true to the variety and Variety name should be tagged.
7. Moss stick used should be made on plastic pipe.
8. Moss stick should be straight and properly fixed in the pot.
9. The rejected plants materials should be removed from the site immediately.
10. Moss stick should be covered with the plants in case of plants supplied with moss stick.
11. The Plant should be well stablished and should have good foliage.
12. Good earth and manure used for filling the pot/poly bag should be free from any inert materialand mixed to proper ratio.
13. Pot/ Poly bag used for filling the plants should be of proper size.
14. There should be proper drainage in pots for plants.
15. The flowering plants should also have proper flowering and should be true to the variety.
16. All plant should have the tendency of growth and should not be stunted or deshaped.
17. There should be no stagnation of water in the pots.
18. Plant should not have any physiological disorder.
19. Tips of the Plants should have intact, there should not be any damages etc.
20. In case of flowering pots flower should be on bud stage/semi bloom stage.
21. In case of potted plant pots should have uniformity/same size and quality.
22. Plants of bigger height should be properly supported/stacked by bamboo stick.
23. Pots/Polybags soil should not be infectious and plant should have free from all kind of diseases.
24. Bulbs, seeds, seedling, suckers should have properly treated with fungicides before supply

RECOMMENDED / PREFERRED MANUFACTURER FOR SOME FACTORY MADE BUILDINGMATERIALS & SPECIFIED WORKS:

GENERAL NOTES:

1. Products with relevant I.S. markings from the B. I.S. Licensed manufacturers, who are in the market for the last three years with valid I.S. License, shall be considered for approval.
2. In case of items where I.S. marked material is not available, the contractor shall procure the same from the following list, subject to prior approval of Engineer-in-charge. Periodic tests shall be carried out as per contract / specifications at contractor's own cost.
3. In case of any new brand other than BIS certified or from departmental list of manufacturer is proposed, adequate information about the product and manufacturer, shall be provided at the tender stage.
4. Department reserves the right to accept / reject any new brand(s) proposed by the tenderer.
5. Samples of all materials, fittings etc. to be incorporated in the work shall be submitted by the contractor and got it approved from the Engineer-in-Charge, before supply in bulk at site of work.Wherever particular make or its equivalent is mentioned in the item schedule, the decision of theEngineer-in-Charge in selection of particular make or its equivalent shall be final and binding onthe contractor. The approved samples will be kept in custody of the Engineer-in-Charge till completion of the work. Materials not conforming strictly to the approved samples will be rejected.

S.N.	DESCRIPTION	MANUFACTURERS
1	Cement	M/s Ultratech, M/s ACC, M/s Lafarge, M/s Ambuja, M/s RAMCO Cement, M/s Binani, M/s Rajshree, M/s Birla Cement, M/s Zuari, M/s. JSW Cement
2	White Cement	M/s J.K Cement; M/s Birla White.
3	Ready Mix Mortar	M/s ROOFIT; M/s WALPLAST; READIPLAST of M/s ULTRATECH Cement Ltd.; ACCOPlast of M/s ACC Ltd.; SILICOplast of M/s Precise Conchem Pvt. Ltd, M/s. Asian Paints, M/s. MYK Arment, Duro Plast of M/s. Godrej
4	Thin Jointing Mortar	Fixoblock of M/s UltraTech; ACCOfix of M/s ACC; SILCOfix of M/s Precise Conchem Pvt ltd., M/s. Asian Paints, M/s. Godrej (Easy Fix)
5	Ready Mix Polymer Modified Repair Mortar	M/s. Asian Paints, M/s. Walplast, M/s. Roofit, M/s. Precise Conchem Pvt Ltd.
6	Ready Mix concrete plant	M/s Ultratech, M/s ACC, M/s Lafarge, M/s. Ready mix India Ltd, M/s. Godrej, M/s. Hella Infra or Nearby RMC plant Subject to approval of the plant by the Department.
7	Reinforcement Steel	M/s TISCO, M/s SAIL, M/s RINL, M/s. JSW Steel, M/s. JSPL
8	Parrallel Threaded Mechnical Splices	M/s Dextra India Pvt. Ltd.; M/s Spplicetek India Pvt. Ltd.
9	Structural Steel Section	M/s TATA, M/s SAIL, M/s RINL, M/s. JSW Steel, M/s. JSPL locally approved Structural Steel SectionManufacturers. (In case of non availability of structural sections with primary manufacturers conforming to IS)
10	Precast Concrete Products (AAC Block)	Siporex Ind.; B.G. Shirke & Co.; Supreme Concrete (Minato Blocks)-Kolhapur, KK-Nasik, M/s AEROCON; XTRALITE of M/s UltraTech Cement Ltd., M/s. Godrej
11	Fly Ash Bricks	M/s Shirke bricks; M/s Unicorn; M/s Shri Samarth; M/s A Cube bricks; M/s LANVIN Infrastructure Pvt. Ltd., M/s. Godrej
12	(i) Anti-termite Treatment chemical	Central Insecticide Board approved (ISI Marked) Chemical.
	(ii) Agency	M/s Paragon; M/s PECOPP; M/s Pest Control India Ltd; M/s Express pesticide corporation or as approved.Specialized agency shall be a Member of IPCA (Indian Pest ControlAssociation)

