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GENERAL

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

ii. It may also be noted that the specification are of generalized nature & these shall be read in conjunction with the description of item in schedule of quantities & drawings. The work also includes all minor details of construction which are obviously & fairly intended & 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 & standards published by the Indian standard Institution & all other standard which may be published by them before the date of receipt of tenders, shall govern in all respects of dosing workmanship quality & propitious of materials & 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 inclusive of all amendments issued to or revisions thereof, if any, up to the date of receipt of tenders.

iv. In case there is no I.S.I specification for the particular work, such work shall be carried out in accordance with the instructions in all respects, & requirements of the Engineers-in-Charge. Wherever any reference to any Indian standard specification occurs in the documents relating to this contract, the same shall be inclusive of all amendment issued there to or revisions thereof, if any, up to the date of receipt of tenders.

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, fitting etc. proposed to be incorporated in the work shall be submitted by the contractor for approval of the Engineers-in-Charge 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 allotted 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 & nothing extra whatsoever shall be payable to the contractor for the test.

x. The contractor shall clear the site thoroughly of all scaffolding materials & rubbish etc. left out of his work & dress the site around the building to the satisfactions & his decision in writing shall be final & binding on all concerned.

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 sample collected 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 Dean (I.P.S.), shall be the sole deciding authority as to the meaning, interpretations and implications for various provisions of the specifications and his decision in writing shall be final and binding on all concerned.

xiii. In case any different or discrepancy between the specification & the description in the schedule of quantities, the schedule of quantities shall take precedence. In case of any difference or discrepancy between specification & drawing, the specification shall take precedence.
II – LIST OF INDIAN STANDARDS:

Following are the various pertinent Indian Standards, relevant to buildings work:

(All Latest Versions of I.S. codes shall be referred)

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| **2. EARTH WORK** | |
| 1200 PL. I-1992 | Method of measurement of Earth work. |
| 4081-1986 | Safety code for Blasting and related drilling operations. |

<p>| <strong>3. MORTAR</strong> | |
| 196-1966 | Atmospheric conditions for testing (Reaffirmed - 1990) |
| 269-1989 | 33 Grade Ordinary, rapid hardening and low heat Portland cement |
| 455-1989 | Portland blast furnace slag cement |
| 650-1991 | Standard sand for testing of cement |
| 712-1984 | Building Limes |
| 1489-1991 | Portland pozzolana cement Fly ash based |
| 1514-1990 | Methods of sampling &amp; Test for Quick Lime &amp; Hydrated Lime. (Reaffirmed - 1996) |
| 1542-1992 | Sand for Plastering. |
| 1727-1967 | Methods of tests for pozzolanic materials |
| 2386-1963 | Methods of Test for Aggregates for Concrete |
| 2386 Pt.I-1 963 | Particle size and shape |
| 2386 Pt.II-1963 | Estimation of deleterious materials and organic impurities |
| 2386 Pt.III-1 963 | Specific gravity, density, voids, absorption and bulking |
| 2686-1977 | Cinder as fine aggregate for use of Lime Concrete. (Reaffirmed – 1992) |
| 3025-1964 | Methods of sampling &amp; test (Physical &amp; Chemical) water used in industry. (Reaffirmed-2003) |
| 3068-1986 | Broken brick (burnt clay) coarse aggregate for use in lime concrete (II-R.) |
| 3182-1986 | Broken brick (Burnt clay) fine aggregate for use in lime mortar |
| 3812-1981 | Fly Ash using as pozzolana and admixtures (Reaffirmed - 1999) |
| 4031-1996 | Methods of physical tests for hydraulic cement (Reaffirmed – 1996) |
| 4032-1985 | Method of chemical analysis of hydraulic cement (Reaffirmed - 1990) |
| 4098-1983 | Lime pozzolana mixture (Reaffirmed - 1989) |
| 6932 (Pt.I to X) | Methods of Test for Building Lime |
| 6932 (Pt.I)-1973 | Determination of insoluble residue, loss of ignition, silicon-dioxide, ferric &amp; Alum. Oxide, |
| 6932 (Pt.II)-1973 | Determination of carbon dioxide content |
| 6932 (Pt.III)-1 973 | Determination of residue on slaking of quick lime. |
| 6932 (Pt.IV)-1973 | Determination of fineness of hydrated lime |
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451-1999 Technical supply condition for wood screws
452-1973 Door springs, rat-tail type (II Rev.) (Reaffirmed 1990)
723-1972 Steel counter sunk head wire nails. (Reaffirmed - 1996)

729.1979 Drawer locks, cup board locks, and box locks (III Rev.) (Reaffirmed 1992)
848-1974 Synthetic resin adhesive for plywood (phenolic and aminoplastic) (I Rev.)
851-1978 Synthetic resin adhesive for construction work (Non-structural) in wood (I-Rev.) (amt
852-1994 Specifications for animal glue for general wood working purposes. (II Rev)
1003-1994 Timber panelled and glazed shutters
1003(Pt.I)-2003 Door shutters (III Rev.) (a
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1141-1993 Code of practice for seasoning of timber (II Rev.)
1200 Method of measurement of Building and Civil Engineering works
1200 (Pt.XIV)-1984 Glazing. (Reaffirmed - 1990)
1200 (Pt.XII)-1973 Wood work and joinery. (Reaffirmed - 1992)
1322-1993 Bitumen felts for water proofing and damp proofing.
1328-1996 Veneered decorative plywood
1341-1992 Steel Butt hinges (VI Rev.)
1378-1987 Oxidized copper finishes. (Reaffirmed - 1998)
1568-1970 Wire cloth for general purposes. (Reaffirmed - 1998)
1629-1960 Rules for grading of out size of timber. Superseded in I.S. 1331
1658-1977 Fiber hard board. (Reaffirmed - 1990)
1659-2004 Block boards
1708-1986 Method of testing of clear specimen of timber (II Rev) (Q.1) (Reaffirmed 1990)
1823-1980 Floor door stoppers. (Reaffirmed - 1992)
875-PET 1987 Dead locds – Unit not of bldg. & stored materials
1837 - 1966 For light pirot (I Rev.) (Reaffirmed 1990)
2095-1982 Gypsum plaster bow (I Rev) (an.1) (Ref. 1991)
2096-1992 A.C. flat sheet (I Rev.)
3828 - 1968 Ventilator chains (Reaf. 1990)
4835 - 1979 Polyvinyl acetate dispersion base adhesive for wood (1990)
2191 (Pt.II)-1983 Particle board face panels and hard board face panels. (Reaffirmed-1991)
2202-1999 Wooden flush door shutters (solid core type)
2202 (Pt.I)-1999 Plywood face panels for wooden flush door shutters
2202 (Pt.II)-1983 Particle board face panels for wooden flush door shutters. (Reaffirmed - 1991)
2209(Pt.I)-1976 Mortise locks (vertical type) (Reaffirmed 1992)
2380-1981 Method of test for wood particle board and boards from lignocellulosic materials (Reaf.1993)
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<td>Method for bend test for steel products other than sheet, strip, wire &amp; tube (reaffirmed)</td>
</tr>
<tr>
<td>1608-1995</td>
<td>Method for tensile testing of steel products (Reaffirmed 2001)</td>
</tr>
<tr>
<td>1852-1985</td>
<td>Rolling and cutting tolerance for hot rolled steel products. (Reaffirmed - 1991)</td>
</tr>
<tr>
<td>1977-1969</td>
<td>Structural steel (ordinary quality) (Reaffirmed 2001)</td>
</tr>
<tr>
<td>2062-1999</td>
<td>Structural steel (fusion welding quality). Supersedes IS 226-1 975</td>
</tr>
<tr>
<td>4351-2003</td>
<td>Steel door frames. (Reaffirmed – 1991)</td>
</tr>
<tr>
<td>4736-1986</td>
<td>Hot-dip zinc coatings on steel tubes. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>6248-1979</td>
<td>Metal rolling shutters and rolling grills</td>
</tr>
<tr>
<td>7452-1990</td>
<td>Hot rolled steel sections for doors, windows &amp; ventilators.</td>
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<tr>
<td>12. Flooring:</td>
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<tr>
<td>210-1993</td>
<td>Grey iron casting (Reaffirmed 1999)</td>
</tr>
<tr>
<td>653-1992</td>
<td>Sheet linoleum</td>
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<tr>
<td>777-1988</td>
<td>Glazed earthen-ware tiles</td>
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<tr>
<td>809-1992</td>
<td>Rubber flooring materials for general purpose</td>
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<tr>
<td>1122-1974</td>
<td>Methods for determination of specific gravity (*and porosity of natural building stones)</td>
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<tr>
<td>1124-1974</td>
<td>Method for test for water absorption of natural building stones</td>
</tr>
<tr>
<td>1130-1969</td>
<td>Marble (blocks, slabs and tiles). (Reaffirmed – 1993)</td>
</tr>
<tr>
<td>1198-1982</td>
<td>Code of practice for laying and maintenance of linoleum floors</td>
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<tr>
<td>1200 (Pt.XI)-1977</td>
<td>Method of measurements of pavings and floor finishes.</td>
</tr>
<tr>
<td>1443-1972</td>
<td>Code of practice for laying and finishing of cement concrete flooring tiles</td>
</tr>
<tr>
<td>1661-1972</td>
<td>Code of practice for application of cement and cement lime plaster finishes</td>
</tr>
<tr>
<td>2114-1984</td>
<td>Code of practice for laying in situ terrazzo floor finish</td>
</tr>
<tr>
<td>3400 (Pt.II)-2003</td>
<td>Hardness</td>
</tr>
<tr>
<td>3400 (Pt.X)-1977</td>
<td>Compression set at constant strain. (Reaffirmed – 2003)</td>
</tr>
<tr>
<td>3462-1986</td>
<td>Flexible P.V.C. Flooring. (Reaffirmed – 1991)</td>
</tr>
<tr>
<td>5339-1969</td>
<td>Code of practice for laying of hardwood parquet and wood block floors. (Reaffirmed –</td>
</tr>
<tr>
<td>9197-1979</td>
<td>Specifications for epoxy resin, hardeners and epoxy resin compositions for floor topping</td>
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### 13. ROOFING:

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<thead>
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<th>Code</th>
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<tr>
<td>73-1992</td>
<td>Paving Bitumen (Reaffirmed 1998)</td>
</tr>
<tr>
<td>277-2003</td>
<td>Galvanised steel sheets (plain and corrugated)</td>
</tr>
<tr>
<td>458-2003</td>
<td>Concrete pipes (with and without reinforcement)</td>
</tr>
<tr>
<td>459-1992</td>
<td>Unreinforced corrugated and semicorrugated asbestos cement sheets</td>
</tr>
<tr>
<td>651-1992</td>
<td>Salt glazed stone ware pipes and fittings</td>
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<tr>
<td>702-1988</td>
<td>Industrial Bitumen</td>
</tr>
<tr>
<td>1200 (Pt.IX)-1973</td>
<td>Method of measurements of roof covering (including cladding)</td>
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<tr>
<td>1200 (Pt.X)-1973</td>
<td>Method of measurements of ceiling and lining</td>
</tr>
<tr>
<td>1322-1993</td>
<td>Bitumen felts for water proofing and damp-proofing. (Reaffirmed -1988)</td>
</tr>
<tr>
<td>1346-1991</td>
<td>Code of practice for waterproofing of roof with bitumen felts</td>
</tr>
<tr>
<td>1626-1994(Part I-III)</td>
<td>Asbestos cement building pipes, gutters and fittings (Spigot and socket types)</td>
</tr>
<tr>
<td>2633-1986</td>
<td>Method of testing uniformity of coating on zinc coated articles. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>3348-1965</td>
<td>Fiber insulation boards. (Reaffirmed - 1990)</td>
</tr>
<tr>
<td>8183-1993</td>
<td>Bonded mineral wool. (Reaffirmed 2004)</td>
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### 14. FINISHING:

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<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>75-1973</td>
<td>Linseed oil, raw and refined. (Reaffirmed – 2003)</td>
</tr>
<tr>
<td>77-1976</td>
<td>Linseed oil, boiled, for paints. (Reaffirmed - 1999)</td>
</tr>
<tr>
<td>102-1962</td>
<td>Ready mixed paint, brushing, red, lead, non setting, priming.( Reaffirmed - 1996)</td>
</tr>
<tr>
<td>104-1979</td>
<td>Specification for ready mixed paint, brushing, zinc chrome, priming. (Reaffirmed - 1999)</td>
</tr>
<tr>
<td>133-1993</td>
<td>Enamel, interior (a) under coating (b) finishing colour as required</td>
</tr>
<tr>
<td>137-1965</td>
<td>Ready mixed paint, brushing, matt or egg-shell flat, finishing, interior, to Indian Standard Colour, as required. (Reaffirmed – 1999)</td>
</tr>
<tr>
<td>158-1981</td>
<td>Ready mixed paint, brushing, bituminous, black lead free acid alkali, water and heat resisting for general purposes. (Reaffirmed – 1999)</td>
</tr>
<tr>
<td>217-1988</td>
<td>Cut back bitumen (reaffirmed 1999)</td>
</tr>
<tr>
<td>I. S. CODE NO.</td>
<td>SUBJECT</td>
</tr>
<tr>
<td>---------------</td>
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</tr>
<tr>
<td>218-1983</td>
<td>Creosote and anthracene oil for use as wood preservatives (Reaffirmed 1998)</td>
</tr>
<tr>
<td>290-1961</td>
<td>Coal tar black paint. (Reaffirmed – 1996)</td>
</tr>
<tr>
<td>337-1975</td>
<td>Varnish, finishing interior. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>347-1975</td>
<td>Varnish, shellac for general purpose. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>348-1968</td>
<td>French polish. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>419-1967</td>
<td>Putty for use of window frames. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>427-1965</td>
<td>Distemper, dry, colour as required. (Reaffirmed – 1999)</td>
</tr>
<tr>
<td>428-2000</td>
<td>Washable distemper</td>
</tr>
<tr>
<td>525-1968</td>
<td>Varnish, finishing, exterior and general purposes. (Reaffirmed – 2001)</td>
</tr>
<tr>
<td>533-1998</td>
<td>Gum spirit of turpentine (oil of turpentine) (Reaffirmed 2003)</td>
</tr>
<tr>
<td>1200 (Pt. XII)-1976</td>
<td>Method of measurements of plastering and pointing</td>
</tr>
<tr>
<td>1200 (Pt.XIII)-1994</td>
<td>Method of measurements of white washing, colour washing, distempering and other finishes</td>
</tr>
<tr>
<td>1200 (Pt.XV)-1987</td>
<td>Methods of measurements of painting, polishing &amp; varnishing.</td>
</tr>
<tr>
<td>2095-1996 (Pt.I - III)</td>
<td>Gypsum plaster boards</td>
</tr>
<tr>
<td>2096-1992</td>
<td>Asbestos cement flat sheets.</td>
</tr>
<tr>
<td>2339-1963</td>
<td>Aluminium paint for general purposes, in dual container. (Reaffirmed – 1999)</td>
</tr>
<tr>
<td>2547-1976 (Pt I &amp; II)</td>
<td>Gypsum building plaster (Reaff. 1992)</td>
</tr>
<tr>
<td>2932-2003</td>
<td>Enamel synthetic, exterior (a) Under coating (b) Finishing.</td>
</tr>
<tr>
<td>2933-1975</td>
<td>Enamel, Exterior (a) Under coating (b) Finishing</td>
</tr>
<tr>
<td>5410-1992</td>
<td>Cement paint (Reaffirmed 1999)</td>
</tr>
<tr>
<td>5411 (Pt.I)-1 974</td>
<td>Plastic emulsion paint for interior use. (Reaffirmed – 1993)</td>
</tr>
</tbody>
</table>

15. DEMOLITION AND DISMANTLING:
1200(Pt.XVIII)-1974 Method of measurements of demolition and dismantling

16. SAFETY CODES
818-1968 (Reaf-03) Safety and healthy requirements in Electric and gas welding and cutting operations.
3696 (Pl.I)-1 1987 Safety code for scaffolds
3696 (Pl.II)-1991 Safety code for ladders
3764-1992 Safety code for Excavation works
4081-1986 Safety code for blasting and related drilling operation
4130-1991 Safety code for Demolition of Building
5916-1970 Safety code for construction involving use of hot bituminous materials
6922-1973 Structural subject to underground blasts code of practice for safety and design of structure subject to underground blasts.
7293-1974 Working with construction machinery- safety code for

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**Plumbing Works**
### Pipes and Fittings

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<th>Description</th>
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<tbody>
<tr>
<td>IS : 458</td>
<td>Specification for precast concrete pipes (with and without reinforcement)</td>
</tr>
<tr>
<td>IS : 651</td>
<td>Sanitary glazed stone ware pipes and fittings.</td>
</tr>
<tr>
<td>IS : 1239 (Part 2)</td>
<td>Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.</td>
</tr>
<tr>
<td>IS : 1536</td>
<td>Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS : 1537</td>
<td>Vertically cast iron pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS : 1538</td>
<td>Cast iron fittings for pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS : 1729</td>
<td>Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</td>
</tr>
<tr>
<td>IS : 1879</td>
<td>Malleable cast iron pipe fittings.</td>
</tr>
<tr>
<td>IS : 1978</td>
<td>Line pipe</td>
</tr>
<tr>
<td>IS : 1979</td>
<td>High test line pipe.</td>
</tr>
<tr>
<td>IS : 2501</td>
<td>Copper tubes for general engineering purposes</td>
</tr>
<tr>
<td>IS : 2643 (Part 1)</td>
<td>Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions.</td>
</tr>
<tr>
<td>IS : 2643 (Part 2)</td>
<td>Dimensions for pipe threads for fastening purposes : Part 2 Tolerances.</td>
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<tr>
<td>IS : 2643 (Part 3)</td>
<td>Dimensions for pipe threads for fastening purposes : Part 3 Limits of sizes.</td>
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<tr>
<td>IS : 3468</td>
<td>Pipe nuts.</td>
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<tr>
<td>IS : 3589</td>
<td>Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).</td>
</tr>
<tr>
<td>IS : 3989</td>
<td>Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</td>
</tr>
<tr>
<td>IS : 4346</td>
<td>Specifications for washers for use with fittings for water services.</td>
</tr>
<tr>
<td>IS : 4711</td>
<td>Methods for sampling steel pipes, tubes and fittings.</td>
</tr>
<tr>
<td>IS : 6392</td>
<td>Steel pipe flanges</td>
</tr>
<tr>
<td>IS : 6418</td>
<td>Cast iron and malleable cast iron flanges for general engineering purposes.</td>
</tr>
<tr>
<td>IS : 7181</td>
<td>Specification for horizontally cast iron double flanged pipe for water, gas and sewage.</td>
</tr>
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### Valves

<table>
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<th>Description</th>
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<tbody>
<tr>
<td>IS : 778</td>
<td>Specification for copper alloy gage, globe and check valves for water works purposes.</td>
</tr>
<tr>
<td>IS : 780</td>
<td>Specification for sluice valves for water works purposes (50 mm to 300 mm size).</td>
</tr>
<tr>
<td>IS : 1703</td>
<td>Specification copper alloy float valves (horizontal plunger type) for water supply fitting.</td>
</tr>
<tr>
<td>IS : 2906</td>
<td>Specification for sluice valves for water works purposes (350 mm to 1200 mm size).</td>
</tr>
<tr>
<td>IS : 3950</td>
<td>Specification for surface boxes for sluice valves.</td>
</tr>
<tr>
<td>IS : 5312 (Part 1)</td>
<td>Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 5312 (Part 2)</td>
<td>Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.</td>
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### Sanitary Fittings

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<td>IS : 771 (Part 1 to 3)</td>
<td>Specification for glazed fire clay sanitary appliances.</td>
</tr>
<tr>
<td>IS : 774</td>
<td>Specification for flushing cistern for water closets and urinals (other than plastic cistern)</td>
</tr>
<tr>
<td>IS : 775</td>
<td>Specification for cast iron brackets and supports for wash basins and sinks</td>
</tr>
<tr>
<td>IS : 781</td>
<td>Specification for cast copper alloy screw down bib taps and stop valves for water</td>
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<tr>
<td>IS : 1700</td>
<td>Specification for drinking fountains.</td>
</tr>
<tr>
<td>IS : 2556 (Part 4)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): part 4 specific requirements of wash basins.</td>
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<tr>
<td>IS : 2556 (Part 6 Sec 2)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): part 6 Specific requirements of urinals, section 2 half stall urinals.</td>
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<td>IS : 2556 (Part 6 Sec 5)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals, section 5 waste fittings.</td>
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<tr>
<td>IS : 2556 (Part 6 Sec 6)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals, section 6 water spreaders for half stall urinals.</td>
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<tr>
<td>IS : 2556 (Part 7)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 7 Specific requirements of half round channels.</td>
</tr>
<tr>
<td>IS : 2556 (Part 8)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 8 Specific requirements of siphoning wash down water closets.</td>
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<tr>
<td>IS : 2692</td>
<td>Specification for ferrule for water services</td>
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<tr>
<td>IS : 2717</td>
<td>Glossary of terms relating to vitreous enamelware and ceramic metal systems</td>
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<tr>
<td>IS : 2963</td>
<td>Specifications for waste plug and its accessories for sinks and wash basins.</td>
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<tr>
<td>IS : 3311</td>
<td>Specification for waste plug and its accessories for sinks and wash basins.</td>
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<tr>
<td>IS : 5961</td>
<td>Specification for cast iron gratings for drainage purposes.</td>
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<td>IS : 6249</td>
<td>Specification for gel-coated glass fibre reinforced polyester resin bath tubs.</td>
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<td>IS : 8931</td>
<td>Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.</td>
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<td>IS : 9758</td>
<td>Specification for flush valves and fitting for water closets and urinals.</td>
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**Water Quality Tolerance**

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<td>Method of sampling and test (physical and chemical) for water and waste water.</td>
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<td>IS : 4764</td>
<td>Tolerance limits for sewage effluents discharged into inland surface waters.</td>
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<td>IS : 10500</td>
<td>Drinking Water</td>
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**Pumps & Vessels**

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<td>Specification for horizontal centrifugal pumps for clear cold fresh water.</td>
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<td>IS : 2002</td>
<td>Steel plates for pressure vessels for intermediate and high temperature service including boilers.</td>
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<tr>
<td>IS : 2825</td>
<td>Code for unfired pressure vessels.</td>
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<tr>
<td>IS : 5600</td>
<td>Specification for sewage and drainage pumps</td>
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<tr>
<td>IS : 8034</td>
<td>Specification for submersible pump sets for clear, cold, fresh water.</td>
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<tr>
<td>IS : 8418</td>
<td>Specification for horizontal centrifugal self priming pumps.</td>
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**General**

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<th>Structural Steel Sections</th>
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<td>IS : 325</td>
<td>Three Phase Induction Motors</td>
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<td>IS : 554</td>
<td>Dimensions for pipe threads where pressure tight joints are required on the threads.</td>
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<td>IS : 694</td>
<td>PVC insulated cables for working voltages upto &amp; including 1100 V.</td>
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<tr>
<td>IS : 779</td>
<td>Specification for water meters (domestic type).</td>
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<tr>
<td>IS : 782</td>
<td>Specification for caulking load.</td>
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<tr>
<td>IS : 800</td>
<td>Code of practice for general construction in steel</td>
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<td>IS : 1068</td>
<td>Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.</td>
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<tr>
<td>IS : 1172</td>
<td>Code of Basic requirements for water supply drainage and sanitation.</td>
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<td>IS : 1367 (Part 2)</td>
<td>Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.</td>
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<tr>
<td>IS : 1554 (Part 1)</td>
<td>PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V.</td>
</tr>
<tr>
<td>IS : 1554 (Part 2)</td>
<td>PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV.</td>
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<tr>
<td>IS : 1726</td>
<td>Specification for cast iron manhole covers and frames.</td>
</tr>
<tr>
<td>IS : 2064</td>
<td>Selection, installation and maintenance of sanitary appliance code of practice.</td>
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<tr>
<td>IS : 2065</td>
<td>Code of practice for water supply in buildings.</td>
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<tr>
<td>IS : 2104</td>
<td>Specification for water meter for boxes (domestic type)</td>
</tr>
<tr>
<td>IS : 2373</td>
<td>Specification for eater meter (bulk type)</td>
</tr>
<tr>
<td>IS : 2379</td>
<td>Colour code for identification of pipe lines.</td>
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</tbody>
</table>

**I. S. CODE NO. S U B J E C T**

| IS : 2527 | Code of practice for fixing rainwater gutters and down pipes for roof drainage. |
| IS : 2629 | Recommended practice for hot dip galvanizing on iron and Steel. |
| IS : 3114 | Code of practice for laying of cast iron pipes |
| IS : 4853 | Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes. |
| IS : 5329 | Code of practice for sanitary pipe work above ground for buildings. |
| IS : 5455 | Cast iron steps for manholes. |
| IS : 6159 | Recommended practice for design and fabrication of material, prior to galvanizing. |
| IS : 7558 | Code of practice for domestic hot water installations. |
| IS : 8321 | Glossary of terms applicable to plumbing work. |
### SIGNATURE & SEAL OF TENDERER

| IS : 8419 (Part 1) | Requirements for water filtration equipment : Part 1 Filteration medium sand and gravel. |
| IS : 8419 (Part 2) | Requirements for water filtration equipment : Part 2 under drainage system. |
| IS : 9668 | Code of practice for provision and maintenance of water supplies and fire fighting. |
| IS : 9842 | Preformed fibrous pipe insulation. |
| IS : 9912 | Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines. |
| IS : 10221 | Code of practice for coating and wrapping of underground mild steel pipelines. |
| IS : 10446 | Glossary of terms relating to water supply and sanitation. |
| IS : 11149 | Rubber Gaskets |
| IS : 11790 | Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings.. |
| IS : 5572 | Code of practice for sanitary pipe work. |
| BS : 6700 | Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages. |
| BS : 8301 | Code of practice for building drainage. |
| BSEN : 274 | Sanitary tap were, waste fittings for basins, bidets and baths. General technical specifications. |

**Fire Fighting & Fire Protection**

| NBC Part – IV | National Building Code of India; Part IV Fire & Life Safety |
| TAC | Tariff Advisory Committee fire protection manual Part-I. |
| TAC | Rules of Tariff Advisory Committee for automatic sprinkler system. |
| NFPA : 13 | Installation of Sprinkler System |
| NFPA : 14 | Installation of Standpipe & Hose System |
| NFPA : 20 | Installation of Stationary pump for Fire Protection |
| IS : 636 | Non-percolating flexible fire fighting delivery hose. |
| IS : 884 | Specification for first aid hose reel for fire fighting. |
| IS : 901 | Specification for couplings, double male and double female, instantaneous pattern for fire fighting. |

### I. S. CODE NO. S U B J E C T

| IS : 902 | Suction hose couplings for fire fighting purposes. |
| IS : 903 | Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner. |
| IS : 904 | Specification for 2-way and 3-way suction collecting heads for fire fighting purposes. |
| IS : 907 | Specification for suction strainers, cylindrical type for fire fighting purposes. |
| IS : 908 | Specification for fire hydrant, stand post type. |
| IS : 909 | Specification for underground fire hydrant, sluice valve type. |
| IS : 910 | Specification for portable chemical foam fire extinguisher. |
| IS : 933 | Specification for portable chemical foam fire extinguisher. |
| IS : 2171 | Specification for portable fire extinguishers dry powder (catridge type) |
| IS : 2190 | Selection, installation and maintenance of first aid fire extinguishers – Code of practice. |
| IS : 2871 | Specification for branch pipe, universal, for fire fighting purposes. |
| IS : 2878       | Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted). |
| IS : 3844       | Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises. |
| IS : 5290       | Specification for landing valves. |
| IS 5714        | Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting. |
| IS : 8423       | Specification for controlled percolation type hose for fire fighting. |
| IS : 10658      | Specification for higher capacity dry powder fire extinguisher (trolley mounted). |
| IS : 11460      | Code of practice for fire safety of libraries and archives buildings. |
| IS : 5514       | Reciprocating internal combustion engines : Performance. |
III – MANDATORY TESTS

NOTES:

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

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

3. Testing charges, including incidental charges and cost of sample for testing shall be born by the contractor for all mandatory tests.

4. Testing charges for optional tests shall be reimbursed by the Department. However, the incidental charges and cost of sample for testing shall be born by the contractor.

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

THE MANDATORY TESTS SHALL BE AS FOLLOWS:

<table>
<thead>
<tr>
<th>Material</th>
<th>Test</th>
<th>Field / laboratory test</th>
<th>Test procedure</th>
<th>Minimum quantity of material / Work for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced cement concrete work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water for Construction purposes</td>
<td>Ph value Limits of</td>
<td>Lab</td>
<td>IS 3025</td>
<td>Water from each source</td>
<td>Before commencement of work &amp; thereafter:</td>
</tr>
<tr>
<td></td>
<td>Acidity Limits of</td>
<td></td>
<td></td>
<td>Mandatory – Once in one year from each source; Optional: once in 3 months from each source; Municipal supply - optional.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alkality Percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>of solids Chlorides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suspended matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulphates Inorganic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>solids Organic solids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforced cement</td>
<td>b) slump test</td>
<td>Field</td>
<td>IS: 1199</td>
<td>a) 20 cu.m. for slabs, beams and connected columns .</td>
<td>a) 20 cu.m. Part there of or more frequently as require by the Engr.-in-Charge.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b) 5 Cu.m in case of columns</td>
<td></td>
</tr>
</tbody>
</table>

TENDER DOCUMENT VOL 2 OF 3 (TECHNICAL SPECIFICATION) 18 | P a g e 3 4 2
SIGNATURE & SEAL OF TENDERER
<table>
<thead>
<tr>
<th>Material</th>
<th>Test</th>
<th>Test procedure</th>
<th>Minimum quantity of material / Work for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>concrete</td>
<td>c) cube test</td>
<td>Lab</td>
<td>IS : 516</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a) 20 cu.m. in slab, beams, &amp; connected columns.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) 5 cum in case of columns.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a) every 20 cum of a day's concreting (Ref. as per frequency of sampling).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) Every 5 cum.</td>
<td></td>
</tr>
<tr>
<td>Ready mixed cement (IS-4926)</td>
<td>Cube test</td>
<td>Lab</td>
<td>IS-516 and as per para 6.3.2 of IS-4926-2003</td>
<td>50 cum</td>
</tr>
<tr>
<td>concrete</td>
<td></td>
<td></td>
<td>One for every 50 cum of production or every 50 batches, whichever is the greater frequency</td>
<td></td>
</tr>
<tr>
<td>Note: for all other small items and where RCC done in a day is less than 5 cum, test may be carried out as required by Engineer-in-Charge.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortars:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lime</td>
<td>Chemical &amp; physical properties of lime</td>
<td>Laboratory</td>
<td>IS; 6932 (part 1 to x)</td>
<td>5 M.T.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 M.T. or part thereof as decided by the Engineer-in-Charge</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>Bulking of Sand</td>
<td>Field</td>
<td>20 CU.M.</td>
<td>Every 20 cu.m or part thereof or more frequently as decided by Engineer-In-Charge</td>
</tr>
<tr>
<td>Silt content</td>
<td>Field</td>
<td>IS:383</td>
<td>20 CU.M.</td>
<td>Every 20 cu.m or part thereof or more frequently as decided by Engineer-In-Charge</td>
</tr>
<tr>
<td>Particle size and distribution</td>
<td>Field / laboratory decided by Engr -in-Charge</td>
<td>IS:383</td>
<td>40 CU.M.</td>
<td>Every 40 cu.m. of fine aggregate / sand required in RCC. work only.</td>
</tr>
<tr>
<td>Organic Impurities</td>
<td>Field / laboratory</td>
<td>IS:383</td>
<td>20 CU.M.</td>
<td>Every 20 cu.m. or part thereof or more frequently as decided by the Engineer-in-Charge</td>
</tr>
<tr>
<td>Chloride &amp; sulphate content tests</td>
<td>Optional</td>
<td></td>
<td>Once in three months.</td>
<td></td>
</tr>
<tr>
<td><strong>Cement</strong></td>
<td><strong>Test requirement</strong></td>
<td><strong>Fineness (m²/kg)</strong></td>
<td><strong>IS 4031 (Part-II)</strong></td>
<td><strong>Each fresh lot</strong></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Normal consistency</td>
<td></td>
<td></td>
<td>IS 4031 (Part-IV)</td>
<td></td>
</tr>
<tr>
<td>Setting time (minutes) a) Initial b) Final</td>
<td></td>
<td></td>
<td>IS 4031 (Part-V)</td>
<td></td>
</tr>
<tr>
<td>Soundness a) Le-Chat expansion (mm) b) Autoclave(%)</td>
<td></td>
<td></td>
<td>IS 4031 (Part-III)</td>
<td></td>
</tr>
<tr>
<td>Compressive Strength (Mpa) a) 72+/-1 hr b) 168+/-2hr</td>
<td></td>
<td></td>
<td>IS 4031 (Part-VI)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Stone Aggregate</strong></th>
<th><strong>a) Percentage of soft or deleterious materials</strong></th>
<th><strong>General visual inspection / Lab test where required by the Engr-in-Charge</strong></th>
<th><strong>IS 2386 Part II</strong></th>
<th><strong>One test for each source</strong></th>
<th><strong>One test for each source</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle size distribution</td>
<td>Field / Lab</td>
<td>-</td>
<td>10 cu.m</td>
<td>Every 40 cum. Or part thereof and</td>
<td></td>
</tr>
</tbody>
</table>

Once in three months for each source for coarse and fine aggregates required in RCC works, for a minimum quantity - 10 cum for coarse aggregate and 40 cum for fine aggregate.

<table>
<thead>
<tr>
<th><strong>Estimation of Organic impurities</strong></th>
<th><strong>Field / Lab</strong></th>
<th><strong>IS 2386 Part II</strong></th>
<th><strong>10 Cum</strong></th>
<th><strong>-do-</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>b) Specific Gravity</td>
<td>Field / Lab</td>
<td>IS 2386</td>
<td>10 Cum</td>
<td>-do-</td>
</tr>
</tbody>
</table>

<p>| <strong>Bulk Density</strong> | <strong>Field / Lab</strong> | <strong>IS 2386</strong> | <strong>10 Cum</strong> | <strong>-do-</strong> |</p>
<table>
<thead>
<tr>
<th>Material</th>
<th>Test</th>
<th>Field / laboratory test</th>
<th>Test procedure</th>
<th>Minimum quantity of material / Work for carrying out</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) Aggregate crushing strength</td>
<td>Field / Lab</td>
<td>IS 2386</td>
<td>10 Cum</td>
<td>-do-</td>
<td></td>
</tr>
<tr>
<td>c) Aggregate impact value</td>
<td>Field / Lab</td>
<td>IS 2386</td>
<td>10 Cum</td>
<td>-do-</td>
<td></td>
</tr>
<tr>
<td>Timber</td>
<td>Moisture</td>
<td>Field (by moisture meter) Laboratory test as required by Engineer-in-Ch.</td>
<td></td>
<td>1 Cu.M.</td>
<td>Every one Cum or part thereof</td>
</tr>
<tr>
<td>Flush Door</td>
<td>End immersion test Knife test Adhesion test</td>
<td>Laboratory</td>
<td>IS: 2202 (Part 1) &amp; (Part II)</td>
<td>26 shutters</td>
<td>As per sampling and testing as instructed by the Engineer-in-Charge.</td>
</tr>
<tr>
<td>Bricks</td>
<td>Testing of bricks / brick tiles for dimensions Compressive strength Water absorption Efflorescence</td>
<td>Laboratory</td>
<td>IS 3495 Part I to IV</td>
<td>No. of bricks to be selected &amp; bricks lot 20 : 2001 to 10000 32 : 10001 to 35000 50 : 35001 to 50000 20 : for every addl. 50000 or part thereof. If &lt; 20000, As per decision of EIC.</td>
<td>Permissible defective bricks in the sample 1 2 3 1</td>
</tr>
<tr>
<td>Material</td>
<td>Test</td>
<td>Field / laboratory test</td>
<td>Test procedure</td>
<td>Minimum quantity of material / Work for carrying out</td>
<td>Frequency of testing</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
<td>----------------</td>
<td>------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Steel for RCC</td>
<td>Physical tests</td>
<td>Lab / field</td>
<td>IS 1608</td>
<td>Each lot from each source from each diameter of bar</td>
<td>Above 100 Tonnes</td>
</tr>
<tr>
<td></td>
<td>a) Tensile strength</td>
<td></td>
<td>IS 1786</td>
<td>Dia &lt; 10 mm one sample for each 25 tonnes or part thereof</td>
<td>Dia &lt; 10 mm one sample for each 40 tonnes or part thereof</td>
</tr>
<tr>
<td></td>
<td>b) Retest</td>
<td></td>
<td>IS 1786</td>
<td>If dia is &gt;10 mm but less than 16 mm: One sample for each 35 tonnes or part thereof</td>
<td>If dia is &gt;10 mm but less than 16 mm: One sample for each 45 tonnes or part thereof.</td>
</tr>
<tr>
<td></td>
<td>c) Re-bound test</td>
<td></td>
<td>IS 1786</td>
<td>If dia &gt;16 mm one sample for each 45 tonnes</td>
<td>If dia &gt;16 mm one sample for each 50 tonnes.</td>
</tr>
<tr>
<td></td>
<td>d) Nominal mass</td>
<td></td>
<td>IS 1599</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Bend test</td>
<td></td>
<td>IS 1786</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) Elongation test</td>
<td></td>
<td>IS 1786</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g) Proof stress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical Tests:</td>
<td></td>
<td>IS 1786</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Carbon Constituent</td>
<td></td>
<td></td>
<td>For every fresh lot of one truck or less as directed by the Engineer-in-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Sulphur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Phosphorus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Phosphorus &amp; Sulphur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soil coretest</td>
<td></td>
<td>IS 12175</td>
<td>Two for every 50 sqm</td>
<td>As per para 1.10 &amp; 1.11 of this book</td>
</tr>
<tr>
<td></td>
<td>OMC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proctor density</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mosaic tiles</td>
<td></td>
<td>IS 13801</td>
<td>5000 tiles and more for each manufacturer &amp; thereafter for every 10000 tiles or part thereof.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per IS 13801</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Para 14.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ceramic tiles</td>
<td></td>
<td>IS 13630</td>
<td>3000 tiles and more for each manufacturer and thereafter for every 3000 tiles or part thereof.</td>
<td></td>
</tr>
</tbody>
</table>

**OTHER MANDATORY TESTS:** Soil core tests; Testing aggregate - particle size distribution; Ceramic tiles; Mosaic tiles

**CI pipes:** Dimensional, mass, Hydrostatic; GI pipes; Lead; RCC hume pipes; Stoneware pipes

**ROAD WORK:** Soil core tests; Grading of metal for WBM; Bitumen grade; Bitumen content; Load test on concrete gratings.

**OPTIONAL TESTS:** Testing aggregate-surface moisture, impact value pectrographic; alkali reaction; Dimensional tests of bricks; Testing the mass of zinc coating on GI door frame, steel windows, test for chemical and physical properties; Anodic coating on aluminium fittings and aluminium sections, Unit weight of aluminium sections;

Testing structural steel; Chequered plate, Unit weight, Thickness, Chemical and physical properties

Presence of preservative on factory made panelled door, kiln seasoned chemically treated wood products, Moisture content in wood products.

**TESTING, TOLERANCE, ACCEPTANCE AND MODE OF PAYMENT:**

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

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**SIGNATURE & SEAL OF TENDERER**
limit as stipulated in relevant IS for acceptance. Such materials shall be accepted as standard.

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 the tests and tolerances are within the specified limits. 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.
IV. SECTION ‘A’ - CIVIL WORKS

1. EARTH WORK

1.1. SCOPE OF WORK:

The scope of work covered under this specifications pertains to excavation of foundations, trenches, pits and 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, levelled 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.

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 the execution 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-ordinate 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 by the 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 1.5 m 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 1.5 m 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 each category.

a) All types of soils, murrum, boulders.

b) Soft rock.

c) Hard rock.

1.5.1.  

a) **All types of Soils, Murrum, Boulders**: This includes earth, murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof and soft and hard murrum, shingle etc. which is loose enough to be removed with spades, shovel and pick axes. Boulders not more than 0.03 cum. in volume found during the course of excavation shall also fall under this classification.

b) **Excavation in Soft Rock**: This shall include all materials which are rock or hard conglomerate, all decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 cum. in volume but not bigger than 0.5 cum. and other varieties of soft rock which can be removed only with pick axes, crow bars, wedges and hammers with some difficulty. The mere fact that the contractor resorts to blasting and/or wedging and chiselling for reasons of his own, shall not mean the rock is classifiable as hard rock.

c) **Excavation in Hard Rock**: This includes all rock other than soft rock mentioned in para 1.5.1 (b) viz. soft rock, occurring in masses, boulders having approximate volume more than 0.5 cum. plain or reinforced cement concrete, which can best be removed by blasting or chiselling and wedging where blasting cannot be permitted owing to any restriction on site.

i) **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.

ii) **Excavation in Hard Rock by Chiselling and Wedging**: Where blasting is not permitted and if the Engineer-in-Charge so desires, the excavation shall be done by chiselling 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
1.6. EXCAVATION PARAMETERS: 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 the width of mudmat 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 no further work shall be taken up until the Engineer-in-Charge has approved the depth and dimensions and also the nature of foundation materials. Levels and measurements shall also be recorded prior to taking up 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 of sides 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 the water discharged sufficiently away from the foundations to keep it free from nuisance to other works in the neighbourhood.

1.9. DISPOSAL OF EXCAVATED MATERIALS:

a) ANTIQUITIES: Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government.

b) 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-Charge and 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 any way shall be disposed off, levelled and compacted as directed by the Engineer-in-Charge within a specified lead. The site shall be left clean of all debris and levelled on completion.

1.10. BACKFILLING IN SIDES OF FOUNDATIONS, PLINTH, UNDER FLOOR ETC.:

The backfilling shall be done after the concrete or masonry has fully set and shall be done in such a way as 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 in backfilling. The scope of work for backfilling/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 150 mm. in thickness, watered and well consolidated by means of rammers to at least 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 in layers not exceeding 150 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 recovered from the contractors bill.

1.11. 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.

i) Earth Filling: The earth, soft murrum etc. so brought shall be filled up in layers of 15 cm depth, each layer being well watered and consolidated by approved hand or mechanical tampers or other suitable means to achieve the required density.

ii) Gravel or Sand Filling: Gravel if required to be filled under floors, shall be single washed gravel of 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 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. LEAD & LIFT

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.

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 not apply to cases where no lift is involved as in hill side cutting.

1.13. MODE OF MEASUREMENTS:

1.13.1. 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 paid for. 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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Maximum limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Waterproofing and shuttering works upto 2M depth</td>
<td>Maximum upto 800mm from wall face or 300mm from the edge of offset / raft, whichever is more.</td>
</tr>
<tr>
<td>ii) Waterproofing and shuttering works beyond 2M depth</td>
<td>Maximum upto 900mm from wall face or 300mm from the edge of offset / raft, whichever is more.</td>
</tr>
</tbody>
</table>

Reasonable working space beyond concrete dimension required for waterproofing and shuttering where considered necessary in the opinion of Engineer-in-Charge will be allowed in execution and considered for payment for underground water tank, sump, septic tank etc.

1.13.2. 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 1.5.1 (c). 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.