S.N.	DESCRIPTION	MANUFACTURERS
13	Concrete Paver Block	M/s Super Tile, M/s Supreme Concrete, M/s Minato Blocks (Kolhapur.), M/s Basant Betons, M/s Gico Tiles (Bhubaneshwar), M/s Vyara Tiles; M/s Intex Designer Tiles pvt. Ltd (Duracrete), M/s. Godrej
14	Ceramic / Glazed/ Vitreous Tiles	M/s Regency Ceramics, M/s Kajaria Ceramics, M/s H. R. Johnson (I), M/s. Orient Bell, M/s Somani Tile, M/s Asian Granito India Ltd; M/s NITCO LTD, M/s Pavit Ceramic.
15	PVC Tile/Sheet (Flooring)	M/s Armstrong, M/s Responsive Industries (M/s Krishna Vinyl), M/s Premier Poly Vinyl; M/s RMG Poly Vinyl India Ltd.(wonder floor); M/s.Royal Cushion Vinyl; Hyundai (Hanwha) Vinyl Flooring.
16	Pressed Steel Door Frames	M/s Welcome Door, M/s AGEW, M/s Multiwyn,) M/s Anjali Enterprises, M/s Shakti Met-dor Limited, M/s Behar Bobbin Engineering Works, Katihar, M/s Nishan Solid door frames (Solidor), M/s B A Enterprise, Kolkata, M/s Sheth Fabricators; M/s Shakti Hormann.
17	Steel Doors, Windows	M/s Welcome Door; M/s Shakti Met-dorLimited, M/s. AGEW, M/s. Abaqs, M/s. Techome; M/s. Windoors, M/s R L Vala & Sons M/s B A Enterprise, Kolkata. M/s Maxo Metal Enterprises, Kolkata, M/s. NCL Seccolar, M/s. Bharat Steel Industries, Pune.
18	M.S. Fire rated door	M/s Shakti Met-dor Limited, M/s. Abaqs, M/s. Godrej, M/s Signum Fire Protection Ltd.; M/s Sheth Fabricators, M/s. Anjali Doors Pvt Ltd.
19	Steel Rolling Shutter	M/s Windoors; M/s Dodia; M/s Anjali Enterprises; M/s Bharath; M/s Shri Ambika Manufacturing Co.; M/s Vijayalakshami Rolling Shutters.
20	Motorized Rolling Shutter and Gate	M/s Gandhi Automation Pvt. Limited; M/s Vijayalakshami Rolling Shutters.
21	PVC/FRP Doors & Frames	M/s Deep Doors, M/s Fibroplast, M/s Jain Irrigation Systems Ltd.; M/s Rajshri Plastiwood.
22	PVC Integral Foam Doors	M/s Jain Irrigation System (Excel Plastic Sheet), M/s Rajshri Plastiwood.
23	Aluminium Sections For Doors, Windows & Wall Spans	M/s Jindal; M/s Hindalco , M/s ALOM Extrusion; M/s Indal; M/s Bhoruka Extrusion.
24	Aluminium Hardware	M/s Metco, M/s Allen, M/s Crown, M/s Ebco, M/s. Alans; M/s. Al-Alfa;
25	Aluminium Grills & Aluminium flush door shutter.	M/s Decogrille, M/s Alufins.
26	Plain Glass	M/s Modi Guard; M/s Saint Gobain, M/s Indo-Asahi Glass,
27	Reflective Glass	M/s Saint Gobain, M/s Indo-Asahi Glass, M/s Glaverbel (Europe); M/s Pilkington (USA, UK).
28	Flush door Shutter	M/s Kalpatru, M/s Kutty Flush Door, M/s Century, M/s Kit-ply, M/s Sylvan Ply, Kolkata; M/s. Shreeji, M/s Jawahar Saw Mills, M/s. Anand Wood Crafts.
29	Ply-wood	M/s Century, M/s Kitply, M/s India Plywood, M/s Green Ply, M/s Sylvan Ply, Kolkata
30	Plain/Pre-laminated Phenol bonded MDF Board	M/s Novopan, M/s Nuwood, M/s Bhutan Board, M/s Green Ply, M/s Action Tesa.
31	Veneers	M/s Century, M/s Kitply, M/s India Plywood, M/s Green Ply, M/s Timex, M/s Merino
32	Decorative Laminates	M/s Formica, M/s Greenlam, M/s Century Ply, M/s Merino, M/s Timex, M/s Royal Touche.

S.N.	DESCRIPTION	MANUFACTURERS
33	Fibre Cement Board / sheet (non-asbestos)	M/s Everest E-board; M/s Ramco Industries- Hicem; M/s Charminar-C boards; M/s Ecopro; M/s Shera Board; M/s VISAKA Industries Ltd.
34	(i) Doors Fittings & Fixtures (MS,Al,SS,Brass)	M/s Shalimar, M/s Saifee, M/s Garg, M/s Alans, Kolkata; M/s. AL-Alfa, M/s Navbharat Hardware; M/s Ebco, M/s. Everite
	(ii) Decorative High SS Finish Fittings and Fixtures	M/s Guardian, M/s Hafele, M/s Hettich, M/s Ozone, M/s Dorma.
	(iii) Mortise Locks, Night latch	M/s Godrej , M/s Guardian, M/s. Everite
	(iv) Door Closer	M/s Everite, M/s Hardwyn, M/s Godrej, M/s Hyper, M/s. Garnish, M/s Dorma
	(v) Floor Spring	M/s Everite, M/s Hardwyn, M/s Godrej, M/s Hyper,M/s Dorma, M/s Hafele, M/s. Garnish.
	(vi) Glass Patch Fittings	M/s Dorma, M/s Ozone,
35	Bitumen impregnated Fibre board & Tarfelt Waterproofing	M/s Tikki Tar Danosa India Ltd, M/s STP Ltd., (Shalimar Tar Products);
36	Expansion joint filler Board (HD-100)	M/s Supreme Industries.
37	APP modified waterproofing membrane	M/s Dr. Fixit, M/s STP Ltd., M/s. Sika, M/s Tikki Tar Danosa India Ltd,
38	Acrylic based chemical water proofing.	M/s Asian Paints; M/s STP; M/s Fosroc; M/s MYK Arment.
39	Integral Water Proofing Compound (Polymers, Sealants)	M/s Cico, M/s Pidilite; M/s Roff.; M/s Mc-Bouchmie; M/s Fosroc,M/s Sunanda Chemicals, M/s. BASF, M/s. Sika, M/s. ACCO Proof, M/s. MYK Arment
40	Polymers/ Chemicals for Structural Repair	M/s Pidilite; M/s Roff.; Mc-Bouchmie; M/s Fosroc, M/s Sunanda Chemicals, M/s Sika.
41	Polymer based tile / stone adhesive	M/s ARDEX(BAL) Endura; M/s Pidilite Roff; M/s MYK-laticrete.
42.1	Gypsum based False Ceiling	M/s Saint Gobain Gyproc India Ltd.
42.2	Calcium silicate based False Ceiling	M/s Ramco Industies (Hilux), M/s Aerolite.
42.3	Mineral Fiber Board based False Ceiling	M/s Armstrong.
42.4	Metal based False Ceiling	M/s Hunter & Douglos, M/s Interarch Building Products, M/s Supersil, M/s Armstrong, M/s Aerolite
43	Metal False Flooring	M/s. Unitile Access Floor
44	Aluminium Composite panel.	M/s ALUCOBOND; M/s REYBOND; M/s ALPOLIC; M/s EUROBOND.