1.13.3. The rate for excavation shall include carting and disposing and levelling 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.

1.13.4. 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 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.

1.13.5. 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 inschedule 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.

1.13.6. 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. Therefore no extra payment will be made for any excavation done other than the required quantity as per the plan dimension indicated in the drawings.

1.13.7. Measurements for excavation over areas shall be determined by levels or by “Dead men” or both at 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.

* * * *

2. ANTITERMITE TREATMENT:

2.1 GENERAL:

Preconstructional 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 subterranean 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 preferably 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 preconstructional 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 works and arrange to carryout the soil treatment in time after proper co-ordination with Department and other contractors if any, working at site.

2.2 SCOPE:

The scope of preconstructional antitermite 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 II) 1981 and/or as per direction of the Engineer-in-Charge.

2.3 SITE PREPARATION:
a) Remove all trees, stumps, logs or roots from the building site.
b) Remove all concrete form work if left anywhere, levelling pegs, timber off-cuts and other builders 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 to a depth of 75 mm. atleast.
f) All sub-floor levelling and grading should be completed, all cutting, trenches and excavations should be completed with backfilling in place, borrowed fill must be free from organic debris and shall be well compacted. If this is not done supplementary treatments should be made to complete the barrier.

2.4 CHEMICAL TO BE USED:

The effectiveness of chemical depends upon the choice of the chemical, the dosage adopted and the thoroughness of application. 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.

Soil Treatment : One of the approved chemicals in water emulsion, recommended by the Indian Pest Control Association (IPCA), and approved by the Engineer-in-Charge, shall be used uniformly over the area to be treated.

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/use 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.

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 the trenches/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 achieve 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 the soil right upto the bottom. The soil shall be tamped back into place after this operation.

2.5.4 Treatment for Expansion Joints: The soil beneath the expansion joints shall receive special attention when the treatment under 2.5.1 above is in progress. This treatment shall be supplemented by treating through the expansion joint after sub-grade has been laid at the rate of 2 litres per 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:

2.7.1 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 vapours 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 in 2.7.2 to 2.7.5 particularly when handling these chemicals in the form of concentrates.

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

2.7.3 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 with soap 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.

2.7.4 The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.

2.7.5 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 all tools, plants, sprayers required for complete operation.

* * * *

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.

3.2.1 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.

3.2.2 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.

3.2.3 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. Excess murrum if any over the surfaces shall be removed. Unless otherwise specified, the murrum 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 a 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 up to 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 soiling work actually done limiting to the dimensions as per drawings 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.

* * *
4.0 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. These specifications also cover the requirement of form work and reinforcement.

4.2. Unless otherwise specified, the manufacture and placing of concrete shall be done by weigh batching. However, in the specific cases where mechanized batching system (Ready mix concrete), mechanical transport and pumping is specified the same shall be followed as per the terms of the contract.

4.3 CEMENT CONCRETE (PLAIN AND REINFORCED):

4.3.1 The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise, shall conform to the applicable portions of these specifications.

4.3.2 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. List of mandatory test for RCC to be carried out is enclosed as Annexure "A".

4.3.3 Materials for Standard Concrete: The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland/Portland pozzolana cement, clean sand, natural coarse aggregate, clean water, ice and admixtures if specially called for on drawings or schedule of quantities.

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 with regard 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.

4.3.3.1 (A). 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 used with 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 rice husk.

Metakaoline: Metakaoline having fineness between 700 to 900 m²/kg may be used as pozzolanic material in concrete.

Note: Metakaoline is obtained by calcination of pure or refined kaolinitic clay at a temperature between 650°C and 850°C, followed by grinding to achieve a fineness of 700 to 900 m²/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.

**Specification for Storage:**

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 kept closed 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.

4.3.3.2 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 coning or segregation. Each layer shall cover the entire area of the stock pile before the 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.

**4.3.3.2.1 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.

**4.3.3.2.2 Machine Made 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.

**4.3.3.2.3 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:

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<tr>
<th>Sl.No</th>
<th>Substances</th>
<th>Percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Uncrushed</td>
</tr>
<tr>
<td>i)</td>
<td>Material finer than 75 micron I.S. Sieve</td>
<td>3.00</td>
</tr>
<tr>
<td>ii)</td>
<td>Shale</td>
<td>1.00</td>
</tr>
<tr>
<td>iii)</td>
<td>Coal and lignite</td>
<td>1.00</td>
</tr>
<tr>
<td>iv)</td>
<td>Clay lumps</td>
<td>1.00</td>
</tr>
<tr>
<td>v)</td>
<td>Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) and (iv) for crushed sand.</td>
<td>5.00</td>
</tr>
</tbody>
</table>

**GRADATION:** Unless otherwise directed or approved, the grading of sand shall be within the limits indicated
<table>
<thead>
<tr>
<th>I.S. Sieve Designation</th>
<th>Percentage passing for single sized aggregates of nominal size</th>
<th>Percentage passing for graded aggregates of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63 mm</td>
<td>40 mm</td>
</tr>
<tr>
<td>75 mm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>53 mm</td>
<td>85-100</td>
<td>100</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>0-30</td>
<td>85-100</td>
</tr>
<tr>
<td>19 mm</td>
<td>0-5</td>
<td>0-20</td>
</tr>
</tbody>
</table>

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.

**4.3.3.2.2 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:
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 its oven 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>
<thead>
<tr>
<th>Sl.No.</th>
<th>Substances</th>
<th>Uncrushed</th>
<th>Crushed</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Material finer than 75 micron I.S. Sieve</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>ii)</td>
<td>Coal and lignite</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>iii)</td>
<td>Clay lumps</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>iv)</td>
<td>Soft fragments</td>
<td>3.00</td>
<td>--</td>
</tr>
<tr>
<td>v)</td>
<td>Total of all the above substances</td>
<td>5.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>

### 4.3.3.3 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 typical of 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 cubes prepared 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 made with the same cement and distilled water. The test blocks shall be prepared and stored in the same manner as specified in IS 516.
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 H2SO4. The details of test shall be as per I.S. 3025 (Part 23).

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

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Type of solid</th>
<th>Tested as per</th>
<th>Permissible limit (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Organic</td>
<td>IS 3025 (Part 18)</td>
<td>200 mg/l</td>
</tr>
<tr>
<td>ii)</td>
<td>Inorganic</td>
<td>IS 3025 (Part 18)</td>
<td>3000 mg/l</td>
</tr>
<tr>
<td>iii)</td>
<td>Sulphates (as SO2)</td>
<td>IS 3025 (Part 24)</td>
<td>400 mg/l</td>
</tr>
<tr>
<td>iv)</td>
<td>Chlorides (asCl)</td>
<td>IS 3025 (Part 32)</td>
<td>2000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced cement concrete work.</td>
</tr>
<tr>
<td>v)</td>
<td>Suspended matter</td>
<td>IS 3025 (Part 17)</td>
<td>2000 mg/l</td>
</tr>
</tbody>
</table>

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

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: This is to investigate the grading of aggregates, water cement ratio, workability and the quantity of cement required to give works cubes of the characteristic strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Mix proportioning shall be carried out according to the ACI standard designation ACI-613 or Design of concrete mixes - Road research Note No.4, Department of Scientific and Industrial Research U.K. or I.S. 10262 - 1982.

After award of the work, if so desired by the contractor, he/she may be allowed by the Engineer-in-Charge, till the designed mix is obtained, to carry out the reinforced concrete work in foundation and plinth as per equivalent nominal mix against the specified design mix concrete as per I.S. Codes. However, all other specification for design mix shall govern for nominal mix also and nothing extra shall be paid for use 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 nominal mix can also be permitted by the Engineer-in-Charge.

GRADES OF CONCRETE: The concrete shall be in grades designated as below.

<table>
<thead>
<tr>
<th>Group</th>
<th>Grade</th>
<th>Specified Characteristic compressive strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary concrete</td>
<td>M 10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M 15</td>
<td>15</td>
</tr>
<tr>
<td>No.</td>
<td>Exposure</td>
<td>Minimum cement content Kg/m³</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Mild</td>
<td>220</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>240</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
<td>250</td>
</tr>
<tr>
<td>4</td>
<td>Very Severe</td>
<td>260</td>
</tr>
<tr>
<td>5</td>
<td>Extreme</td>
<td>280</td>
</tr>
</tbody>
</table>

**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 maybe 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.

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 M35 and above.

Nominal cover to meet specified period of fire resistance

<table>
<thead>
<tr>
<th>Fire resistance</th>
<th>Nominal cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BEAMS</td>
</tr>
<tr>
<td>Simply Supported</td>
<td>Continuous</td>
</tr>
<tr>
<td>H mm</td>
<td>mm</td>
</tr>
<tr>
<td>0.5</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>70</td>
</tr>
</tbody>
</table>

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 to reduce the risks of spalling.

Adjustments to Minimum cement contents for Aggregates other than 20 mm Nominal Maximum size:

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Nominal maximum</th>
<th>Adjustments to Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i)</td>
<td>10</td>
<td>+40</td>
</tr>
<tr>
<td>ii)</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>iii)</td>
<td>40</td>
<td>-30</td>
</tr>
</tbody>
</table>

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 and characteristic strength not less than appropriate values given in the table above.

**DEGREE OF CONTROL:**

**Selection of Water Cement Ratio:** Since different cements and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concretes of different compressive strength for the same free water cement ratio, the relationship between strength and free water-cement ratio should preferably be established for the materials actually to be used. In the absence of such data, the preliminary free water-cement ratio (by mass) corresponding to the target strength at 28 days may be selected from the relationship shown in Fig.1 of I.S. 10262.

Alternately, the preliminary free water cement ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig.2- I.S. 10262, using the curve corresponding to the 28 days cement strength to be used for the purpose.

Other relevant items to be used with design of mix should strictly conform to the relevant clauses and appendices of I.S. 10262.

The calculated mix proportions shall be checked by means of trial batches as per IS 10262.

The free water cement ratio selected as above, should be checked against the limiting water cement ratio for the requirement of durability and the lower of the two values should be adopted.

Whenever there is a change either in required strength of concrete or water cement ratio or workability or the source of aggregates and/or cement, fresh tests shall be carried out to determine the revised proportion of the mix to suit the altered conditions. While designing mix proportions, over wet mixes shall always be avoided.

While fixing the value for water cement ratio for Design Mix assistance may be derived from the standard graph showing the relationship between the 28 days compressive strength of concrete mixes with different water-cement ratios and the 7 days compressive strength of cement tested in accordance with I.S.269.

It will be contractors sole responsibility to establish the concrete mix designs for different grades of concrete specified in the work consistent with the workability required for nature of work and also taking into consideration the assumed standard deviation which will be expected at site or by establishing the standard deviation based on 30 test results at site for each grade of concrete so as to produce concrete of required strength, durability and surface finish. The materials and proportions used in making the tests to be carried out either at site or under laboratory, conditions shall be similar in all respects to those to be actually employed in the works, as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce the concrete of the required consistency to give such specified strength.

**4.4.2: STANDARD DEVIATION:**

The standard deviation for each grade of concrete shall be calculated separately.

**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:

\[ \text{Estimated standard deviation } S = \sqrt{\frac{\sum \Delta^2}{n-1}} \]

ii) Where \( \Delta \) 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>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Assumed Standard Deviation N/ mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 10</td>
<td>3.5</td>
</tr>
<tr>
<td>M 15</td>
<td></td>
</tr>
<tr>
<td>M 20</td>
<td>4.0</td>
</tr>
<tr>
<td>M 25</td>
<td></td>
</tr>
<tr>
<td>M 30</td>
<td>5.0</td>
</tr>
<tr>
<td>M 35</td>
<td></td>
</tr>
<tr>
<td>M 40</td>
<td></td>
</tr>
<tr>
<td>M 45</td>
<td></td>
</tr>
<tr>
<td>M 50</td>
<td></td>
</tr>
</tbody>
</table>

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 gradings 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 / mm².

4.4.3 Proportioning, Consistency, Batching and Mixing of Concrete:

4.4.3.1 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 gradings 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.

**Exposure conditions**: General environment:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Environment</th>
<th>Exposure Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Mild</td>
<td>Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.</td>
</tr>
<tr>
<td>ii)</td>
<td>Moderate</td>
<td>Concrete surfaces sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water Concrete surfaces sheltered from saturated salt air in coastal area</td>
</tr>
<tr>
<td>iii)</td>
<td>Severe</td>
<td>Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea water Concrete exposed to coastal environment.</td>
</tr>
<tr>
<td>iv)</td>
<td>Very severe</td>
<td>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.</td>
</tr>
<tr>
<td>v)</td>
<td>Extreme</td>
<td>Surface of members in tidal zone Members in direct contact with liquid/solid aggressive chemicals.</td>
</tr>
</tbody>
</table>

**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 themixer 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.

**4.4.3.2 Consistency and slump**: Concrete shall be of a consistency and workability suitable for the
condition 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 otherwise instructed by the Engineer-in-Charge.

**Workability of concrete:**

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

**Note:**

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, use of adequate materials, and components to be supplied by the producer, 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...
general Quality Assurance Plan which shall identify the key elements necessary to provide fitness 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 intended needs. 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.

4.4.3.3 Batching and mixing of concrete:

**BATCHING**

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 of both 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 medium project 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 graded aggregate 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 proportions when 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 be checked 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 bulk densities 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.
Surface water carried by aggregate

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Aggregate</th>
<th>Approximate quantity of surface water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percent by mass</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i)</td>
<td>Very wet sand</td>
<td>7.5</td>
</tr>
<tr>
<td>ii)</td>
<td>Moderately wet sand</td>
<td>5.0</td>
</tr>
<tr>
<td>iii)</td>
<td>Moist sand</td>
<td>2.5</td>
</tr>
<tr>
<td>iv)</td>
<td>Moist gravel or crushed rock</td>
<td>1.25 – 2.5</td>
</tr>
</tbody>
</table>

Coarser aggregate less the 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.

MIXING:

Concrete shall be mixed in a mechanical mixer. The mixer should have 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. If there 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, plasticisers and superplasticizers shall be restricted to 0.50, 1.0 and 2.0 % respectively by weight of cementious 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>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cast iron cube moulds 15 cm. Size</td>
<td>12 Nos. (min.)</td>
</tr>
<tr>
<td>2.</td>
<td>Slump cone complete with tamping rod</td>
<td>1 Set</td>
</tr>
<tr>
<td>3.</td>
<td>Lab. balance to weigh upto 5 kg. with sensitivity of 10 gm.</td>
<td>1 No.</td>
</tr>
<tr>
<td>4.</td>
<td>Laboratory balance of 2 kg. capacity and of sensitivity of 1 gm.</td>
<td>1 No.</td>
</tr>
<tr>
<td>5.</td>
<td>I.S. sieves for coarse and fine aggregates.</td>
<td>1 Set</td>
</tr>
<tr>
<td>6.</td>
<td>A set of measures from 5 ltrs. to 0.1 ltr.</td>
<td>1 Set</td>
</tr>
<tr>
<td>7.</td>
<td>Electric oven with thermostat upto 120 °C.</td>
<td>1 No.</td>
</tr>
<tr>
<td>8.</td>
<td>Pycnometer</td>
<td>1 No.</td>
</tr>
<tr>
<td>10.</td>
<td>Glass flasks and metal containers</td>
<td>As required</td>
</tr>
<tr>
<td>11.</td>
<td>Concrete cube testing machine (optional)</td>
<td>1 No.</td>
</tr>
</tbody>
</table>
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 approved laboratories. The choice of laboratory shall rest with the Department. All incidental charges / cost shall be borne by the contractor.

In case the testing is carried out by the Department in its laboratory at Anushaktinagar, Bombay - 400 094, the contractor has to arrange to transport all the materials, cubes etc. to be tested, to the laboratory at Anushaktinagar at his own cost. The contractor shall bear the testing charges which are given below:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Name of test</th>
<th>Testing charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Concrete</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Crushing strength for cubes</td>
<td>Rs. 16/- per cube.</td>
</tr>
<tr>
<td></td>
<td>ii) Design Mix (Determination for mix proportion)</td>
<td>Rs. 2000/- per mix design</td>
</tr>
<tr>
<td>2.</td>
<td>Aggregates:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Sieve analysis for combined grading</td>
<td>Rs. 65/- per test</td>
</tr>
<tr>
<td></td>
<td>ii) Moisture content and absorption test</td>
<td>Rs. 65/- per test</td>
</tr>
<tr>
<td></td>
<td>iii) Crushing value</td>
<td>Rs. 50/- per test</td>
</tr>
<tr>
<td></td>
<td>iv) Specific gravity and bulk density</td>
<td>Rs. 30/- per test</td>
</tr>
<tr>
<td></td>
<td>v) Void ratio</td>
<td>Rs. 25/- per test</td>
</tr>
<tr>
<td>3.</td>
<td>Bricks:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Absorption test</td>
<td>Rs. 25/- per test</td>
</tr>
<tr>
<td></td>
<td>ii) Crushing strength</td>
<td>Rs. 40/- per test</td>
</tr>
<tr>
<td>4.</td>
<td>Core test in soil</td>
<td>Rs. 25/- per test</td>
</tr>
<tr>
<td>5.</td>
<td>Physical test of cement (set of following test)</td>
<td>Rs. 400/- per test</td>
</tr>
<tr>
<td></td>
<td>i) Initial and final setting time;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) Fineness by sieve analyses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii) Sound ness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iv) 3 and 7 days compressive strength</td>
<td></td>
</tr>
<tr>
<td></td>
<td>v) Consistency</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Non - Destructive Tests:</td>
<td>Rs. 1500/- per visit for both tests</td>
</tr>
<tr>
<td></td>
<td>i) Rebound Hammer test</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) Ultrasonic Pulse Velocity test</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Plywood / Block Boards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Moisture content tests</td>
<td>Rs. 65/- per test</td>
</tr>
<tr>
<td></td>
<td>ii. Adhesion of Plies</td>
<td>Rs. 90/- per test</td>
</tr>
<tr>
<td></td>
<td>iii. Knife test</td>
<td>Rs. 65/- per test</td>
</tr>
<tr>
<td>8.</td>
<td>Flush door shutters:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. End immersion test</td>
<td>Rs. 125/- per test</td>
</tr>
<tr>
<td></td>
<td>ii. Glue adhesion test</td>
<td>Rs. 125/- per test</td>
</tr>
<tr>
<td></td>
<td>iii. Knife test</td>
<td>Rs. 65/- per test</td>
</tr>
</tbody>
</table>

4.7 SAMPLING AND STRENGTH TEST OF CONCRETE:

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 be taken for general guidance in the case of concrete made with ordinary cement. In all cases, the 28 days compressive strength specified shall alone be the criterion for acceptance or rejection of the concrete. If however, 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.

Optional Tests Requirements of Concrete:

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Compressive strength on 15 cm cubes min. at 7 days</th>
<th>Modulus of rupture by beam at 72 (+/-) 2 hours</th>
<th>Modulus of rupture by beam at 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 10</td>
<td>7.0</td>
<td>1.2</td>
<td>1.7</td>
</tr>
<tr>
<td>M 15</td>
<td>10.0</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>M 20</td>
<td>13.5</td>
<td>1.7</td>
<td>2.4</td>
</tr>
<tr>
<td>M 25</td>
<td>17.0</td>
<td>1.9</td>
<td>2.7</td>
</tr>
<tr>
<td>M 30</td>
<td>20.0</td>
<td>2.1</td>
<td>3.0</td>
</tr>
<tr>
<td>M 35</td>
<td>23.5</td>
<td>2.3</td>
<td>3.2</td>
</tr>
<tr>
<td>M 40</td>
<td>27.0</td>
<td>2.5</td>
<td>3.4</td>
</tr>
</tbody>
</table>

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 the following:

<table>
<thead>
<tr>
<th>Quantity of concrete in the work (in cum.)</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>1</td>
</tr>
<tr>
<td>6-15</td>
<td>2</td>
</tr>
<tr>
<td>16-30</td>
<td>3</td>
</tr>
<tr>
<td>31-50</td>
<td>4</td>
</tr>
<tr>
<td>51 and above</td>
<td>4 plus one additional for each additional 50 cum. or part there of</td>
</tr>
</tbody>
</table>

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 4.4.2 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 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 of Table below.

<table>
<thead>
<tr>
<th>Specified grade</th>
<th>Mean of the Group of 4 Non-overlapping consecutive test results in N/mm²</th>
<th>Individual test results in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 15</td>
<td>=$&gt;/f_{ck}+ 0.825 \times$ established standard deviation (rounded off to nearest 0.5 N/mm²) or $=/f_{ck}+ 3$ N/mm² whichever is greater</td>
<td>=$&gt;/f_{ck}–3$ N/mm²</td>
</tr>
<tr>
<td>M 20 or Above</td>
<td>=$&gt;/f_{ck}+ 0.825 \times$ established standard deviation (rounded off to nearest 0.5 N/mm²) or $=/f_{ck}+ 4$ N/mm², whichever is greater</td>
<td>=$&gt;/f_{ck}–4$ N/mm²</td>
</tr>
</tbody>
</table>

Note – 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.

Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexural strength.
(a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm²

(b) The strength determined from any test result is not less than the specified characteristic strength less 0.3N/mm²

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 60m³

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 harmful compounds 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.

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 an amount 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 of measuring 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 based on 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 as approved by the Department.

4.11 TESTING OF STRUCTURES :

4.11.1 Optional Tests : Engineer-in-Charge, if 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 for heat 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 charges of optional tests. 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, optional tests etc. Complete. However, the Department will test the cubes departmentally. The contractor will have to make arrangements for transportation to the laboratory and testing charges will be borne by the contractor.

The contractor should also conduct conclusive tests such as ultrasonic pulse test, core test etc. to prove the suitability of concrete, in case cube tests give unsatisfactory results. The cost of the conclusive test should 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, shall be 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

4.11.3 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 been done, load test (see 4.11.3) may be resorted to.

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
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 13311 (Part 1)] and rebound hammer [IS 13311 (Part 2)], probe penetration, pull out and maturity. Non destructive 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 level exceeds 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. The cost 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 RCC tank for water tightness as per above specifications. The contractor shall make his own arrangement to tap 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 bear the 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 (Na2O and K2O) 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 when all 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 not include 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 Na2O equivalent).

Further advantage can be obtained by use of fly ash (Grade I) conforming to IS 3812 or granulated blast furnace slag conforming to IS 12089 as part replacement of ordinary Portland cement (having total alkali content as Na2O equivalent not more than 0.6 percent) provided fly ash content is at least 20 % or slag content is at least 50 percent.

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

b) 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.

Chlorides in the concrete

Whenever there is chlorides in concrete there is an increased risk of corrosion 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.

Limits of Chloride Content of Concrete

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Type or Use of Concrete</th>
<th>Maximum Total Acid soluble Chloride Content Expressed as kg/m³ of Concrete.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete</td>
<td>0.4</td>
</tr>
</tbody>
</table>
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.

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 expansion and disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as SO₃, 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 apply 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 trench drain, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedments to be cast in the concrete as indicated on the drawing or as directed by the Engineer-in-Charge. 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 be caused 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 newly placed concrete shall be removed by approved means and
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 conveyors 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 rehandled before placing.

4.13.4 Retempered or Contaminated Concrete:

Concrete must be placed in its final position before it becomes 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:

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.

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.

3 Avoiding Segregation: Concrete shall in all the cases be deposited as nearly as practicable directly in its final position and shall not be rehandled 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 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 handle in a manner which will cause segregation.

5 Placing by Mechanical Equipment: The following specifications shall apply when placing of concrete by sus 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 comes 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.

6 **Placement in Restricted Forms** : Concrete placed in restricted forms by borrows, buggies, cars, short chutes or hand shovelling 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.

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.

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 this method.

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.

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 a minimum 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.

COMPACTION:

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 care shall 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.

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 of adequate 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.

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 to come 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.

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 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.

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.

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

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 before the start of a subsequent placement.

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 case may be. Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by Engineer-in-Charge.

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.

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 water jet or any other appropriate means.

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:

1 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.

2 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.

3 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 watertightness.

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

5 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.

6 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:

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.

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.

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 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.

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.

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

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 weather 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.

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 be filled 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 shall be 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 against shuttering 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.

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.

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 for this 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 of the surrounding
congrete. 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.

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 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.

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 specified for
use.

Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish,
extcept repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes 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 levelled, 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 1 in 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
floatd.

Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power
toolsand 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.

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.

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 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 concrete or 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 jet even 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 earth and well compacted as directed by the Engineer-in-Charge. Where specified, lean concrete shall be provided in the earth stratum for receiving concrete. The surface of absorptive soil against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from 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 be done 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 as determined by Engineer-in-Charge.

Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of placement of 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, or the 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 HOT WEATHER REQUIREMENTS:

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 30°C.

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 and other 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. However, when concrete placement under water is necessary, all work shall conform to I.S.456 and procedure shall be as follows:

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

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...
4.30 PRECAST CONCRETE & 4.31 PRECAST REINFORCED CONCRETE

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

4.31.1 General requirements: Precast reinforced concrete units such as columns, fencing posts, door and window frames, lintels, chajjas, coping, sills, shelves, slabs, louvers etc. shall be of grade of mix as specified 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 or steel 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.

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

4.31.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have no cracks or 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. On being fractured, the interior of the units should present a clean homogenous appearance.

4.31.4 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 posts where the minimum cover shall be 25 mm.

4.31.5 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. The concrete shall be cured at least for 7 days from the date of casting.

4.31.6 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.

4.31.7 Marking

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

4.31.8 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.
4.32 PRECAST CEMENT CONCRETE JALI:

4.32.1 The Jali shall be of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 6 mm nominal size) reinforced with 1.6 mm thick mild steel wire, unless otherwise specified.

4.32.2 Fixing: The Jali shall be set in position true to plumb and level before the joints, sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement : 3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

4.32.3 Measurement: The Jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

4.32.4 Rate: The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sill and soffits, which will be paid for under relevant items of plastering.

4.33 CURING:

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.

4.34 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.

4.35 GROUTING:

4.35.1 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>
<thead>
<tr>
<th>Use</th>
<th>Grout thickness</th>
<th>Mix. proportions</th>
<th>W/C. Ratio in (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Fluid mix</td>
<td>Under 25 mm.</td>
<td>One part Portland cement to one part sand.</td>
<td>0.44</td>
</tr>
<tr>
<td>b) General</td>
<td>25 mm. and over</td>
<td>One part Portland cement to 2 parts of sand.</td>
<td>0.53</td>
</tr>
<tr>
<td>c) Stiff mix.</td>
<td>50 mm. and over</td>
<td>One part Portland cement to 3 parts of sand.</td>
<td>0.53</td>
</tr>
</tbody>
</table>

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

- 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 all oil, 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.

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

4.36 INSPECTION:

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval 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.

4.37 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.
4.38 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 suit the 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>
<thead>
<tr>
<th>Proportion of Ingredients</th>
<th>Cement</th>
<th>Quantity of materials used per bag of cement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fine aggregate (sand)</td>
</tr>
<tr>
<td>1:5:10</td>
<td>1</td>
<td>175 ltrs.</td>
</tr>
<tr>
<td>1:4:8</td>
<td>1</td>
<td>140 ltrs.</td>
</tr>
<tr>
<td>1:3:6</td>
<td>1</td>
<td>105 ltrs.</td>
</tr>
<tr>
<td>1:2:4</td>
<td>1</td>
<td>70 ltrs.</td>
</tr>
</tbody>
</table>

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 be decided by the Engineer-in-charge on the basis of test in each case.

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

<table>
<thead>
<tr>
<th>Type of concrete</th>
<th>Max. slump (in mm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass concrete</td>
<td>50</td>
</tr>
<tr>
<td>Concrete below water proofing treatment</td>
<td>50</td>
</tr>
<tr>
<td>Coping</td>
<td>25</td>
</tr>
<tr>
<td>Floor paving</td>
<td>30</td>
</tr>
</tbody>
</table>

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 cement aggregate 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.

4.39 SPECIFIC REQUIREMENTS FOR CONCRETE AND ALLIED WORKS:

The following specific requirements shall be met within addition to those provided in the clause of specification for Concrete and allied works.

4.39.1 General: If so specified in Schedule ‘A’ for the work, the Department shall supply with specification for “Concrete and allied works” and the contractor shall be solely responsible for supplying mixed concrete in accordance with the specification for concrete and allied works and also this specification. The rates for the reinforced concrete work shall be based on the issue rates of cement and steel as given in the schedule ‘A’.

4.39.2 Water: Clean water in pipes under pressure shall be provided by the contractor with all necessary equipment for giving a nozzle pressure of not less than 2.0 kg/sqcm. for the convenient and effective jetting of rock foundations and concrete surfaces, for cooling aggregate required for concrete, for curing concrete and other requirements.

4.39.3 Fire Protection System: The contractor shall provide and maintain at all times in adequate fire protection system to protect his equipment, materials and construction. In case of an emergency, the contractor shall permit the Engineer-in-Charge to use the system for protecting equipment, works etc. on the project.

4.39.4 Concrete: The rates for all concrete work should be based as per specifications and taking into consideration the guidelines indicated in special instruction under relevant clause.

4.39.5 The Placement Intervals: Each placement of concrete shall be allowed to set for a period of 48 hours and longer when required, before the start of subsequent placement. A time gap between the two adjoining pours in the horizontal plane and the two adjacent pours in the vertical plane shall be 7 days and 3 days respectively.

4.39.6 Finishing of Concrete:

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.
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.

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 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 and edges of concrete with edging tools.

4.40 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 drawings and 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 cross sectional 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 \( V = \frac{H}{3} \times (A_1 + A_2 + \sqrt{A_1 \times A_2}) \); 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 top of 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 and lintels 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 up to 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.

* * *

5. FORM WORK:

5.0 GENERAL:
The form work shall consist of shores, bracings, sides of beams and columns, bottom of slab etc. including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned for the 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 the loads 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
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 of columns, 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: Tread: (+/-) 3.0 mm. (+/-) 5.0 mm.
   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 50 mm.

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:

Formwork 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...
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, water 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, from vibrators 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 or other 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.

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.
Replopping 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 on wedges 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 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 forkheads.

   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
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 formoil 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 before placing 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, forms shall 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 chamfers or 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 diagonal face 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 therefrom.

In no circumstances shall forms be struck until the concrete reaches a strength of 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°C.) forms may be struck after expiry of the following periods:

**Stripping time:**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Type of form work</th>
<th>Minimum period before striking form work</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Vertical form work to columns, walls beams</td>
<td>16 – 24 h</td>
</tr>
<tr>
<td>b)</td>
<td>Soffit form work to slabs (Props to be refixed immediately after removal of formwork)</td>
<td>3 days</td>
</tr>
<tr>
<td>c)</td>
<td>Soffit form work to beams (Props to be refixed immediately after removal of formwork)</td>
<td>7 days</td>
</tr>
<tr>
<td>d)</td>
<td>Props to slabs: 1) Spanning up to 4.5 m 2) Spanning over 4.5 m</td>
<td>7 days 14 days</td>
</tr>
<tr>
<td>e)</td>
<td>Props to beams and arches; 1) spanning up to 6 m 2) spanning over 6 m</td>
<td>14 days 21 days</td>
</tr>
</tbody>
</table>

For other cements and lower temperature, the stripping time recommended above may be suitably modified.

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 shock or 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 removal of formwork which otherwise may be in-accessible.

Tie rods, clamps, form bolts etc. which must be entirely removed from walls or similar structures shall be 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 forms shall be re-constructed at contractors cost.

5.12 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 of formwork in square meters.

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, deshuttering and removal of materials from site and labour required for all such operations etc.

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 (latest revision), in the following strength grades:

a) Fe 415, Fe 415D;

b) Fe 500, Fe 500D;

c) Fe 550, Fe 550D; and

d) Fe 600.

Where “Fe” stands for specified minimum 0.2% proof / yield stress in N/mm$^2$ and “D” stands for same specified minimum 0.2% proof / yield stress but with enhanced specified minimum percentage elongation.

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/cumm 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 (also termed 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) or M/s. TATA Steel (TISCO) or M/s. Rashtriya Ispat Nigam Ltd (RINL) or M/s. Indian Iron & Steel Co. (IISCO) Ltd., 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 of IS 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, the test 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 case of 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:

---
THE PROPERTIES AS PER IS 1786 – 2008 ARE REPRODUCED BELOW:

**Chemical Composition of the bars shall conform to the following requirement:**

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Fe 415</th>
<th>Fe 415D</th>
<th>Fe 500</th>
<th>Fe 500D</th>
<th>Fe 550</th>
<th>Fe 550D</th>
<th>Fe 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.300</td>
<td>0.250</td>
<td>0.300</td>
<td>0.250</td>
<td>0.300</td>
<td>0.250</td>
<td>0.300</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.045</td>
<td>0.055</td>
<td>0.040</td>
<td>0.055</td>
<td>0.040</td>
<td>0.055</td>
<td>0.040</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.045</td>
<td>0.055</td>
<td>0.040</td>
<td>0.055</td>
<td>0.040</td>
<td>0.055</td>
<td>0.040</td>
</tr>
<tr>
<td>Sulphur &amp; Phosphorus</td>
<td>0.085</td>
<td>0.105</td>
<td>0.075</td>
<td>0.100</td>
<td>0.075</td>
<td>0.075</td>
<td>0.075</td>
</tr>
</tbody>
</table>

Notes

1. For welding of deformed bars, the recommendations of IS 9417 shall be followed.
2. 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 both additional 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.

**Mechanical Properties of High Strength Deformed Bars and Wires**

<table>
<thead>
<tr>
<th>Property</th>
<th>Fe 415</th>
<th>Fe 415D</th>
<th>Fe 500</th>
<th>Fe 500D</th>
<th>Fe 550</th>
<th>Fe 550D</th>
<th>Fe 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Low yield &amp; yield stress, Min, N/mm²</td>
<td>415.0</td>
<td>415.0</td>
<td>500.0</td>
<td>500.0</td>
<td>550.0</td>
<td>550.0</td>
<td>600.0</td>
</tr>
<tr>
<td>ii. Elongation, % elongation, Min. on gauge length 5.65 A &lt;i&gt; where A is the Cross – sectional area of the test piece</td>
<td>14.5</td>
<td>16.0</td>
<td>12.0</td>
<td>16.0</td>
<td>10.0</td>
<td>14.5</td>
<td>10.0</td>
</tr>
</tbody>
</table>
### Tensile Strength, Min

<table>
<thead>
<tr>
<th>Grade</th>
<th>Tensile Strength, Min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tensile Strength, Min</td>
</tr>
<tr>
<td></td>
<td>10% more than the actual 0.2% proof stress/yield stress but not less than 485.0 N/mm²</td>
</tr>
<tr>
<td></td>
<td>12% more than the actual 0.2% proof stress/yield stress but not less than 500.0 N/mm²</td>
</tr>
<tr>
<td></td>
<td>8% more than the actual 0.2% proof stress/yield stress but not less than 545.0 N/mm²</td>
</tr>
<tr>
<td></td>
<td>10% more than the actual 0.2% proof stress/yield stress but not less than 565.0 N/mm²</td>
</tr>
<tr>
<td></td>
<td>6% more than the actual 0.2% proof stress/yield stress but not less than 585.0 N/mm²</td>
</tr>
<tr>
<td></td>
<td>8% more than the actual 0.2% proof stress/yield stress but not less than 600.0 N/mm²</td>
</tr>
<tr>
<td></td>
<td>6% more than the actual 0.2% proof stress/yield stress but not less than 660.0 N/mm²</td>
</tr>
</tbody>
</table>

### Total Elongation at Maximum Force, Percent, Min

<table>
<thead>
<tr>
<th>Grade</th>
<th>Total Elongation at Maximum Force, Percent, Min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>-</td>
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<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

**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, 40 mm. (Other sizes viz. 7mm, 18mm, 22 mm, 45 mm and 50 mm may be procured on specific
6.7 NOMINAL MASS

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

<table>
<thead>
<tr>
<th>SN</th>
<th>Nominal Size in mm</th>
<th>Tolerance on the nominal mass in Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Batch</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Up to and including 10</td>
<td>± 7</td>
</tr>
<tr>
<td>ii)</td>
<td>Over 10 up to and including 16</td>
<td>± 5</td>
</tr>
<tr>
<td>iii)</td>
<td>Over 16</td>
<td>± 3</td>
</tr>
</tbody>
</table>

6.8 LAPS:

Laps and splices for reinforcement shall be shown on the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on 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.

6.9 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. Reinforcing bars 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°C) and after bending shall be allowed to cool slowly with out 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.

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.

6.10 FIXING / 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 displacement during 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.
TOLERANCE ON PLACING OF REINFORCEMENT:

Unless otherwise specified, reinforcement shall be placed within the following tolerances:

<table>
<thead>
<tr>
<th>Tolerance in spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) For effective depth, 200 mm or less + /- 10 mm</td>
</tr>
<tr>
<td>b) For effective depth, more than 200 mm + /- 10 mm</td>
</tr>
</tbody>
</table>

6.11 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.

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 25 mm., 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 25 mm., 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 with such 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 concrete blocks 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.

6.12 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.

6.13 INSPECTION:

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

6.14 MODE OF MEASUREMENT FOR REINFORCEMENT FOR R.C.C. WORKS:

TENDER DOCUMENT VOL 2 OF 3 (TECHNICAL SPECIFICATION)
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>
<thead>
<tr>
<th>Nominal size in mm</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Sectional area in mm²</td>
<td>28.30</td>
<td>38.50</td>
<td>50.30</td>
<td>78.60</td>
<td>113.10</td>
<td>201.20</td>
<td>254.60</td>
<td>314.30</td>
</tr>
<tr>
<td>Mass / Weight in Kg / RM</td>
<td>0.222</td>
<td>0.302</td>
<td>0.395</td>
<td>0.617</td>
<td>0.888</td>
<td>1.580</td>
<td>2.000</td>
<td>2.47</td>
</tr>
</tbody>
</table>

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 reinforcement of beams, slabs and columns etc. will be paid as per the rate of reinforcement only up to the extent shown in the drawings. As far as possible laps in bars shall be avoided. Any laps and hooks provided by the 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 as required 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.

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7. PILE FOUNDATION

(TECHNICAL SPECIFICATIONS FOR BORED CAST-IN-SITU R.C.C. PILES)

7.1 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.

7.2 EQUIPMENT & ACCESSORIES: 

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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 by more than 75mm Bentonite shall be used as drilling mud and its basic properties shall conform to Appendix - ‘A’ of I.S. 2911 (Part-I/Section-2) 1987. Tremie shall be used for placing concrete into the bore holes.

7.3. GENERAL CONSIDERATIONS:

The construction of pile foundation shall be in such a way that the load from 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 done at 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.

Coarse Aggregate, Fine Aggregate & Water:

Coarse aggregate fine aggregate and water shall conforming to IS 456 (L.R) and I.S 383 (L.R)

Concrete:

Concrete to be used for the pile shaft shall be M 20. 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 100 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.

7.4. WORKMANSHIP:

a) Control of piling installation: Bored cast-in-situ piles shall be installed by employing suitable drilling rigs using a combination of bailer and a suitable chisel with DMC method. Bore hole shall be stabilised by bentonite as drilling mud and concreting shall be done by use of tremie.

b) 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 pile cap 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.

c) 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 ahead of 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 tremie from 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 lying on 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.

d) Defective Pile : In case defective piles are formed, they shall be removed or left in place whichever is convenient without affecting, performance of the adjacent piles or the cap as a whole without any extra cost 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 are beyond 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.

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.

7.5. ROUTINE LOAD TEST :

The contractor shall be required to carry out routine load tests as directed by the 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 unsatisfactory results being revealed on any routine test it shall be the contractor’s responsibility to carry out 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 for by the Department at the rates accepted in the tender since the piles are working piles.
7.6. 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 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. completed.

7.7. GUARANTEE FOR THE PILE FOUNDATION SYSTEM:

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: Proforma 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”.

8. READY MIX CONCRETE:

(SPECIFICATIONS FOR READY MIXED CONCRETE, CONFORMING TO IS 4926)

8.1. Ready mix Concrete shall conform to latest revision of IS : 4926 following are the requirement for supply of R.M.C:

8.1.1 Concrete delivered at site shall be in a plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

8.1.2 The process of continuing the mixing of concrete at a reduced speed during transportation to prevent segregation.

8.1.3 Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

8.1.4 Concrete produced by completely mixing cement, aggregates, admixtures if any and water at a stationary central mixing plant and delivered in containers fitted with agitating devices. The concrete may also be transported without being agitated as a special case and as requested.

8.1.5 Concrete produced by placing cement, aggregates and admixtures, if any other than those to be added with mixing water, in a truck mixer at the batching plant, the addition of water and admixtures to be added along with mixing water, and the mixing being carried out entirely in the truck mixer either during the journey or on arrival at the site of delivery. No water shall be added to the aggregate and cement until the mixing of concrete commences.

8.2. MATERIALS:

8.2.1 The cement used shall be of specified grade ordinary Portland cement or low heat Portland cement conforming to IS: 269 or Portland slag cement conforming to IS: 455 or Portland-pozzolana cement conforming to IS:1489 or rapid hardening. Portland cement conforming to IS: 8041 as may be specified at the time of placing the order. If the type is not specified, ordinary Portland cement shall be used.

8.2.2 Fly ash when used for partial replacement of cement, shall conform to the requirements of IS-3812 (Part I).
8.2.3 The aggregate shall conform to IS: 383. Fly ash when used as fine aggregate shall conform to the requirements of IS 3812 – (Part - II).

2.4 Water used for concrete shall conform to the requirement of IS 456-2000.

8.2.5 The admixtures shall conform to the requirements of IS : 456-2000 and their nature, quantities and methods of use shall also be specified. Fly ash when used as an admixture for concrete shall conform to IS : 3812 (Part II) – 1981. However, partial replacement of cement by fly ash shall not be more than 15% of designed requirement.

In case if fly ash is used more than 15%, the same shall be guided under table 5.1 of the IS, and in which case specific care shall be taken in terms of curing, protecting, repairing, finishing, de-shuttering etc. as detailed in the Chapter “FLY ASH CONCRETE”, here in after.

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 in accordance 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:

8.4.1 When a truck mixer or agitator is used for mixing or transportation concrete, no water from the truck-watersystem or from elsewhere shall added after the initial introduction of the mixing water for the batch, when no arrival atthe site of the work, the slump of the concrete is less that specified, such additional water to bring the slump within limits shall be injected into the mixer under such pressure and direct flow that the requirements for uniformity specified.

8.4.2 Unless otherwise specified when a truck or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be complete within 1 ½ hour (when the prevailing atmospheric temperature above 20°C) and within 2 hours (when the prevailing atmosphere temperature is at or below 20 °C) of adding the mixing water to the mix of cement and aggregate or adding the cement to the aggregate which ever is earlier.

8.4.3 The temperature of the concrete at the place and time of delivery shall be not less than 5°C. Unless
otherwise required by the purchaser, the concrete shall be delivered when the site temperature is less than 2.5°C.

8.4.4 Adequate facilities shall be provided by the manufacturer/supplier to inspect the materials used in the process of manufacture and methods of delivery of concrete. He shall also provide adequate facilities to take samples of the materials used.

8.4.5 The tests for consistency or workable shall be carried out in accordance with requirements of IS 1199 by such other method as may be agreed to between the purchaser and manufacturer.

8.4.6 The sampling and testing of concrete shall be done in accordance with the relevant requirements of IS 456, IS 1199 and IS 516.