S.N.	DESCRIPTION	MANUFACTURERS
45	Acoustic / Thermal Insulation (Poly Fibre / glass wool /Rock wool)	M/s Twiga Insul (M/s. Saint Gobain), M/s Rockwool India Pvt. Ltd, M/s. Mechtrix India
46	Thermal Insulation Phenolic Foam Phenotherm board	M/s Bakelite Hylam.
47	Wall care Putty	M/s Birla White, M/s. Walplast, M/s J K White.
48	Interior & Exterior Paints	M/s Asian Paints, M/s. Kansai Nerolac, M/s ICI Dulux Paints, M/s Jenson Nicholson, M/s Berger Paints; M/s Jotun, M/s Snowcem (M/s. Saurashtra Cement Limited - Paint Division)), M/s Nitco Paints (M/s Sherwin Williams), M/s Jotun Paints.
49	Fire Retardant Paints	M/s Noble Paints, M/s Cygnet Surface coatings.
50	Wood Polish Finishes(Lacquer, Varnish, Polyurethane)	M/s Asian Paints, M/s ICI Dulux Paints, M/s Berger, M/s Kansai Nerolac
51	RCC Hume pipe	The Indian Hume Pipe, M/s Pranali, M/s West Bengal Concrete Industries, Kolkata, M/s Sur Industries, Kolkata.
52	Upvc Doors and windows.	M/s Yashashri Polyextrusion Ltd; M/s NCL Alltek & Seccolar Ltd.

APPENDIX - "B"

THEORETICAL STANDARD REQUIREMENT OF CEMENT FOR VARIOUS ITEMS OF WORK

S.NO.	BRIEF DESCRIPTION OF ITEM	UNIT	CEMENT IN BAGS
1	Cement Concrete 1:5:10	Cum	2.60
2	Cement Concrete 1:4:8	Cum	3.40
3	Cement Concrete 1:3:6	Cum.	4.40*
4	Cement Concrete 1:2:4	Cum	6.40*
5	Reinforced Cement Concrete 1:2:4	Cum	6.40*
6	Reinforced Cement Concrete 1:1.5:3	Cum.	8.00*
7	Reinforced Cement Concrete 1:1:2	Cum	12.20*
* Note : For controlled concrete items like M-10, M-15, M-20, M-25 etc., the consumption of cement will have to be assessed by the Engr-in-Charge on the basis of design mixes approved for individual work.			
8	Brick masonry in C.M. 1:4	Cum.	1.90
9	Brick masonry in C.M. 1:6	Cum	1.25
10	Half brick masonry in C.M. 1:4 with RCC 1:2:4 stiffeners	Sqm.	0.27
11	Half brick masonry in C.M. 1:4	Sqm	0.21
12.(a)	R.R. Masonry in C.M. 1:6	Cum.	1.65
12.(b)	C.R. Masonry in C.M. 1:6	Cum.	1.56
13.	IPS Flooring (C.C. 1:2:4, finished smooth)		
(a)	30mm. thick	Sqm	0.24
(b)	40mm. thick (smooth/broom finish)	Sqm	0.34
(c)	50mm. thick	Sqm	0.42
14	Hardonate flooring -50mm. thick (C.C. 1:2:4, finished smooth)	Sqm.	0.42
15	Kota stone:		
(a)	Flooring (with cement mortar 1:4 bedding 20mm thick pointed with matching cement slurry)	Sqm	0.35
(b)	Skirting with12mm. thick C.M. 1:3 backing	Sqm	0.28
(c)	Coping	Sqm.	0.15
16(a)	Ceramic/Vitrified tile flooring and dado over 20mm. C.M.1:4 bedding	Sqm	0.35
16(b)	Ceramic/Vitrified tile dado over 12mm. C.M.1:3 backing	Sqm	0.28
17	Cement tile :		
(a)	Flooring (cement mortar1:4,20mm bedding).	Sqm	0.35
(b)	skirting with 12mm thick C.M. 1:3 backing	Sqm	0.28
18	Granite/ Marble		
(a)	Flooring (with cement bedding 1:4, 20mm thick)	Sqm	0.35
(b)	Skirting	Sqm	0.27
19	Additional thickness of base mortar in flooring over 20mm for every 10mm in CM1:4	Sqm	0.09
20.	Cuddapah stone kitchen platform over 20mm. thick C.M. 1:4	Sqm	0.30
21	Cuddapah stone window sill over 20mm. thick C.M. 1:4	Sqm	0.27
	Plaster Skirting, 20mm thick in CM 1:3	Sqm	0.30
22	Fixing hold fasts in CC 1:3:6 of size 300x100x150 mm. for doors & windows	100 Nos	2.20
23	Cement Plaster in C.M. 1:4/1:5 without cement punning.		
(A)	Cement Mortar 1:4		
(a)	6mm. thick	Sqm	0.06
(b)	12 mm. thick	Sqm	0.11
(c)	15 mm. thick	Sqm	0.13
(d)	20 mm. thick.	Sqm	0.17