8.4.7 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.

8.4.8 The testing shall be carried out in accordance with the requirements and the cost shall be borne by the Contractor.

8.4.9 The manufacturer shall keep batch records of the quantities by mass all the solid materials, of the total amount of water used in mixing and of the results of all tests. If required insisted, the manufacturer shall furnish certificates, at agreed intervals, giving this information.

8.4.10 Mode of measurement for ready mixed concrete (RMC) will be the same as mode of measurement for concrete work already mentioned at page No. 42 & 43 of clause 4.40. However, consumption of RMC shall be maintained at site. Wastage, spillover, wastage due to pump blockage etc. shall not be considered for payment.

* * *
9. FLY ASH CONCRETE

NOTES:

a) The fly ash should have consistent quality satisfying the requirements of Grade-1 FA of IS 3812 and Class-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 which will be used should be done as per above two codes for each 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.

f) The mix proportion should be approved by competent authority. The information to be supplied for approval would be identified by the competent authority.

g) Any change in mix proportion, after approval, should be concurred by appropriate authority.

h) Samples to be taken, at each time of casting, for 7 days and 28 days.

i) All ingredients of concrete should satisfy the requirements of relevant IS codes and specifications.

9.1.0 Curing, Protecting, Repairing and Finishing

9.1.1 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 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 super sulphated cement shall be carried out as directed by Engineer-in-charge.

9.1.2 Curing of concrete with low water binder ratios having partial replacement of cement by pozzolanic materials.

9.1.3 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 sheet or other type of impermeable covers. The initial curing should be continued up to a minimum period of 12 hours 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 up to a minimum period of 14 days.

9.1.4 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 uniformed 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.

9.1.5 Continuous Spraying

Curing shall be assured by use of 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.

9.1.6 Alternate Curing Methods:

Whenever in the judgement 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 edge and corner of the slab to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

9.1.7 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.

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

9.2.0 Form Work

9.2.1 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 for the 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.

9.2.2 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-charge 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 the loads vertical as well as lateral that the forms will be carrying including live and vibration headings.

9.2.3 **Type of Form Work:** Form work may be of timber, plywood, metal, plastic or concrete. For special finishes, the form work 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.

9.2.4 **Formwork Requirements:** Forms shall conform to the shapes, lines grooves and dimensions including camber of the concrete as called for in the drawings. Ample studs, water 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, form vibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free form sap, shakes, loose knots, worm holes, wraps 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 or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

Ply wood 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 planned to remove irregularities or unevenness in the face. Form work with lining will be permitted.

All new and used form 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.

Form work, during any stage of construction showing signs of distortion of 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 form work 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.

9.2.5 **Bracings, Struts and Props:** Shuttering shall be braced, struttered, 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
offits of slab can be removed without disturbing the beam bottoms.

Repropping 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 on wedges 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.

9.2.6 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 members 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 used

iii) Be restrained laterally near each end.

iv) Have means for centralising beams placed in the fork heads

v) 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 nut sand bolts shall be adequate.

m) Provisions of the design and/or drawings shall be complied

n) Cantilever supports shall be adequate

c) 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.

9.2.7 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 form work of the other concrete structures, a non staining mineral oil or other approved oil CEMOL-35 of M/s. Hindustan Petroleum Co. Ltd may be used, provided it is applied before placing 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, forms shall be thoroughly cleared of dried splatter of concrete from placement of previous lift.

Any loss of water through the shuttering should be strictly prevented from placement specially for concrete mix with low water binder ratio or having partial replacement of cement by pozzolanas. In case of wooden shutter approved quality of form oil or plastic sheet can be use for this purpose.

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

9.2.8.1 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.

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

9.2.11 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.

9.2.12 Removal of Forms: Contractors shall record on the drawings or a special register, the date upon which the
In no circumstances shall forms be struck until the concrete reaches a strength of 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 the forms.

In normal circumstances (generally where temperatures are above 200°C) forms may be struck after expiry of the following periods.

<table>
<thead>
<tr>
<th>S.N</th>
<th>Part of Structure</th>
<th>Earliest concrete age at stripping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cement with low and having pozzolanas</td>
</tr>
<tr>
<td>a)</td>
<td>Walls, columns and vertical sides of beams</td>
<td>3 days</td>
</tr>
<tr>
<td>b)</td>
<td>Slabs (Props left under)</td>
<td>14 days</td>
</tr>
<tr>
<td>c)</td>
<td>Beam, soffits (Props left under)</td>
<td>14 days</td>
</tr>
<tr>
<td>d)</td>
<td>Removal of props</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>i) Spanning up to 4.5m</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>ii) Spanning over 4.5m</td>
<td>14 days</td>
</tr>
<tr>
<td>e)</td>
<td>Removal of props in beams &amp; arches</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>i) Spanning up to 6m</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>ii) Spanning over 6m</td>
<td>14 days</td>
</tr>
<tr>
<td>f)</td>
<td>For perforated 120mm thick</td>
<td>14 days</td>
</tr>
</tbody>
</table>

Shutting shall be done slowly with utmost care to avoid damage to arise and application and without shock or vibration by gently easing the wedge etc. After removing the form work, if 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 provide as directed by Engineer-in-charge, to facilitate removal of form work which otherwise may be in inaccessible.

Tie, rods, clamps form-bolts etc. which must be entirely removed from walls or similar structures shall be loosened not sooner that 24 hours not 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 forms shall be re-constructed at contractor's cost.

10. DAMP PROOF COURSE:

10.1 SCOPE OF WORK: The work covered under this specifications consists supplying and laying plain cement concrete as damp proof course with or without 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 as per proportion indicated in the schedule. Approved water proofing compound @ 3% 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 wall and the edges shall be straight, even and truly vertical. Wooden forms shall be used to obtain good edges. No masonry work shall be commenced on freshly laid damp proof course unless it is cured for 48 hours of its laying but the curing of cement concrete shall be continued along with the masonry work. Specifications for cement, sand, aggregate and water shall be as described herein before for concrete works.

10.3 MODE OF MEASUREMENT : The work shall be measured in Sqm. area actually laid limited to sizes as shown in drawing. The rate shall include cost of all the materials, labour etc.

* * * *

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. M.S. reinforcement of 6 mm. dia. or as specified 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 (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. 456-1964 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 M.S. 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 reinforcement, moulds etc.

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 complete in strict accordance with this specifications and the applicable drawings.

12.2 MATERIALS:

12.2.1 All structural steel shall be of standard sections as marked on the drawings 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.

12.2.2 All structural steel and electrodes shall comply in all respects with I.S.S. 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. 800-1984 section-11. 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 the purpose of inspecting the work and no work shall be taken down, painted or despatched until it has been inspected 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 has been 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. 1477-1 971 (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 (red lead) 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:


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. 1395-1 982 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. 7280-1 974. The combination of arc and flash shall satisfy the requirements of I.S. 3613-1 974.

The filler rods and bare electrodes for gas shielded metal, arc welding shall conform to I.S. 6419-1971 and I.S. 6560-1972 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>
<thead>
<tr>
<th>Average thickness of plate or section</th>
<th>Maximum gauge or diameter of electrodes to be used.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3/16&quot;</td>
<td>10 S.W.G.</td>
</tr>
<tr>
<td>3/16&quot; and above but less than 5/16&quot;</td>
<td>8 S.W.G.</td>
</tr>
<tr>
<td>5/16&quot; and above but less than 3/8&quot;</td>
<td>6 S.W.G.</td>
</tr>
<tr>
<td>3/8&quot; and above but less than 5/8&quot;</td>
<td>4 S.W.G.</td>
</tr>
<tr>
<td>5/8&quot; and above but less than 1&quot;</td>
<td>5/8&quot; dia.</td>
</tr>
<tr>
<td>1&quot; and above thick section</td>
<td>3/8&quot; dia.</td>
</tr>
</tbody>
</table>

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 electrode size 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 contractor to 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 steering 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 the quality 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:

**Throat Thickness of Fillet**

<table>
<thead>
<tr>
<th>Angle between fusion faces</th>
<th>Throat thickness in cms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>60°~90°</td>
<td>0.70</td>
</tr>
<tr>
<td>91°~100°</td>
<td>0.85</td>
</tr>
<tr>
<td>101°~106°</td>
<td>0.80</td>
</tr>
<tr>
<td>107°~113°</td>
<td>0.55</td>
</tr>
<tr>
<td>114°~120°</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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 undercutting at 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 cut out and re-welded. Where serious undercutting 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:**

All structural steel shall be measured on weight basis in metric tonnes or quintals or kgs. as mentioned in the schedule of quantities. The length or areas of various members including gusset plates shall be measured correct to two places of decimals and the net weight worked out from the standard steel tables approved by Indian Standard Institution. No separate measurements shall be taken for welding, riveting, bolting, field connections etc. The rate shall 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.

* * *
13. BRICK WORK:

13.1 SCOPE OF WORK:

The work covered under this specification pertains to procurement of well burnt clay bricks of class 35 unless otherwise specified and workmanship in building walls of various thickness, in strict compliance with the specifications and applicable drawings.

13.2 MATERIALS:

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 in the 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 the same 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 tolerance, the contractor shall chip out the exposed edges of bricks up to 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/cm² 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 as described herein before under cement concrete. Bricks shall be thoroughly soaked in water before using till the bubbles cease 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.

13.3 WORKMANSHIP:
Four courses of brick work with four joints should not exceed by more than 40 mm., the same bricks piled one 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 around 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 position at 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 12.5 mm.
- 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 be properly
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 building and the work shall be protected from sun and rain.

**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. 6 mm. diameter M.S. bars or as specified in the schedule as bottom reinforcement (only the M.S.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, if any, shall not be less than 30 cm.

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 the work 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.

**13.4 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.

2. Frequency of test shall be as per relevant IS specifications.

**13.5 MODE OF MEASUREMENT:**

**13.5 a) For Brick Work Measured in Cubic Metres:**

The contract rate shall be for a unit of one cubic metre of brick masonry as actually done. 230 mm. thick (or as specified in schedule) brick walls shall be taken as one brick thick.

All openings in brick work for doors, windows and ventilators shall be deducted to get the net quantity of actual brick work done.
13.5 b) For brick work measured in square metre:

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 specifications 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/ballast 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. All stones shall be wetted before use. Stones shall be neatly 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. 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 shall be used 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. 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 up to 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 themain 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 KHANDKI FACING STONE MASONRY:

The specifications for Random rubble masonry as given in item No. 14.2 shall generally apply to these for quality of stones, workmanship etc. except for the following:

The face of the stones shall be square/ rectangular in shape and shall be so dressed around that those can be set on proper bases and shall render uniform joints. The stones may have bushing on the face but shall not project more than 40 mm. The external faces shall be laid in courses of about 200 mm. height or as specified and the internal face shall be finished with rubble backing.

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.

15. PRECAST CEMENT CONCRETE SOLID BLOCK MASONRY:

15.1 Scope of Work: The work covered under this specifications 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. The ingredient and the cement concrete used shall confirm to relevant I.S. as stipulated in specification for cement concrete works herein before.

Minimum crushing strength of the solid blocks shall be 40 to 60 Kg/ sqcm. at 28th day after curing. 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 390 x 190 x 140 mm. and 390 x 190 x 100 mm. and the proportion used in making the blocks shall be 1:11 (1 cement : 11 fine and coarse aggregates). 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
15.3 Workmanship and Mode of Measurement: The workmanship and mode of measurement shall be as stipulated in the specification for brick work as applicable stated earlier and concrete block masonry with 140 mm. thick block shall be measured in sqm. nearest to two places of decimals of a metre. 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. CEMENT CONCRETE FLOORING (IPS):

16.0 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.

16.1 CEMENT CONCRETE FLOORING (INDIAN PATENT STONE):

16.1.1 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.

16.1.2 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 2.75 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 wooden or 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 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 in cement mortar 1:2 @ 600 mm. centres or as specified in the schedule for full depth of the finished floor. The depth of dividing strips shall be the thickness as proposed for the finished floor in the item. In the case of flush joins, alternate panels only may be cast on same day. At least 48 hours shall elapse before the concreting of adjacent bay is commenced.

16.1.3 Mixing: The topping concrete shall be of mix of one part of cement, two parts of sand and 4 parts of 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.

16.1.4 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 levelled 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 levelled. 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 blemishes and 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.

16.1.5 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 retroflew 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 fine aggregate on to the surface shall not be permitted. Trowel marks should not be seen on the finished surface.

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 brass or 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.

16.1.6 Steel Trowel Finish: Areas where Marblex tiles are proposed to be used are required to have base concrete finished smooth by steel trowel.

16.1.7 Curing: The completed flooring shall be protected from sun, wind and rain for the first two days and movement of persons over the floor is prohibited during this period. The finished surface shall be covered and cured continuously from 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.

16.1.8 **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 up to two places of decimals of a metre and area worked out up to two places of a square metre.

17. **IRONITE (OR HARDONATE) FLOORING.**

17.1 **GENERAL** :

To withstand heavy wear and tear, concrete flooring with metallic concrete hardening compound such as Ironite/ hardonate shall be laid as wearing layer as detailed below:

17.2 **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.

17.3 **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 surfaces shall be roughened with 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.

17.4 **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, water cement ratio not exceeding 0.4.

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 pressed into 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.

17.5 CURING, PRECAUTIONS, MEASUREMENTS ETC. :

Specifications for curing, precautions, quantity measurements etc. shall be same as specified for cement concrete flooring.

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18. CEMENT CONCRETE FLOORING WITH RED OXIDE TOPPING :

18.1 GENERAL :

Red oxide of iron when used, gives an improved appearance to concrete flooring. The specifications shall be as under.

18.2 RED OXIDE OF IRON :

Red oxide powder as the name indicates is a fine powder of iron oxide, red in colour normally available in market shall be obtained in adequate quantity and stores in clean dry place.

18.3 PREPARATION OF BASE :

The specifications for cement concrete flooring (I.P.S.) shall be followed for this work also.

18.4 UNDER LAYERS :

The under layer of flooring of specified thickness shall be of cement concrete 1:2:4 mix using 10mm. maximum size coarse aggregate. The dividing strips of aluminium or glass if required to be retained shall not be removed and kept in position properly. After the consolidation is over, the top surface shall be left rough by drawing diagonal lines 2 mm. deep at 75 mm. centres both ways.

18.5 TOP LAYER :

18.5.1 Mortar: The top layer shall consist of uniform and smooth layer of specified thickness and of mix 1.3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement. The cement shall be mixed dry with red oxide powder in the proportion of 3.5 kg. of red oxide to 50kg. (1 bag) of cement. This mixture shall be used in both the cases i.e. for mixing mortar for top layer and also for floating coat. Full quantity of materials required for one room shall be mixed and kept ready to ensure uniform colour. Net mortar shall be prepared in usual manner.

18.5.2 Laying of Top Layer: The top plaster shall be done the following day after the under layer is laid. The plaster shall be done to specified thickness (normally 10 mm.) and finished smooth with cement and red oxide slurry at 2.2 kg. of cement red oxide mix per sqm. The surface shall be polished smooth with polishing stones. Alternate panels shall then be taken in hand for laying under layers, top layers as process repeated. Rounding at the junction with the wall shall be done, if required, to a radius of 25 mm.

18.6 CURING: Similar to Cement concrete flooring (IPS).

18.7 MODE OF MEASUREMENT: Similar to Cement concrete flooring (IPS).

* * * *
GENERAL NOTE FOR ALL TILING WORKS:

Where the size of flooring files 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 shall be paid for the same.

19. TERRAZZO / CEMENT TILE FLOORING, SKIRTING/ DADO ETC.:

19.1 MORTARS:

19.1.1 Lime Mortar: Deleted

19.1.2 Cement Mortar: This shall be prepared by mixing cement and sand in specified proportions given in schedule of quantities, in a mixer. Hand mixing will not be allowed.

19.1.2.1 Proportioning: The unit of measurement for cement shall be a bag of cement weighing 50 kg. and this shall be taken as 0.035 cum.. Sand in specified proportion shall be measured in boxes of suitable size. It shall be measured on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage which shall be determined as per IS specifications and as per the method given herein before.

19.1.2.2. Mixing: The mixing of mortar shall be done at site of work in mechanical mixer. Hand mixing, if permitted, shall be done as directed by the Engineer-in-charge.

19.1.2.3 Mixing in Mechanical Mixer: Cement and sand in the specified proportion shall be mixed dry. Care shall be taken not to add more water than that shall bring the mortar to the consistency of a 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.

19.1.2.4 Hand Mixing: The measured quantity of sand shall be levelled on clean masonry platform and cement bags emptied on top. In hand mixing the quantity of cement shall be increased by 5% above the specified, 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 time till the mix is of a uniform colour. The quantity of dry mix which shall be used within 30 minutes shall then be mixed in thoroughly with just sufficient quantity of water to bring the mortar to the consistency of a stiff paste. Mixing of mortar on floor slabs or landings of staircase shall not be allowed.

19.1.3 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.

19.2 MATERIALS:

The terrazzo/ cement tiles for flooring and skirting shall be hydraulically pressed under a minimum pressure of 140 kg./sqcm. and shall conform to I.S. 1237-1959 in respect of constituent materials, manufacture, shape, tolerances, wearing layers, colour, appearance, general quality of tiles, strength, resistance to wear, water absorption and other tests. The tile shall be nominal size and thickness as specified in the schedule for flooring, skirting, dado work etc. and shall be of approved make.

Department shall be at liberty to inspect the manufacture of tiles even at the factory to ascertain whether the manufacture is as per the approved tiles for its quality of materials and manufacture. Tiles to be used for skirting and dado shall be semipolished before placing in position. Contractor shall submit samples for flooring and skirting tile for
approval of the Engineer-in-charge. The Engineer-in-charge may direct new samples made with varying proportions, sizes and colour of terrazzo chips against varying base before conveying his decision about the approved samples. No claims will be entertained for rejected samples. The contractor shall ensure the terrazzo finish as per approved sample for the entire qty. of tiles, by dry mixing of the cement, marble chips, powder, white cement, pigments etc. in the same proportions. For wearing layer of all tiles, the contractor shall use the cement from one consignment only to ensure uniformity in background colour/ shade.

If there is a doubt about the quality of the tiles, they shall be tested from each consignment as specified in I.S. 1237-1959 and cost of testing shall be borne by the contractor. Sample tiles after being approved shall be kept with the Engineer-in-Charge for reference till the completion of the work. All tiles which are to be incorporated in the work shall strictly conform to the approved samples.

The tiles shall be stored in room or under such cover as will prevent exposure to dampness, sun, rain, accidental injury or staining. Tiles to be incorporated in the work shall be immersed in water for a minimum period of 6 hours before use.

19.3 BEDDING/ BACKING COAT :

In case of flooring / skirting, the mortar bedding / backing shall be of cement mortar of specified thickness and mix as specified in the schedule of work.. All the ingredients of cement mortar shall be got approved by the Engineer-in-charge before incorporating in the work.

19.4 CLEANING OF SURFACE & LAYING OF CEMENT MORTAR BEDDING :

Before laying the cement mortar bedding the concrete floor surface 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 (1:4 of specified thickness or more if required to make up the level or grade) shall be laid evenly and to the required slopes as directed. The terrazzo tiles shall then be laid immediately after laying them. All tiles shall be truly and evenly set in a thick slurry of cement of honey like consistency applied to the sides and bottom and over the prepared base at the rate of 4.4 kg/sqm over such an area would accommodate about 20 tiles. The tiles shall then be tamped down with wooden mallet until they are properly bedded and exactly in true plane and line, with the adjacent tiles. Care shall be taken to ensure that the tiles are solidly bedded without voids and air pockets. All tiles shall be extended up to the unplastered surfaces of masonry walls/ RCC columns/ RCC walls. Wherever full tiles / half tiles can not be fixed, tiles shall be cut /sawn from full tile to the required size and their edges rubbed smooth to ensure a straight and true joint. The tiles shall be close jointed in matching cement slurry and the cement slurry oozing out through the thin joints shall be immediately wiped clean. The joints between the tiles shall not be greater than 1.5 mm. and shall be kept in straight lines or to suit the required pattern. The junction between wall plaster and tile work shall be finished neatly and without any waviness. All tiles shall be laid as to have continuous lines from various rooms to the passage. People should not be allowed to walk over the freshly laid tiles.

Adjustment of levels in thickness of mortar bedding due to different type of flooring if any, shall be done by the contractor within a reasonable limit/distance as directed by the Engineer-in-Charge without any extra cost to the Department.

19.5 CURING, POLISHING & FINISHING:

The day after the tiles are laid, all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a
depth of 5mm. and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shade of the topping of the wearing layer of the tiles.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be ground evenly with machine fitted with coarse grade grit blocks (No. 60 ). 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 fine grade grit blocks (No. 120) and shall be grouted again the opened out joints with matching cement.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be ground evenly with machine fitted with coarse grade grit blocks (No. 60 ). 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 fine grade grit blocks (No. 120) and shall be grouted again the opened out joints with matching cement.

The final grinding with machine fitted with the finest grade grit blocks (NO.320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor as ordered by the Engineer-in-charge.

For small areas or where circumstances so required, hand polishing may be permitted in lieu of machine polishing after laying, entirely at the discretion of the Engineer-in-charge. For hand polishing, the following carborundum stone shall be used. The polishing shall be done in such a manner that there are no visible scratches on the terrazzo tiles. If scratches are observed, the tiles shall be removed and replaced by new tiles.

1st Grinding  Coarse Grade stone ( No. 60)
2nd Grinding  Coarse Grade stone ( No. 60)
Final Grinding Fine grade stone (No. 120)

In all other respects, the process shall be similar as for machine polishing. After the final polish, oxalic acid crystals ground into powder shall be dusted over the surface (@ 2/3 lb per 100 sft. or 32.5 gm. per sqm.), 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.