S.NO.	BRIEF DESCRIPTION OF ITEM	UNIT	CEMENT IN BAGS
(B)	Cement Mortar 1:5		
(a)	12 mm. thick	Sqm	0.09
(b)	15 mm. thick	Sqm	0.11
(c)	20 mm. thick	Sqm	0.14
24.	Cement plaster in C.M. 1:4 in two coats with neat cement punning		
(a)	15 mm. thick.(10mm + 5mm)	Sqm	0.18
(b)	20 mm. thick.(15mm + 5mm)	Sqm	0.22
25	Cement plaster in C.M. 1:4, 20mm. thick rough finish (for external brick/concrete surfaces)	Sqm.	0.17
26.	Sand faced plaster, 20mm. thick in 2 coats (10mm each in C.M. 1:4)	Sqm	0.21
27.	Rough cast plaster, 25 mm thick (12mm C.M. 1:4 + 13 mm C.M.1:3)	Sqm	0.27
28.	(+) 10 mm wide & 18 mm thick plain or moulded cement mortar band in CM 1:4	100 R.M	0.152
29.	Cement plaster in C.M. 1:3 finished smooth with neat cement		
(a)	12mm. thick	Sqm	0.19
(b)	15mm thich	Sqm	0.22
(b)	20mm. thick	Sqm	0.27
30.	Cement pointing in C.M. 1:3		
(a)	Ruled pointing (groove pointing)	Sqm	0.02
(b)	Raised & cut pointing	Sqm	0.04
(c)	Flush pointing	Sqm	0.02
31.	Cement based waterproofing works (Through the agency approved by the Department)		
(a)	i)Cement based brick bat waterproofing (terrace) average 115 mm. thick	Sqm	0.72
	ii) Cement based brick bat waterproofing (sunshade,balcony) average 65 mm. thick	Sqm	0.50
(b)	Basement type (Box type)-horizontal surface	Sqm	0.68
(c)	Basement type- (Box type)-vertical surface	Sqm	0.89
(d)	In sunken floor of toilets, chajjas, parapets	Sqm	0.32
(e)	Brickbat coba in toilets, extra in roof terrace	Cum	3.10
(f)	O.H. Water tanks	Sqm	0.50
(g)	Expansion joints.	R.M	0.50
32.	Damp proof course in C.C. 1:2:4		
(a)	25mm. thick	Sqm	0.16
(b)	38mm. thick	Sqm	0.24
33.	Laying R.C.C. spun pipes in C.M. 1:1/1:2		
(a)	100 mm dia.	10m	0.10
(b)	150 mm dia	10m	0.12
(c)	250 mm dia.	10m	0.18
(d)	300 mm dia	10m	0.22
(e)	450 mm dia	10m	0.48
(f)	600 mm dia	10m	0.64
(g)	900 mm dia	10m	0.98
(h)	1200 mm dia	10m	1.36
34.	Cement mortar 1:4 screed		
(a)	20mm. thick	Sqm	0.16
(b)	50mm. thick	Sqm	0.38
35.	Chain link fencing/barbed wire fencing - C.C. 1:2:4 pockets of 450x450x600mm		
(a)	Angle iron posts	m	0.21
(b)	Cement Concrete 1:2:4 posts	m	0.37