The finished floor shall not sound hollow when tapped with a wooden mallet.

19.6 TERRAZZO / CEMENT TILE SKIRTING :

Terrazzo tile in skirting shall be of size as specified in schedule of quantities or as directed by the Engineer-in-charge, hydraulically pressed and shall be obtained from the same source as for the terrazzo/ cement tiles for flooring. The design and shade of the skirting tiles shall be exactly similar to that of flooring tiles. The specifications for materials and workmanship shall be same as for flooring except that the skirting tile shall be laid against a 12 mm. thick backing of cement mortar 1:3 to the full height of skirting, thus allowing uniform projection beyond the plastered surfaces. In case of dado, the back of tiles shall be buttered with a coat of grey cement slurry/paste and edges with grey or white cement slurry/paste as the case may be, with or without pigment to match the shade of tiles and set in the backing/bedding mortar. Any cutting of brick work, concrete etc. required due to unevenness of brick surface shall be carried out at no extra cost to the Department to maintain this uniform projection beyond the plastered surfaces.

The skirting tiles shall be true in plane, line, level and plumb or in slope. The vertical lines of skirting tiles should 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 terrazzo tile 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.
19.7 SAMPLING AND TEST:

Tiles required for carrying out tests described below shall be taken by “random sampling”. Each tile samples shall be marked to identify the consignment from which it was selected. Minimum quantity of tiles for carrying out the test and frequency of test shall be as per IS : 13801. Cost of these tests shall be borne by the contractor.

<table>
<thead>
<tr>
<th>Mandatory Tests</th>
<th>No. of</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) For conformity to requirements of shape and dimensions, wearing layer and general quality.</td>
<td>12 tiles</td>
<td>Concavity &amp; Convexity shall not exceed 1 mm. Perpendicularity shall not exceed 2% of the length of edge.</td>
</tr>
<tr>
<td>b) For wet transverse strength test</td>
<td>6 tiles</td>
<td>Strength shall not be less than 30 kgf/cm²</td>
</tr>
<tr>
<td>c) For resistance to wear test</td>
<td>6 tiles</td>
<td>Average wear shall not exceed 3.30 mm and wear on individual specimen shall not exceed 4 mm.</td>
</tr>
<tr>
<td>d) For water absorption test</td>
<td>6 tiles</td>
<td>Shall not be more than 10%</td>
</tr>
</tbody>
</table>

19.8 MODE OF MEASUREMENT:

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 up to 2 places of decimal of a meter and area so worked out shall be correct up to 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.

19.9 PLAIN CEMENT TILE FLOORING & SKIRTING:

The specifications, mode of measurements etc. in respect of terrazzo tiles in flooring and skirting shall be applicable in general to plain cement tiles except that no marble chips & white cement shall be used in tile manufacture.

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20. IN-SITU TERRAZZO FLOORS, SKIRTING, TREADS OF STAIRCASE, WINDOW SILLS ETC.

20.1 FLOORING:

In situ terrazzo flooring, the underlayer shall consists of cement concrete mix 1:2:4 (the maximum size of aggregate used shall not exceed 10 mm.) the thickness of which shall be as specified in item of schedule of quantities.

The terrazzo topping shall consist of white cement or grey cement wherever specified in the schedule of quantity with or without pigment and marble chips of best approved quality, shade and grade all mixed in proper proportion as provided in I.S. 2114 and/or approved by the Engineer-in-Charge. The total combined thickness of the underlayer and topping shall as provided in the I.S. Specification and as specified and approved by the Engineer-in-Charge.

The floor surface shall be thoroughly cleaned of all dirt, dust, laitance and loose material, thoroughly wet with water.
and then smeared with cement slurry. Cement concrete under layer immediately be laid in regular bays not exceeding 1.5 sqm. in area or as directed and allowed to harden. The surface of screed shall be well scratched whilst it is not sufficiently hard to form key for terrazzo topping. 25 x 1.5 mm. aluminium dividing strips or 3mm. thick glass dividing strips whichever specified in the item of schedule of quantities shall be placed to form bays as directed. When the screed has sufficiently hardened but not later than 24 hours, it shall be thoroughly cleaned down, washed with water and brushed over with neat cement slurry of about the consistency of thick cream. Terrazzo top layer shall then be laid in alternative bays in plastic condition, well troweled into position. Surplus moisture and cement slurry from surface shall be removed and allowed to set sufficiently hard to stand machine or hand grinding, thoroughly cleaned to reveal surface voids, and grouted with neat cement of the same tint as used in terrazzo. When dry and hard, machine grinding with grit blocks as per specifications for terrazzo tiles shall be done with 3 to 5 days between successive grinding during which the terrazzo shall be cured and grouted with neat cement of same tint, if required. The entire surface shall then be kept wet for at least seven days. The edges of treads and window sills shall have straight edges and corners properly rounded up. In case of window sills, only top layers is covered under the relevant item and concrete base layer under RCC item. The window sills and treads of staircase shall be hand polished instead of machine polished.

Cleaning and applying oxalic acid shall be same as specified for terrazzo tile flooring.

20.2 IN-SITU SKIRTING & DADO ETC. :

In situ skirting and dado shall be as specified in the schedule of finishes.

The surface shall be prepared as per plastering work where required by the architects, the dado or skirting shall be sectionalised as for in situ floor. If shown and required, the junction of the floor and dado shall be rounded to a proper, neat and uniform round to the satisfaction of the Engineer-in-charge. After the work is complete, the surface shall be kept continuously wet for 7 days. Unless otherwise specified, skirting and dado shall match the floor.

Terrazzo skirting and dado shall consist of under coat of 1:4 cement-sand plaster of the thickness specified. This shall be laid simultaneously with the borders of the flooring and same joints as in the floor shall continue. The topping shall be terrazzo as per specifications for in-situ terrazzo flooring except that in-situ polishing shall be done by hand to the satisfaction of Engineer-in-charge. 1.5 mm. thick aluminium strip joint (wherever mentioned 3mm. glass strips shall be fixed) shall be provided in situ terrazzo in both direction or as directed. Care shall be taken to see that the terrazzo in skirting and dado matches the floors. The dado work in columns shall be done in one operation for the full height of the column. The shape of the finished surface shall be uniform for all such columns treated and checked for its accuracy during the progress of work.

20.3 MODE OF MEASUREMENT :

Mode of measurement for cast-in-situ terrazzo flooring and dado shall be same as per terrazzo tile flooring and skirting.

The rate shall include all materials, curing, rounding of junctions, labour, scaffoldings etc.

* * *

21. KOTAH STONE FLOORING/ SKIRTING/ FACIA / SHELVES :

21.1 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 stone shall 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 slightly as per the availability in the market. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm 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 up to (+/-) 5 mm for hand cut slabs & (+/-) 2 mm for machine cut slabs. At its thinnest, no stone shall be thinner than the specified thickness.

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 the same.

21.2 BEDDING/ BACKING COAT: In case of flooring / skirting / dado, the mortar bedding / backing shall be of cement mortar of thickness and mix specified in the schedule of work.

21.3 CEMENT MORTAR: Cement mortar bedding shall be as specified under relevant specification for terrazzo/ plain cement tile flooring.

21.4 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 be taken 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, set mortar 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.

21.5 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 be gently 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 be removed 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.

21.6 CURING: The work shall be kept well wetted with damp sand or water for seven days.

21.7 POLISHING AND CLEANING: 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 handled over from any mortar stains etc. Polishing shall be done as per relevant IS and IS-14223 (Specification for polished building stones).

21.8 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 of terrazzo tiles. 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.

Fixing, curing, polishing and cleaning shall be as specified herein before under cement/ terrazzo tile skirting. Polishing may be done by hand, but a smooth surface and fine polishing shall be obtained. 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.

**21.9 MODE OF MEASUREMENTS :** Flooring, skirting and dado/ facia shall be measured same as that for terrazzo cement tile, flooring/ skirting/ dado. Unless otherwise specified, shelves shall be paid on area basis in sqm. calculated to two places of decimal, where length and breadth shall be measured inclusive of bearings correct to a cm. The permissible tolerance in the specified thickness shall be (+/-) 2 mm.

**Note:** Wastage in obtaining the required machine cut, hand cut sizes as specified from the commercial sizes available in market shall be taken into consideration by contractor while quoting the rate for work and no extra claim on this account shall be entertained.

**21.10 TAN DUR 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.

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**22. GLAZED TILE FLOORING, DADO/ SKIRTING/ FACIA.**

**22.1 MATERIALS :**

**White Glazed Tiles :** The tiles shall be of approved make and shall generally conform to IS : 777. They shall be flat and true to shape and free from cracks, blisters, welts, crawling, crazing spots, chipped edges, corners or other imperfections detracting from their appearance. The glazing shall be of uniform shade.

The tiles shall be of square or rectangular of nominal sizes such as 300x200mm, 150x150mm, 100x100mm, 100x200mm or other as directed by the EIC. The length of all four sides shall be measured correct to 0.1 mm and average length-breadth shall not vary more than (+ -) 0.8 mm from specified dimensions. The variation of individual dimensions from average value of length/breadth shall not exceed (+ -) 0.5 mm. Tolerance in thickness shall be (+ -) 0.4 mm. Size of tiles different form the specified one, may be allowed to be used with prior approval of the EIC.

The thickness of the tiles shall not be less than 5 mm or as specified in the items and shall confirm to I.S. 777 in all respects. Samples of tiles shall be got approved by the Engineer-in-charge before use on the work. Top surface of tile shall be glossy or matt as specified. The underside of tiles shall not have glaze on more than 5% of the area in order to have proper adherence to the back.

**22.2 PREPARATION OF SURFACE & LAYING :**

Sub grade concrete or RCC slab or side brick wall/ or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

The bedding/backing for the tile shall be of C.M. 1.3 or as specified and shall be applied and allowed to harden. The mortar shall be roughened with wire brushes or by scratching diagonal lines 1.5mm. deep at 7.5mm. centre both ways.

The back of tiles shall be buttered with a coat of grey cement slurry paste and edges with white cement slurry and set in the bedding mortar. The tiles shall be tapped gently with wooden mallet and corrected to proper planes and lines.
The tile shall be butt jointed in pattern and joints shall be as fine as possible. The top of skirting/ dado shall be truly horizontal and joints truly vertical.

After a period of curing of 7 days minimum, the tiles shall be cleaned and shall not sound hollow when tapped.

The surface during laying shall be checked with a straight edge 2 m. long. Where full size tiles cannot be fixed, these shall be cut/sawn to the required size & their edges rubbed smooth to ensure straight and true joints.

Tiles shall enter not less than 10mm. under side skirting.

After the tiles have been laid, surplus cement grout shall be cleaned off.

### 22.3 MORTAR AND BEDDING:

Cement mortar for bedding shall be of proportion specified in items schedule and shall conform to the specification for materials, preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned of all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be even and smoothly spread over the base by use of screed battens to proper level or slope.

Cement mortar of thickness and proportion as specified in the schedule for dado shall be applied to the wall after preparing the wall surface as specified under cement plaster 20mm. thick and brought to correct line and plumb and the surface left rough to receive the tiles.

### 22.4 FIXING OF TILES FOR FLOORING:

The tiles before laying shall be soaked in water for atleast 2 hours. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles which are fixed on the floor shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Neat cement mortar grout 1:2, using fine sand (table III, zone-IV and as per I.S. 383 ) of honey like consistency shall be spread over the bedding mortar just to cover as much area as can be tiled within half an hour. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. The surface of the flooring during laying shall be frequently checked with a straight edge about 2M long to obtain a true surface with the required slope. The joints between tiles shall not exceed 1.00 mm. in width. The joint shall be grouted with white/matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

### 22.5 FIXING TILES FOR DADO & SKIRTING/FACIA:

The dado work, shall be done only after fixing the tiles/slabs on the floor. The approved white glazed tiles before laying shall be soaked in water for atleast 2 hours. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff.

The back of the tile shall be covered with this layer of cement mortar 1:2 using fine sand (table III, zone IV, I.S. 383-1963) and the edge of the tile smeared with neat white cement slurry. The tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from bottom of wall upwards without any

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hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. The tiles shall be jointed with white cement slurry. Any thickness difference in the thickness of the tiles shall be arranged out in cushioning mortar so that all tiles faces are in one vertical plane. The joints between the tile shall not exceed 1.00 mm. in width and they shall be uniform.

While fixing tiles in dado work, care shall be taken to break the joints vertically. The top of the dado shall be touched up neatly with the rest of the plaster above.

After fixing the dado/skirting etc. they shall be kept continuously wet for 7 days.

If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

22.6 CLEANING:

After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting over shall be washed thoroughly clean. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust. It shall be removed only after completion of the construction work and just before the floor is used.

22.7 POINTING AND FINISHING:

The joints shall be cleaned off with wire brush to a depth of 3 mm. and all dust and loose mortar removed. Joints shall then be flush pointed with white cement and floor kept wet for 7 days and then cleaned. Finished floor shall not sound hollow when tapped with a wooden mallet.

22.8 MODE OF MEASUREMENT:

Dado/flooring/skirting shall be measured in sqm. correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm.

The rate shall include all the cost of labour and materials involved.

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23. CHEQUERED TILES IN STAIR TREADS AND LANDINGS:

23.1 SCOPE OF WORK:

The work envisaged under these specifications consists of supplying and laying chequered cement tiles in the treads of staircase steps and over landings.

23.2 MATERIALS:

Chequered Tiles: The size of tiles including nosing shall be as shown in drawing and shall have the thickness not less than 28 mm.

The nosing edge of the tile shall be rounded and the front portion of the tiles for a minimum length of 75 mm. from and including the nosing shall have groves running parallel to the nosing and at centres not exceeding 25 mm. Beyond that the nosing tiles shall have normal chequered pattern, centre to centre distance being not less than 25 mm. and not
more than 50 mm. The nosing shall have the same wearing layers as the top portion of the tile.

The overall thickness of the tile as mentioned earlier shall not be less than 28 mm. with the top layer measured from the top of the chequers which shall not be less than 6 mm. The tiles shall be given the first grinding before delivery to site. The tiles shall conform to the specification for terrazzo tiles/cement tiles, in respect of method of manufacture and the mix of the backing and wearing layers, as specified in the item.

23.3 PREPARATION OF SURFACE AND LAYING:

The method of preparation of surface and laying shall generally be similar to as specified herein before under terrazzo tile flooring.

23.4 CURING, POLISHING AND FINISHING:

The specifications shall be the same as specified herein before under terrazzo tile flooring except that polishing of the treads nosing and chequered grooves, after laying shall be done by hand. Special care shall be taken to polish the nosing and the grooves in such a manner as to get a uniform erection for the grooves and the nosing and their finish shall match with the finish of the flat portion of the tiles.

23.5 MODE OF THE MEASUREMENT:

Length shall be measured from finished face of skirting, dado or wall plaster correct to a centimetre and the width shall be measured from the outer edge of the tread to the finished face of riser. In the case of tiles laid over the landing, the mode of measurement shall be as per terrazzo tiles specifications. The area shall be in square metres correct to two places of a decimal.

The rate shall include the cost of all materials and labour, transport, scaffolding etc. required in all the operations described above.

24. MARBLE STONE FLOORING, TREADS, RISERS, SILLS, CLADDING, DADO ETC.:

24.1 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.

24.2 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.

24.3 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.

24.3.1 Mixing : The mixing of mortar shall be done in mechanical mixer or hand mixing as specified/as directed by the Engineer-in-Charge.

a) 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.

b) 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 on top. 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.

c) 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.

24.4 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.

24.5 MARBLE SILLS, TREDS 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.

24.6 MARBLE STONE DADO & CLADDING :

Only machine cut and machine polished marble stone will 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 the places 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.

24.7 POLISHING AND FINISHING :

The polishing and finishing shall be carried out in the similar manner as specified under chapter "TERRAZZO / CEMENT TILES FLOORING, SKIRTING / DADO ETC." as far as it is applicable.

24.8 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 as directed 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.

24.9 RATE :

The rate shall include the cost of all materials, transport tools, plants, scaffolding and labour involved in all operations described above.

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25. CERAMIC TILE FLOORING, DADO / SKIRTING / FACIA.

25-1 MATERIALS :

Ceramic Tiles : The tiles shall be of approved make and shall generally conform to IS : 13712-1998. They shall be flat and true to shape and free from cracks, blisters, welts, crawling, crazing spots, chipped edges, corners or other imperfections detracting from their appearance. The glazing shall be of uniform shade.

The tiles shall be of square or rectangular of nominal sizes as mentioned in schedule of quantities and as directed by the EIC. The length of all four sides shall be measured correct to 0.1 mm and average length-breadth shall not vary
more than (+/-) 0.8 mm from specified dimensions. The variation of individual dimensions from average value of length/breadth shall not exceed (+/-) 0.5 mm. Tolerance in thickness shall be (+/-) 0.4 mm. Size of tiles different form the specified one, may be allowed to be used with prior approval of the EIC.

The thickness of the tiles shall not be less than 6 mm or as specified in the items and shall confirm to I.S. 13712 in all respects. Samples of tiles shall be got approved by the Engineer-in-charge before use on the work. Top surface of tile shall be glossy or matt as specified. The underside of tiles shall not have glaze on more than 5% of the area in order to have proper adherence to the back.

25-2 PREPARATION OF SURFACE & LAYING:

Sub grade concrete or RCC slab or side brick wall/ or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

The bedding/backing for the tile shall be of C.M. 1.3 or as specified and shall be applied and allowed to harden. The mortar shall be roughened with wire brushes or by scratching diagonal lines 1.5mm. deep at 7.5mm. centre both ways.

The back of tiles shall be buttered with a coat of grey cement slurry paste and edges with cement slurry and set in the bedding mortar. The tile shall be butt jointed in pattern and joints shall be as fine as possible. The top of skirting/ dado shall be truly horizontal and joints truly vertical.

After a period of curing of 7 days minimum, the tiles shall be cleaned and shall not sound hollow when tapped.

Tiles shall enter not less than 10mm. under side skirting.

After the tiles have been laid, surplus cement grout shall be cleaned off.

25-3 MORTAR AND BEDDING:

Cement mortar for bedding shall be of proportion specified in items schedule and shall conform to the specification for materials, preparations etc. as specified under cement mortar. The amount of water added while preparing mortars shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar, the base shall be cleaned of all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be even & smoothly spread over the base by use of screed battens to proper level or slope.

Cement mortar of thickness and proportion as specified in the schedule for dado shall be applied to the wall after preparing the wall surface as specified under cement plaster as specified in schedule of quantities and brought to correct line and plumb and the surface left rough to receive the tiles.

25-4 FIXING OF TILES FOR FLOORING:

The tiles before laying shall be soaked in water for at least 2 hours. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles which are fixed on the flooring adjoining the wall shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Neat cement mortar grout 1:2, using fine sand (table III, zone-IV and as per I.S. 383) of honey like
consistency shall be spread over the bedding mortar just to cover as much area as can be tiled within half an hour. The edges of the tiles shall be smeared with neat cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straigntline. The surface of the flooring during laying shall be frequently checked with a straight edge about 2M long to obtain a true surface with the required slope. The joints between tiles shall not exceed 1.00 mm. in width. The joint shall be grouted with matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

25-5 FIXING TILES FOR DADO & SKIRTING/FACIA:

The dado work, shall be done only after fixing the tiles/slabs on the floor. The approved ceramic tiles before laying shall be soaked in water for atleast 2 hours. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff.

The back of the tile shall be covered with this layer of cement mortar 1:2 using fine sand (table III, zone IV, I.S. 383-1963) and the edge of the tile smeared with neat cement slurry. The tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from bottom of wall upwards without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. The tiles shall be jointed with cement slurry. Any thickness difference in the thickness of the tiles shall be arranged out in cushioning mortar so that all tiles faces are in one vertical plane. The joints between the tile shall not exceed 1.00 mm. in width and they shall be uniform.

While fixing tiles in dado work, care shall be taken to break the joints vertically. The top of the dado shall be touched up neatly with the rest of the plaster above.

After fixing the dado/skirting etc. they shall be kept continuously wet for 7 days.

If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

25-6 CLEANING:

After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting over shall be washed thoroughly clean. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust. It shall be removed only after completion of the construction work and just before the floor is used.

25-7 POINTING AND FINISHING:

The joints shall be cleaned off with wire brush to a depth of 3 mm. and all dust and loose mortar removed. Joints shall then be flush pointed with cement and floor kept wet for 7 days and then cleaned. Finished floor shall not sound hollow when tapped with a wooden mallet.

25-8 MODE OF MEASUREMENT:

Dado/flooring/skirting shall be measured in sqm. correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm.
26. VITRIFIED TILE FLOORING, DADO / SKIRTING / FACIA:

26.1 MATERIALS:

Vitrified Tiles: The tiles shall be of approved make like Marbonite / Granamite or equivalent and shall generally conform to the approved standards. They shall be flat and true to shape, free from cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm or as per tender schedule / drawings or as directed by the Engineer-in-Charge. Thickness shall be as per recommendations of the approved manufacturers.

Technical specifications of the tiles shall be generally conforming to the following standards:

<table>
<thead>
<tr>
<th>NO</th>
<th>PROPERTY</th>
<th>EXPECTED STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deviation in length</td>
<td>(+/-) 0.6%</td>
</tr>
<tr>
<td>2</td>
<td>Straightness of sides</td>
<td>(+/-) 0.5%</td>
</tr>
<tr>
<td>3</td>
<td>Rectangularity</td>
<td>(+/-) 0.6%</td>
</tr>
<tr>
<td>4</td>
<td>Surface flatness</td>
<td>(+/-) 0.5%</td>
</tr>
<tr>
<td>5</td>
<td>Water absorption</td>
<td>&lt; 0.50%</td>
</tr>
<tr>
<td>6</td>
<td>Mohs. hardness</td>
<td>&gt; 6</td>
</tr>
<tr>
<td>7</td>
<td>Flexural strength</td>
<td>&gt; 27 N / mm²</td>
</tr>
<tr>
<td>8</td>
<td>Abrasion resistance</td>
<td>&lt; 204 mm²</td>
</tr>
<tr>
<td>9</td>
<td>Skid resistance (friction coefficient)</td>
<td>&gt; 0.4</td>
</tr>
<tr>
<td>10</td>
<td>Glossiness</td>
<td>Min. 85% reflection</td>
</tr>
</tbody>
</table>

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-in-charge before bulk procurement for incorporation in the work.