S.NO.	BRIEF DESCRIPTION OF ITEM	UNIT	CEMENT IN BAGS
36	Kerb stone in CC 1:3:6 of size 125x375mm	m.	0.21
37.	Shahabad stone paving, pointed in C.M.1:3, 15x10 mm groove.	Sqm	0.02
38	Pointing & grouting stone pitching in C.M. 1:3	Sqm	0.14
39	Solid Block Masonary/Siporex in C.M.1:4	Cum	1.04
40	Fixing heat reflective tile(China mosaic) on roof with C.M1:4	Sqm	0.27
41	Fixing Pressed Clay (Mangalore) tile on roof jointed with C.M1:4	Sqm	0.20
42	Polymer - (For Polymer modified mortar and bond coat)	Litre	0.11
43	Ready mix cement mortar = 2.15 Kgs/Sqm/mm thickness of plaster		

APPENDIX -"C-1"

CONSUMPTION OF PAINT FOR SOME PAINTING ITEMS

Coverage Achieved Per Litre or Per Kg of Paint / Material				
Sl. No.	Name of Paint	Area coverage For one coat (Old work)	Area coverage For two coats (New Work)	Area coveragePer addl. coat
1	Synthetic enamel paint	14m^2 per Ltr.	8.5m^2 per Ltr.	18m^2 per Ltr.
2	Plastic emulsion paint	14m^2 per Ltr.	8.5m^2 per Ltr.	18m^2 per Ltr.
3	Oil Bound distemper	10m^2 per Ltr.	6.0m^2 per Ltr.	12m^2 per Ltr.
4	Dry Distemper	10m^2 per kg	6.5 m^2 per kg	12 m^2 per kg
5	White wash	5m^2 /kg of lime	3.5m^2/kg of lime	10 m^2 /kg of lime
Note : Following things to be added in lime (i) Adhesive (DDL/SDL) - 5% of lime (ii) Neel (Blue) - 3 gm per kg of lime (iii) Water - 5 kg of water per kg of lime				
6	Cement based paint	4.5 m^2 per kg	2 m^2 per kg	6 m^2 per kg
7	Aluminium paint	20m^2 per Ltr.	12.5 m^2 / Ltr.	28 m^2 per Ltr.
8	Bitumen Paint/Black Japan	14 m^2 per Ltr.	14 m^2 per Ltr.	28 m^2 per Ltr.
9	Neeru (or lime punning with slacked lime) over plaster	0.5 m2 per kg of slacked lime		
10	Red oxide metal primer	16 m^2 per Ltr.		
11	Cement primer	12 m^2 per Ltr.		
12	Wood primer	13 m^2 per Ltr.		
13	Wax polishing of new wood work with ready made polish	20m^2 per kg	20m^2 per kg	20m^2 per kg
14	French or spirit polish	10.5 m^2 / Ltr.		
15	Varnish	14 m^2 per Ltr.	8.5 m^2 per Ltr.	18 m^2 per Ltr.
16	Requirement of paint per coat in Structural steel work on tonnage basis. (i) Truss and Lattice girder work - 4.5 litres per tonne. (ii) Plane Beam/plane girder work - 2.5 litres per tonne			

CO-EFFICIENT FOR EQUIVALENT PLAIN AREAS FOR PAINTING ITEMS: (PARA REFERRED TO CHAPTER 50 - PAINTING)