26.2 PREPARATION OF SURFACE FOR FLOORING: Following procedure shall be followed:

- **Sub grade**: concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

- **Mortar and bedding**: Cement mortar for bedding shall be prepared of mix 1:4 or as specified in the schedule of items, to a consistent paste and shall conform to the specification for materials, preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

- **Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water. Apply on an average 20 mm thick bedding of mortar over an area of 1 sqm. at a time over surface of the area for laying**
tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

26.3 LAYING OF TILES FOR FLOORING: The tiling work shall be done as per the pattern shown in the drawing or as directed by the Engineer-in-Charge. As a general practice laying of tiles shall be commenced from the centre of the area and advanced towards the walls. Cut tiles, if any, shall be laid along wall with necessary border pattern as shown/ directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall / floor. A white cement slurry to the back of the tile to be applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the round edgetiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile. Do not use an iron hammer or some heavy material to press the tile.

The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joints shall be grouted with white / matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

26.4 FIXING TILES FOR DADO & SKIRTING / FACIA: The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

- The back of tiles shall be cleaned off and covered with layer of approved adhesive like BAL-ENDURA or equivalent with proper trowelling as per manufacturers recommendations.

- The edges of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive. The joints shall be kept in straight line or as per the approved pattern.

- While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

- The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles faces shall be in one vertical plane.

26.5 : GROUTING OF JOINTS IN FLOOR / SKIRTING / DADO: The joints, if specified, shall be cleaned off and all dust and loose particles removed. Joints shall then be filled with approved adhesive like BAL-ENDURA or equivalent grouts. After finishing the grouting process, after 15 minute, wipe off excess grout with a damp sponge and polish the tiles with asoft & dry cloth for a clean surface. The finished work shall not sound hollow when tapped with a wooden mallet.

26.6 CLEANING: As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives should not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.
26.7 MODE OF MEASUREMENT AND RATE: Dado / flooring / skirting shall be measured in sqm correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm. The rate shall include all the cost of labour and materials involved.

26.8 CLEANING AGENTS FOR VITRIFIED TILES: Vitrified tiles are resistant to all chemicals (except hydrofluoric acid and its derivatives), hence commercially available detergents and cleaning agents can also be used for regular maintenance. Any spills and stains must be removed immediately. If left dry they may leave stains, which may be difficult to remove completely.

**CLEANING AGENTS FOR VITRIFIED TILES**

<table>
<thead>
<tr>
<th>STAINS</th>
<th>CLEANING AGENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robin Blue</td>
<td>Household detergent / Warm water</td>
</tr>
<tr>
<td>Marker ink</td>
<td>Turpentine / Acetone / Trichloroethylene</td>
</tr>
<tr>
<td>Pen ink</td>
<td>Acetone / Isopropyl alcohol</td>
</tr>
<tr>
<td>Methylene blue</td>
<td>Isopropyl alcohol / Acetone</td>
</tr>
<tr>
<td>Sauce</td>
<td>Ammonia solution</td>
</tr>
<tr>
<td>Cement</td>
<td>Turpentine / Acetone / Trichloroethylene / Conc. HCL</td>
</tr>
<tr>
<td>Tea</td>
<td>Hydrochloric acid / Bleaching powder</td>
</tr>
<tr>
<td>Coffee</td>
<td>Sodium hydroxide / Potassium hydroxide</td>
</tr>
<tr>
<td>Beer</td>
<td>Sodium hydroxide / Potassium hydroxide</td>
</tr>
<tr>
<td>Diesel</td>
<td>Acetone / Petrol</td>
</tr>
<tr>
<td>Lab indicator</td>
<td>Acetone / Isopropyl alcohol</td>
</tr>
<tr>
<td>Cement and grouting</td>
<td>Hydrochloric acid</td>
</tr>
<tr>
<td>Pencil mark</td>
<td>Benzene or Toluene or Xylene</td>
</tr>
<tr>
<td>Plaster of Paris (POP)</td>
<td>Ammonium sulphate solution</td>
</tr>
<tr>
<td>Iodine (Tincture iodine)</td>
<td>Sodium hydroxide / Potassium hydroxide</td>
</tr>
<tr>
<td>Hair dye</td>
<td>Per chloric acid</td>
</tr>
<tr>
<td>Paan</td>
<td>Lemon juice or citric acid</td>
</tr>
<tr>
<td>Marker pen</td>
<td>Acetone</td>
</tr>
</tbody>
</table>

OT (other tiles). 9 TANDUR STONE/CUDDAPPA STONE/ POLISHED SHAHABAD STONE / BLUE WADI STONE FLOORING / SKIRTING / DADO: The specifications for Tandur, Cudappa, polished Shahabad and blue Wadi stone flooring / skirting / dado shall be similar to those respecting specifications for Kotah stone flooring / skirting / dado specified herein before in all respects.

**27: RED OR WHITE ROUGH DRESSED SAND STONE FLOORING**

27.1 Stone Slabs: The slabs shall be red or white as specified in the description of the item. The stone slabs shall be hard, sound, durable and tough, free from cracks, decay and weathering. In case of red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of slabs approved by the Engineer-in-charge. The slabs shall be hand or machine cut to the requisite thickness along planes parallel to the natural bed of stone and should be of uniform size if required.

27.2 Dressing of Slabs: Every slab shall be cut to the required size and shape, and rough chisel dressed on the top, so that the dressed surface shall not be more than 6 mm from a straight edge when placed on the top. The edge of
depressions or projections shall be chisel dressed in a slant so that the surface does not have sharp unevenness. The edges shall also chisel dressed to a minimum depth of 20mm so that the dressed edge shall at no place be more than 30 mm from a straight edge butted against it. Beyond this depth the sides may be dressed slightly splayed so as to form inverted ‘V’ shaped joint with adjoining slabs. All angles and edges of the slabs shall be true, square and free from chipings & the surface reasonably true and plane. Where slabs are used for treads without nosing, the exposed edges shall be rough chisel dressed to full depth and cut to uniform thickness. The thickness of the slabs after it is dressed shall be 40 mm or as specified in the description of the item with a permissible tolerance of (+/- 2mm)...

27.3: Laying

27.3.1 Base concrete on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be of cement mortar 1:5 (1 cement : 5 coarse sand) or as given in description of the item.

27.3.2 The average thickness of the bedding mortar under the slabs shall be 20 mm and the thickness at any place under the slabs shall not be less than 12 mm.

27.3.3: The slab shall be laid in the following manner: Mortar of specified mix shall be spread under each slab. The slab shall be washed clean before laying. It shall then be laid on top, pressed and larded, so that all hollows underneath get filled and surplus mortar works up through the joints. The top shall be tapped with a wooden mallet and brought to level and close to the adjoining slabs, with thickness of joint not exceeding 5mm. Subsequent slabs shall be laid in the same manner. After laying each slab surplus mortar on the surface of slabs shall be cleaned off and joints finished flush.

27.3.4 In case pointing with other mortar mix is specified, the joint shall be left raked out uniformly and to a depth of not less than 12 mm when the mortar is still green. The pointing shall be cured for a minimum period of 7 days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engr.-in-charge.

27.3.5 Slabs that are fixed in the floor adjoining the wall, shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster, skirting and floor shall be finished neatly and without waviness.

27.3.6 The finished floor shall not sound hollow when tapped with wooden mallet.

27.4 Finishing: Any unevenness existing between the edges of slab joints shall be removed by chiselling in a slant.

27.5 Measurements: The flooring work shall be measured in square metre correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. 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 laying the floor at different levels in the same room/area.

27.6 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above. Where pointing is to be done, this will be paid extra unless specifically included in the description of the item.

28: PVC SHEET / TILES FLOORING:

28.0 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 the PVC flooring materials. It shall be laid on a base that is finished even and smooth such as concrete, metal or timber boarding.
28: 1 Materials

28.1 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 polymeric material shall be compounded with suitable plasticizers and stabilizers.

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.

28.1.2 Thickness of PVC sheets shall be measured with micrometer or Ratechet type or a dial gauge graduated 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 points taken at random on the rear surface of each tile with a suitable depth gauge.

28.1.3 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.

28: 1.4 Tolerance

<table>
<thead>
<tr>
<th>(a)</th>
<th>In Thickness</th>
<th>(+/-) 0.15 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>In Width: as under:</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>300 mm square tiles</td>
<td>(+/-) 0.2mm</td>
</tr>
<tr>
<td>(ii)</td>
<td>600 mm square tiles</td>
<td>(+/-) 0.4mm</td>
</tr>
<tr>
<td>(iii)</td>
<td>900 mm square tiles</td>
<td>(+/-) 0.6mm</td>
</tr>
<tr>
<td>(iv)</td>
<td>Sheets and rolls</td>
<td>(+/-) 0.1 per cent</td>
</tr>
</tbody>
</table>

28.1.5 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 of water.

28: 2 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.

Where it is expected that the dampness may find its way from the surrounding walls, the same shall also be effectively damp-proofed uptil at least 150 mm above the level of the sub-floor and the damp proof treatment below the floor shall be extended over the walls.

**28.3 Laying and Fixing**

28.3.1 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.

28.3.2 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°C nor exceed 30°C. These conditions shall be maintained during laying and for 48 hours, there after.

28.3.3 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 unless the 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.

28.3.4 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.

28.3.5 The adhesive shall be applied by using a notched trowel to the sub-floor and to the back side of the PVC sheet 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.

28.3.6 Care should be taken while laying the flooring under high humidity conditions so that condensation does not take place of the adhesive. It is preferable to avoid laying under high humidity conditions.

28.3.7 The area of adhesive to be spread at one time on the sub-floor depends entirely upon local circumstances. Incase 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.

28.3.8 When the adhesive is just tack free the PVC flooring sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background 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.

28.3.9 The alignment should be checked after laying of each row of sheet is completed. If the alignment is not perfect, the sheets may be trimmed by using a straight edge.

28.3.10 The tiles shall be fixed in exactly the same manner as for the sheets. It is preferable to start laying of the tiles 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 removing and 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.

28.3.11 Any adhesive which may squeeze up between sheets or tiles should be wiped off immediately with a wet cloth 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.

28.3.12 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.

28.3.13 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).

28.3.14 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 used and should be securely fastened to the sub floor to protect edges of the flooring.

28.4 Precaution for Maintenance

28.4.1 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.

28.4.2 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 wash with 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.

28.5 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.

28.6 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.
28. 7. 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.

29 - LINOLEUM FLOORING

29.0 Linoleum may be used on any base that is finished even and smooth, such as concrete, timber boarding or mastic asphalt. Unevenness or undulations in the base will show badly on the surface even and are liable to damage the linoleum. Linoleum flooring is suitable only for locations wholly inside the building. Linoleum is not resistant to indentations from heels or static load. Heavy objects left in one position may leave indentations. As linoleum flooring can become dangerously slippery when highly polished or wet, care should be taken to use polish with reduced tendency to slipperiness. If full damp proofing of the base surface can not be ensured, the linoleum should not be used for floor covering. Linoleum is a combustible material and should not be used where an incombustible flooring is required. Linoleum flooring is a specialised work, which shall be carried out through specialist firms.

29.1 Materials

29.1.1 Linoleum: Linoleum shall conform in all respects to IS: 653. Linoleum shall be of thickness specified in the description of the item. Linoleum shall be of either plain, moire, jaspe or marble type or a combination of the above types as shown in drawings or as directed by the Engineer-in-charge.

Linoleum shall be stored in a clean, dry & well-ventilated place without exposure to direct sunlight as directed by the Engineer-in-charge. Before starting the work the contractor shall get the samples of Linoleum approved by the Engineer-in-charge.

Recommended thickness: Linoleum used shall be of a thickness adequate for the conditions of surface and situation. The following thickness shall generally be used.

<table>
<thead>
<tr>
<th>S</th>
<th>SITUATION</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>For public buildings, cinemas, restaurants, ships and the like</td>
<td>6 to 6.7 mm</td>
</tr>
<tr>
<td>b)</td>
<td>For offices, shops and the like, depending upon the intensity of traffic</td>
<td>3.2 to 4.5 mm</td>
</tr>
<tr>
<td>c)</td>
<td>For residential house</td>
<td>3.2 mm</td>
</tr>
</tbody>
</table>

29.1.2 Adhesive: The adhesive used for laying the linoleum shall be those recommended by manufacturers of the floor covering and shall conform to specifications laid down for adhesive in IS: 1198. It shall be of heavy consistency and of reasonably short drying time.

29.2 Laying: It shall conform to IS: 1198.

29.2.1 Before laying linoleum it is essential to ensure that the base is thoroughly dry and damp proof as per relevant IS and/or as directed by the Engineer-in-Charge, as moisture slowly rots the base and damage the adhesive resulting in the linoleum being separated from the base and curled up. Damp proofing where required may be either with an impervious membrane incorporated in the thickness of the base or with a layer of mastic asphalt of 12.5 mm minimum thickness spread and finished even and smooth on the concrete or other base.

29.2.2 Linoleum shall be kept at a temperature of not less than 20°C for at least 48 hours before it is unrolled. Linoleum shall be unrolled and loose laid out flat for 2 to 3 days before it is cut to size, as it shrinks in length and expands in width after rolling. Till the expansion of spread roll stops, the two widths of linoleum should be allowed overlap and after the expansion stops it should be cut to fit. Laying should be taken up only after the sheets are finally cut to size after expansion is stopped. Linoleum pieces shall be cut to the required size and shapes with a
sharp straight edge and gauge as explained below and laid dry to the margin and pattern as shown in the drawings or as directed by the Engineer-in-charge.

29.2.3 The length for borders shall be first cut and adjusted. Linoleum shall then be adjusted in the central portion with their edges overlapping the adjacent pieces by about 12 mm. The edges shall then be cut with the help of a special instrument called the 'Gauge' which enables the marking of the edge of the top pieces exactly over edge of the adjacent piece, so that when the overlapping is cut along the line, the edges of adjacent sheets butt against each other without any gap, what so ever.

29.2.4 Adhesive shall then be brushed over the base, which shall have been thoroughly cleaned in advance, and shall be allowed to become tacky. The sheets shall then be firmly pressed down and rolled with a light cast iron 70 kg roller, to ensure that they stick evenly to the base and no air pockets are left under them. If any air pockets are left, the sheets shall be removed and re-laid after brushing more adhesive on the base and roll. The sheets shall be laid with butt joints throughout and the joints shall be very fine. Sandbags shall be placed over the edges and joints to keep the sheets pressed down and prevent curling. Linoleum shall not be used for coves, skirting and dado.

29.2.5 Coves of wood or metal may be formed to cover or mask the joints between the linoleum flooring and the wall facing where so required, but this shall be paid for separately.

29.3. Finishing: After laying, any adhesive contaminating the face of the sheets shall be removed immediately with kerosene oil or spirit. The flooring shall be cleaned with soap and wet cloth wiped dry. It shall then be wax polished to give a smooth shining surface, taking care to ensure that the flooring does not become slippery due to excessive polish.

29.4. Precautions: Linoleum shall not be creased, as it will crack. Excess water, which is liable to creep into the joints and strongly alkaline soaps, shall not be used for cleaning. Mild bar soap may be used. Linoleum shall be handled carefully with its exposed face protected from damage by sharp points.

29.5. Measurements: Length and breadths of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deductions 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.

29.6. Rate: The rate shall include the cost of all materials and labour involved in all the operations described above but will not include the cost of sub-base floor or damp proof treatment stated above.

30. WOODEN FLOORING

30.0 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.

30.1 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 per design furnished.

30.2 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 preceding chapters 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 except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be 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 shall occur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

30.3 Iron Screws: Iron screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm subject to a minimum of 40 mm, & of designation of No. 9 conforming to IS : 451.

30.4 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 or perpendicular 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.

30.5 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.

30.6. 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.

30.7. 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.

31. WOOD WORK IN FRAMES, SHUTTERS AND PANELLING:

31.1 WOOD WORK:

All timber mentioned in the item in schedule of quantities shall be from the heart of a sound tree of nature growth merely 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 large, loose, dead or cluster knots, wedges, injuries, open shakes, borer holes, rot,
decay date, discoloration, soft or spongy spot, hollow pockets, pith or centre bore 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.

**TEAK WOOD:**

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 not be allowed.

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.

**HARD WOOD:**

No individual hard and sound knot shall exceed 25mm in diameter and aggregate area of all knots shall not exceed one percent of the area of the piece. Sapwood is very perishable and should not be used.

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 shall be judged from its moisture content as laid down in I.S. 287. The seasoning of timber shall conform to I.S. 1141 -1 993. 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 work shall 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 tenonned into the mortises to the full widths as shown in the drawing. All necessary mortising, tenonning, 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 recognised 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 case they 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 of brick masonry. For frames abutting concrete surfaces, 6 nos., 100 mm. long coach screws with sunk heads minimum 10 mm. from face of frames, shall be provided. Each screw shall be secured in concrete with 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 shall be carried out as per 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.

31.2 TEAK WOOD PANELLED SHUTTERS:

Teak wood door shutter shall generally conform to standard laid in I.S. 1002 or the latest revision for requirements of materials, construction workmanship and shall be of specified thickness and of 1st class C.P. teak wood of approved design with stiles, top, bottom and lock rail generally as per drawing. Wherever shown, each 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.

31.3 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.

31.4 GLAZING:

Glazing shall be generally with 4 mm. thick plain sheet glass/bajra glass unless otherwise mentioned in the schedule of quantities. The detailed specifications for glazing given hereafter shall be followed generally.

31.5 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.

31.6 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.

31.7 ADHESIVES:

Phenol formaldehyde synthetic resin (liquid type adhesives) conforming to I.S. 848 specifications for synthetic resins shall be used for bonding.

31.8 LIPPING:

The lipping shall be of best quality hard wood variety unless otherwise mentioned. In case teak wood lipping is mentioned in the schedule of quantities, it shall conform the specification for best quality teak wood. The internal
lipping around the shutter sides shall be one piece of size not less than 25 mm. wide and depth equal to the thickness of core. In case of double leaf shutters, the meeting stiles shall have lipping of not less than 35 mm. deep.

31.9 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.

31.10 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.

31.11 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.

31.12 MISCELLANEOUS:

Wherever mentioned in the Schedule of quantities, vision panels, venetians, plastic laminates, push plates 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 around the glass. The glass shall be 4 mm. thick or as specified of best quality (M/s. Triveni, I.A.G., Shree Vallabh or equivalent approved), free from defects.

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.

Formica or approved equivalent plastic laminate of required design, required shade and colour 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 formica 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.
31.13 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.
iv) In case of flush doors, the rate for individual item mentioned in the schedule of quantities shall include cost of shutters, labour for provision of glass for vision panel, plastic laminate sheet push plate, teak wood louvers etc., transporting charges and labour for fixing of fixtures and fastenings except fixing of door closers and painting and polishing as specified.

32. PRESSED STEEL DOOR FRAME:

32.1. Scope of work: This specification lays down the requirements regarding material, dimensions and construction of steel door frames for internal and external use.

32.2. Material: Steel door frames shall be manufactured from commercial mild steel sheets of 1.25 mm. thickness, conforming to I.S. 513 (Spn. for cold rolled carbon steel sheets) or I.S. 1079 (Spn. for hot rolled carbon steel sheet and strip). Sheets shall be galvanised for 240 g / Sqm. Zinc deposit on its surface including both sides as per IS 277 – 2003.

32.3. Standard sizes, Tolerances and Designations:

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.

Tolerances: The sizes indicated in drawings for door frames shall not vary by more than (+/-) 2 mm.

32.4. Profile: Steel door frames with or without fanlight shall be made in the profile as per I.S. 4351 (latest version) as per drawings. Any of the three 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.

32.5. 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.

32.6. Base ties and angle thresholds: Base ties shall be of pressed mild steel 1.25 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.

32.7. Fittings: 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 strip not less than
40 mm. wide and not less than 1.0 mm. thick.

Mortar Guards: Mortar guards specified in the tender 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.

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.

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 whenso
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 plate and 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.

32.8. 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.

33. FACTORY MADE PARTICLES BOARD PANELLED DOOR SHUTTERS.

33.1 GENERAL: Factory made particle board panelled door shutters shall be made of kiln seasoned and
chemically treated timber as specified generally with stiles and top rails of 100 mm. in width, bottom rail and lock rails of
150/175 mm. width and panels made of 12 mm. thick both side commercial veneered teak wood particle board or as
specified in schedule of quantities, bonded with phenol formaldehyde synthetic resin adhesive and generally
conforming to I.S. 3091.

Factory made shutters, as specified shall be obtained from factories to be approved by the Engineer-in-Charge and shall
conform to I.S. 2202 (Part-I). The contractor shall inform well in advance to the Engineer-in-Charge the name and
address of the factory where from the contractor intends to get the shutters manufactured. The contractor will place
order for manufacture of shutters only after written approval of the Engineer-in-Charge in this regard is given. The
contractor is bound to abide by the decision of the Engineer-in-Charge and recommend the name of another factory
from the approved list, in case the factory already proposed by the contractor is not found competent to manufacture
quality shutters.