SN	DESCRIPTION OF WORK	MULTIPLYING CO-EFFICIENTS
I.	WOOD WORK : DOORS, WINDOWS ETC.	
1	Panelled or framed and braced doors, windows etc.	1.30 (for each side)
2	Ledged & battened or ledged, battened & braced doors, windows etc.	
3	Flush doors etc	1.20 (for each side)
4	Part panelled and part glazed or gauzed doors,windows etc.	1.00 (for each side)
5	Fully glazed or gauzed doors, windows etc.	0.80 (for each side)
6	Fully venetioned or louvered doors, windows etc.	1.80 (for each side)
7	Trellis (or Jaffri) work one way or two way.	2.00 (for painting all over)
8	Carved or enriched work:	2.00 (for each side)
9	Weather boarding:	1.20 (for each side)
10	Wood shingle roofing:	1.10 (for each side)
11	Boarding with cover fillets and match boarding.	1.05 (for each side)
12	Tile and slate battening:	0.80 (for painting all over)
II.	STEEL WORK: DOORS, WINDOWS ETC.	
13	Plain sheeted steel door or windows:	1.10 (for each side)
14	Fully glazed or gauzed steel doors and windows	0.50 (for each side)
15	Partly panelled and partly gauzed or glazed doors and windows.	0.80 (for each side)
16	Corrugated sheeted steel doors or windows.	1.25 (for each side)
17	Collapsible gates	1.50 (for painting all over)
18	Rolling shutters of inter locked laths.	1.10 (for each side)
III.	GENERAL WORKS :	
19	Expanded metal, hard drawn steel wire fabric of approved quality, grillwork and gratings in guard bars, balusters, railings, partitions and m.s. bars in window frames.	1.00 (for painting all over)
20	Open palisade fencing and gates including standards, braces, rails, stays etc. in timber or steel.	1.00 (for painting all over)
NOTE: The height shall be taken from the bottom of the lowest rail, if the palisades do not go below it (or from the lower end of palisades, if they project below the lowest rail) upto the top of palisades but not upto the top of standards, if they are higher than the palisades.		
21	Corrugated iron sheeting in roofs, side cladding etc.	1.14 (for each side)
22	A.C. Corrugated sheeting in roofs, side cladding etc.	1.20 (for each side)
23	A.C. Semi-corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets.	1.10 (for each side)
24	Wire gauze shutters including painting of wire gauze.	1.00 (for each side).

APPENDIX - D

PROFORMA FOR GUARANTEE TO BE EXECUTED BY CONTRACTORS FOR STABILITY OF PILEFOUNDATION SYSTEM AGAINST RISK OF SETTLEMENT & OTHER TYPE OF DISTRESS TO THE BUILDING(S).

(Applicable in case the pile foundation system design is under the scope ofcontractor)

(PARA 7.17 OF PILE FOUNDATION)

This Agreement made this ..... day of Two thousand .....
between M/s. .....(hereinafter called the Guarantor of the one part) and the PRESIDENT OF INDIA (hereinafter called the Government of the other part).
Where as this Agreement is supplementary to a contract (hereinafter called the Contract) dated.....
and made between the Guarantor of the one part and the Government of the other part whereby the contractor interalia undertook to render the damages caused to the buildings and structure to the satisfaction of the Department.
AND WHEREAS THE GUARANTOR agreed to give a guarantee for the stability of pile foundation system against the risk of settlement and against all damages caused to the buildings erected on pile foundationsystem for a period of five (5) years from the certified date of completion.
NOW THE GUARANTOR hereby guarantees that the stability of the pile foundation system provided byhim will render the structures completely free from settlement and any other type of distress for a period of five (5) years to be reckoned from the certified date of completion of the work.
During this period of guarantee, if the Guarantor fails to execute necessary rendering work due to damages/distress caused to the buildings and structures for settlement of pile foundation system or commits breach thereunder, then the Guarantor will indemnify the principal and successors against all loss, damage, cost, expense or otherwise which may be incurred by the Department by reason of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.
As to the amount of loss and/or damage and/or cost incurred by the Government, the decision of the Engineer-in-charge shall be final and binding on the contractors.
IN WITNESS WHEREOF these presents have been executed by the Obligator.....
..... and by.....and for and on behalf of the PRESIDENT OF INDIA on the day, month and year first above written.

SIGNED, sealed and delivered by (OBLIGATOR) in the presence

of : (1)

(2)

SIGNED FOR AND ON BEHALF OF THE PRESIDENT OF INDIA

BY in the presence of :

(1)

(2)