The contractor will also arrange stage-wise inspection of the shutters at factory of the Engineer-in-Charge or his
authorised representative. Contractor will have no claim if the shutters brought at site are rejected by Engineer-in-
Charge in part or in full lot due to bad workmanship/quality. Such shutters will not be measured and paid and the
33.2 TIMBER:

The timber to be used in door shutters shall generally conform to relevant I.S. specifications for materials, moisture content, seasoning, preservation and workmanship.

All timber shall be from the heart of a sound tree of mature growth, entirely free from sapwood. It shall be uniform in texture, straight in fiber and shall be well and properly seasoned. It shall be free from large, loose or dead or cluster knots, soft or spongy spots, hollow pockets, pith or centre heart, waves, injurious open shakes, borer holes, rot, decay, discoloration and all other defects or any other damages of harmful nature which will affect the strength, durability, appearance of its usefulness for the purpose for which it is required.

33.3 PARTICLE BOARD PANELS:

It shall be of well seasoned teak timber particles of uniform thickness, bonded with liquid phenol formaldehyde synthetic resin adhesive of the hot press type. The particle board shall be either flat plate on press or extrusion type as approved by the Department conforming to the latest I.S. specifications. Panels shall be embedded into frames to a minimum of 12 mm. with 1.5 mm. air gaps.

33.4 SEASONING AND TREATMENT:

All timber to be used for sills and rails shall be kiln seasoned to the required standards as per I.S. 1141-1973.

33.5 ADHESIVE:

The adhesive for bonding of stiles, rails etc. shall be of highly water resistant type synthetic resins (liquid type) adhesive conforming to relevant specifications for synthetic resins.

33.6 WORKMANSHIP AND FINISH:

The workmanship shall be of best quality. All members shall be in continues length. All the faces of the door shutter shall be secured and in true planes. All wrought timber is to be sawn, planed, drilled or otherwise moulded work to the correct size and shapes indicated in drawing or as specified. All joinery work shall fit truly and without wedging or filling. All the faces of the shutters shall be sanded to smooth even texture. The finished sizes and sections shall be as per drawing or as specified. The shutters shall be got approved from the Engineer-in-Charge at factory site before carting the same to the site of work. The shutters damaged during the cartage and if any sub-standard 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.

33.7 PRIMER COAT:

All factory made panel door shutters with seasoned teak wood/hard wood frame shall be painted with approved Primer coat as per I.S. specifications 1003 (Part-I).

33.8 TESTS:

Tests shall be conducted as per mandatory test requirement by the Department at the contractors cost. All shutters shall have manufacturer’s trade marks.

33.9 TOLERANCES:

SIGNATURE & SEAL OF TENDERER
Tolerances on nominal width and height shall be (+/-) 3 mm. Tolerance on nominal thickness shall be (+/-) 1.5 mm. The thickness of the shutter frame shall be uniform throughout with a variation not exceeding 1 mm., when measured at two points.

33.10 SAMPLES:
Sample of door shutter shall be got approved before manufacturing on large scale.

33.11 FIXING:
The shutter shall be fixed to teak wood or rolled M.S./EZ door frame (teak wood/rolled steel in door frames paid under relevant items) with necessary fittings as per drawing (cost of fittings and fixtures paid under relevant items). The shutter shall be painted as specified. The shutters of specified thickness and of required sizes as fixed in position as shown in drawing/schedule of quantities shall be measured for payment. The length and width of the shutter fixed in position shall be measured correct up to three places of decimal of a metre and the areas so worked out shall be corrected up to two places of decimal of a square metre. The area of the shutter shall be measured for the exposed surfaces of shutter between frames from inside or outside whichever is more.

33.12 RATE TO INCLUDE:
The rate quoted by the contractor shall be:

i) for supplying and fixing in position of finished shutters with necessary fittings and fixtures as per drawings (excluding cost of fittings and fixtures which shall be paid under relevant items).

ii) painting/polishing as specified and as directed by the Engineer-in-charge.

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34: GLASS FIBRE REINFORCED PLASTIC (GRP) PANEL TYPE DOOR SHUTTERS

(For Internal Use)

34.1 SCOPE
The specification for Glass Fibre Reinforced Plastic (GRP) Panel Type Door 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.

34.2 REFERENCES: The above cited IS 14856 shall be referred with its associated codes.

34.3 TERMINOLOGY

- **Aggregate Defects:** Presence of impurities such as pin holes, impurities and traces of mending more than 5 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 1.5% by weight, aerosil powder (500 micron ground silica) suitably formulated to high viscosity given to exposed exterior sections of the moulded door shutter to provide a smooth glossy finish, enhance aesthetics and improve weathering and water resistant properties of the moulded door shutter. The thickness of the coat shall be between 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 of fittings and other accessories.

RTM Process: Resin Transfer Moulding includes all forms of resin injections, resin infusion vacuum infusion 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.

34.4 HANDING: Handing and direction of closing of shutters shall be designated in accordance with IS 4043.

34.5 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: Isophthalic 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 acetone peroxide, etc.

2. Accelerator used shall be cobalt napthalate, cobalt octonate, N.N. dimethyl aniline, etc.

Fillers and Additives

1. Permissible fillers are fine 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 be used as a mould release agent.
Pigments: Pigments compatible with isophthalic resin and gelcoat shall be used to obtain the shade of finish 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 hard wood 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.

34.6 CONSTRUCTION / FABRICATION

34.6.1 The GRP shutter shall have hollow rails and stiles monolithically cast with panels.

34.6.2 The shutters shall be contact moulded by either hand lay up or Resin Transfer Moulding (RTM) process into two pieces as shown in Fig. 1. 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 using the 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 two parts of isophthalic resin).

34.6.3 Blocks of any seasoned hardwood of bulk density not less than 450 kg/m3 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.

34.6.4 Blocks shall be provided at predetermined places in the shutter so as to fix hinges, mortice locks, tower bolts, aldrops, door closures, etc.

34.6.5 The finished surface shall be buffed and polished 3 IS 14856:2000 with wax.

34.7 DIMENSIONS, SIZES AND TOLERANCES

34.7.1 Dimensions of Components and Tolerances: The finished dimensions and tolerances of the different components of door shutter shall be as given below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Description</th>
<th>Width (in mm)</th>
<th>Thickness (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Vertical stile, top and freeze rail</td>
<td>90 (+/-) 3</td>
<td>30 (+/-) or 35 (+/-) 1</td>
</tr>
<tr>
<td>ii</td>
<td>Lock rail</td>
<td>120 (+/-) 3</td>
<td>30 (+/-) or 35 (+/-) 1</td>
</tr>
<tr>
<td>iii</td>
<td>Bottom rail</td>
<td>150 (+/-) 3</td>
<td>30 (+/-) or 35 (+/-) 1</td>
</tr>
</tbody>
</table>

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.

34.7.2 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.

34.7.3 Tolerances: Tolerances on the sizes of door shutters shall be ±mm.

34.8 LOCATIONS OF FITTINGS AND ACCESSORIES

34.8.1 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.

34.8.2 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.

34.8.3 Other fixtures shall also be provided at the locations where blocks have already been provided.

34.9 FINISH

34.9.1 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.

34.9.2 Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable.

34.9.3 Panels, rails and stiles of the door shutters shall be flat and shall have smooth and level surface.

34.9.4 Shutter shall be finished in colour & design as specified in the agreement item.

34.10 TESTS

34.10.1 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>
<thead>
<tr>
<th>Sr. No.</th>
<th>Tests (as per IS requirement)</th>
<th>Acceptable Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Fibre glass content Annex B</td>
<td>25 percent (Min)</td>
</tr>
<tr>
<td>ii)</td>
<td>Barcol hardness Annex C</td>
<td>30 BHU (Min)</td>
</tr>
<tr>
<td>iii)</td>
<td>Tensile strength Annex D (MPa)</td>
<td>100 (Min)</td>
</tr>
<tr>
<td>iv)</td>
<td>Bending strength Annex E (MPa)</td>
<td>120 (Min)</td>
</tr>
<tr>
<td>v)</td>
<td>Elastic modulus Annex F in bend (MPa)</td>
<td>1500 (Min)</td>
</tr>
<tr>
<td>vi)</td>
<td>Water absorption Annex G</td>
<td>0.5 percent (Max)</td>
</tr>
<tr>
<td>vii)</td>
<td>Fire retardancy Annex H</td>
<td>100 mm length of the specimen shall not burn within 60 seconds</td>
</tr>
</tbody>
</table>

34.10.2 Requirements on Shutters

The following tests in accordance with IS 4020 (Parts 1 to 16) shall be conducted on the door shutters:

34.10.2.1 Dimensions and Squareness Test: Door shutters, when tested in accordance with IS 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. The nominal thickness of the shutter shall be within a limit of (+/-) 1.5mm.

34.10.2.2 General Flatness Test: Door shutters, when tested in accordance with IS 4020 (Part 3), the twist, cupping and warping shall not exceed 6 mm.

34.10.2.3 Local Planeness Test: Door shutters, when tested in accordance with IS 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

34.10.2.4 Impact Indentation Test: Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delamination and the depth of indentation shall not be more than 0.2 mm.

34.10.2.5 Edge Loading Test: Door shutters, when tested in accordance with IS 4020 (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.

34.10.2.6 Shock Resistance Test

1. Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8), 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.

34.10.2.7 Buckling Test: Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show any 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.

34.10.2.8 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 any visible 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 any visible damage in any part of the door at the end of 100 successive impacts.

34.10.2.9 Misuse Test

Door shutters, when tested in accordance with IS 4020 (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.

34.11 SAMPLING AND CRITERIA FOR CONFORMITY: The sampling and criteria for conformity shall be in accordance with IS 4020 (Part 1).

34.12 MARKING

1. All door shutters conforming to this specification shall be marked with the following information:
34.13 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 up to two places of decimals of a metre. The area for payment shall be worked out correct up to two places of decimal of a square metre.

34.14 RATE TO INCLUDE: The rate quoted by the contractor shall include supplying and fixing the shutters including supplying and fixing all fittings and fixtures as per item and / or drawing. Unless otherwise specified, frame work for the shutters shall be measured and paid separately under relevant item.

* * *

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 the work 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, nodized 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.

Fittings shall be of Mild steel, Stainless steel, aluminium, brass or as specified. The fittings shall be well made, smooth, and free from sharp edges and corners, flaws and other defects.

Mild steel fittings shall be bright satin finish black stone nodized or copper oxidised (black finish), nickel chromium
Brass fittings shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

Aluminium fittings shall be finished 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 shall also 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 latest I.S. specifications butt hinges shall generally conform to relevant I.S viz IS 1341 (M.S.) IS : 205 (Cast brass & aluminium), IS : 362 (Parliament hinges); IS : 453 spring hinges, IS : 3818 (Piano hinges) etc. The size of butt hinges shall be taken as the length of the hinge. Width of the hinge shall be measured from the centre line of hinge pin to end of flange.

35.4 PARLIAMENT HINGES: These shall be manufactured from extruded section for brass and aluminium and from M.S. sheets for iron oxidised and shall be free from cracks and other defects. The size of the parliamentary hinges shall be taken as the width between open flanges, while the depth 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 nodized, 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.

35.6 TOWER BOLTS: These shall generally conform to IS 204 (Part II & I). They shall be well made and shall be free from defects.

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 firmlynodize 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 be taken as the length of barrel without top socket.

35.7 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, CP or oxidised as or specified.
35.8 ALDROPS:

These shall be oxidised brass or nodized 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.

35.9 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 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.

35.10 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 nodized 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 leaf door a rebated face. Level handles with springs shall be mounted on
plates and shall be of approved quality, nodized aluminium or as specified.

35.11 HYDRAULIC DOOR CLOSER:

This shall be generally conform to IS : 3564. Hydraulic door closer shall be of approved quality and make. The
operation of the Hydraulic door closer shall be very smooth.

This should be of H.D.-66 for external/main doors and elegant - 63 for all internal doors. The overall height
should not be more than 170 mm. for H.D.-66 and 160 mm. for elegant - 63, base shall be 110 x 60 mm. for H.D.-66 and
100 x 55 mm. for elegant - 63 weighing not less than 4.5 kg. for H.D.-66 and 4 Kg. for elegant - 63. 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.

35.12 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.

35.13 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

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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.

35.14 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. The size of door stopper shall be determined by the length of its plate. The body of the door stopper shall be cast 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.

35.15 MODE OF MEASUREMENT AND RATE: Unless otherwise specified, all fittings including all necessary accessories shall be measured in numbers and 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 furnishing and fixing the glass panes to teak wood or steel doors and windows, strictly in accordance with these specifications and drawings.

36.2 MATERIALS:

i) Glass: The glass shall be special selected / selected ordinary quantity glass of M/s. Shree Vallabh / Triveni / I.A.G. or of equivalent manufacture, as specified. Toughened float glass of approved manufacturer shall be used wherever 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 Makers original packings and Makers 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 brought to site shall be protected against damages. Wherever frosted (obscure) glass is mentioned in the item of schedule 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.

ii) 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 drawings. 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 mitre jointed.

iii) Dimensions, Thickness and weight of the glass: Unless otherwise specified, these shall be as per table given below. All panes shall have properly squared corner and straight edges

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Range of</th>
<th>Weight in gms</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 mm</td>
<td>2.8 to 3.2 mm</td>
<td>07.5</td>
</tr>
<tr>
<td>4.0 mm</td>
<td>3.8 to 4.2 mm</td>
<td>10.0</td>
</tr>
</tbody>
</table>
36.3 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 with aluminium 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 by setting blocks. There shall be no whistling or rattling.

36.4 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.

36.5 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, labour, transport, scaffolding etc.

37. STEEL DOORS, WINDOWS AND VENTILATORS:

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.

37.1 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.
37.2 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 unless otherwise shown in drawing. Glazing used will be clear sheet glass of special selected quality manufactured by M/s. Shree Vallabh or other approved equivalent, unless otherwise specified. 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.

37.3 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 rivetted to the frame.

37.4 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.

37.5 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 prepared openings 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 original condition.

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 preferably just 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.
37.6 DETAILS OF COMPONENT PARTS:

37.6.1 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.

37.6.2 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 riveted to the frame shall also be provided. Handles shall be of brass or bronze and shall be of brass or bronze, and 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.

37.6.3 VENTILATORS:  

a) Top hung ventilators: These shall be fixed with plain hinges, riveted to the frame 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.

b) 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 open at 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 pulley wheel in a mild steel or malleable iron brackets, shall be fitted with screws or welded at the sill and a cord eye shall be fixed to inner frame of ventilators to facilitate opening of ventilators.

37.6.4 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.

37.7 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 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 afterthe
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.

**37.8 GLASS AND GLAZING :** Specifications for glazing given in this book under chapter Glass and Glazing, shall also be applicable for steel doors / windows / ventilators.

**37.9 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.

**38. ROLLING SHUTTERS :**

**38.1 SCOPE OF WORK & GENERAL :**

Item refers to supplying and fixing rolling shutters of size and type as specified in the description of item.

**38.2 MATERIALS :**

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 of quantities. 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 shall consist of 80 mm. wide MS laths 1.25 mm thick or gauge as specified of best quality mild steel sheet machine rolled. Laths shall be inter-locked together throughout their entire length and joined together at the end with end locks. These shall be mounted on specially designed pipe shaft. 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 the same 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 quality and shall be easy in operation.

**38.3 FIXING :**

Brackets shall be fixed on the lintel/beam or under the lintel/beam as specified in item with rawl plugs and screws, bolts, washers etc. The shaft along with the spring shall then be fixed on the brackets. The lath portion (shutters) shall be laid on ground and the side guide channels shall be bound with it. The shutter shall then be placed in position. The side guide channels shall be fixed to the wall through the plates welded to the guides. These plates and brackets shall be fixed by means of steel screws, bolts and rawl plugs drilled into the wall. The plates and screws, bolts shall be concealed in plaster to make their locations invisible. Fixing shall be done accurately in a workman like manner that the
operation of the shutter is easy and smooth. All grout holes and damages on the wall while fixing of shutters shall be made good by the contractor at no extra cost to the Department. The contractor shall ensure smooth and easy working of shutters. All the members of the rolling shutter shall be thoroughly cleaned of dust, scales, rust etc. and shall be given approved priming coat 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 :

The area of rolling shutters shall be measured in square metre correct upto two places of decimal. Width and height shall be taken for net opening correct to a centimeter.

38.5 RATE :

The rate shall include the cost of materials, labour involved in all the operations described above.

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 alignment. Any undulations, bends etc. found shall be rectified by the contractor at his own cost. The complete 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:

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.

The rate is to 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 polished with wax polish/french polish/solignum with two or more coats over one coat of wood primer or painted with two coats of synthetic enamel paint/flat oil paint of approved make and shade over one coat of approved primer. M.S. grills, balusters etc. also to be painted as per specifications specified under painting/polishing.

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 up to 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. ALUMINIUM ENTRANCE DOORS, WALL SPANS, GLAZING ETC.

40.1 SCOPE OF WORK:

The scope of work in the present tender item includes fabrication, supply and installation of white anodised matt finished aluminium entrance doors, glazing etc. strictly in accordance with these specifications and relevant detailed approved shop drawings.

40.2 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, details of 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. The tenderer shall intimate at the time of tendering, the type of sections he proposes to use on the works.

40.3 MATERIALS:

Aluminium alloy for extruded sections for the above work shall correspond to I.S. 733 & 737 specifications or any further revision thereof(extruded sections shall conform to I.S. Designation HE 9- WP. Hollow sections shall conform to I.S. Designation HV9-WP) 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 INDAL 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. Each door leaf shall be prepared to receive glazed panel of required thickness. Glazing shall be done with neoprene dry set glazing gasket (of best quality and approved make) with snap-in-bevelled while anodised matt 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 a minimum thickness of 0.015 mm.

40.4 FABRICATION:

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. A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate shall be applied on the finished sections of the aluminium work by the contractor to protect the surfaces from wet cement, lime, dirt, dust etc. during the construction activities. The size for door, window or ventilator frames shall not vary by more than (+/-) 1.5 mm.

40.5 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/handling 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.
40.6 FIXING:
Fixing and glazing of doors, windows and ventilators shall be conforming 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/poly sulphide compound in order to ensure watertight 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.

40.7 GLASS AND GLAZING:

40.7.1 Glass: The glass shall be of selected quality/special selected quality of M/s. Triveni / Shree Vallabh, I.A.G. or equivalent manufacture, as specified under the chapter GLASS AND GLAZING.

40.7.2 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.

40.7.3 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. Premeasurement of each panel prior to the cutting of glass is essential.

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.

40.7.4 Glazing: The glass panes shall be fixed to the frame as mentioned above with approved Neoprene dry set glazing gasket (of best quality and approved make) with snap-in-bevelled white 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 is properly taken over by the Engineer-in-Charge. All wall spans glazing and entrances, fixed glazing etc. shall be tested for water tightness. Any leakage found during testing, it is the responsibility of the contractor to rectify the same without any extra claim.

40.7.5 General: After the inspection is over and permitted by the Engineer-in-Charge, the glass panes shall be cleaned off 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
40.8 MODE OF MEASUREMENT :

a) **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 extruded section used for fabrication shall be measured outer to outer of cut length correct upto 1 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.

b) **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.

40.9 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 handles, mortise lock, dead lock, door closer, floor springs, concealed door lower bolts 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 the job involved.

40.10 TESTING :

Aluminium sections shall be tested for its unit weight, anodic coating etc. as per relevant IS codes.

40.11 GUARANTEE :

All materials used in above work shall be **guaranteed for one year** (unless otherwise specified) from the date of handing over the work. Any defect found in the guarantee period shall be replaced/repaid to original condition/position entirely at the contractors cost.

41. ALUMINIUM WINDOWS, VENTILATORS, COMPOSITE UNIT ETC. :

41.1 SCOPE OF WORK :

The scope of work in the tender item includes fabrication, supply and installation of white anodised matt finished aluminium windows, ventilators, 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 IS 1948 & 1949. The contractor shall submit six copies of shop drawings covering all types/details of work as generally shown in Architectural drawing and envisaged under these specifications before manufacture. The drawing shall show all dimensions, details of construction,
installation, fixtures and relation to adjoining and related works. No fabrication work shall be under- taken prior to the approval of shop drgs. from the Engineer-in-Charge. The tenderer shall intimate at the time of tendering, the types of sections he proposes to use on the works.

41.3 MATERIALS:

The aluminium alloy used in the manufacture for extruded window section shall correspond to I.S. 733 (or any further revision thereof). Extruded sections shall conform to I.S. designation HE9-WP and Hollow sections shall conform to I.S. Designation HV9-WP. The frame work, stiles, Mullions, beadings, transoms, hinges, pegstays, handles etc. shall be of aluminium anodised sections as shown in the detailed drawings. All sections and hardware shall have minimum anodic film thickness of 0.015 mm. All sections shall be of INDAL or other equivalent make as per drg. The contractor can also propose nearest alternative sections they manufacture/posses without changing the elevations and functional requirements. Department reserves the right to accept the alternative sections or otherwise. The sections shall be structurally suitable to withstand all the load, the members have to sustain. Countersunk screws, nuts, bolts, washers, rivets and other miscellaneous fastening devices shall be of approved cadmium plated or stainless steel as specified in the approved drawings.

41.4 FABRICATION:

The frames shall be manufactured square and flat. The corners of the frames shall be fabricated to true right angles. All the fixed, sliding, openable frames shall be constructed from sections which have been cut to length, mitred and mechanically jointed or welded at the corners. Where hollow sections are used with welded joints, argonarc welding or flash butt welding shall be employed (Gas welding or brazing not to be done). Sub-dividing bars of units shall be tenoned and rivetted into the frames. In case welded joints are used, all welding shall be on unexposed sides in order to prevent pitting, discolouration and other surface imperfections after finishing. 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 minimum film thickness of 0.015 mm, for the entire surface. A thick layer of clear transparent lacquer based on methacrylate or cellulose butyrate shall be applied on the finished sections of the aluminium windows etc. by the supplier to protect the surfaces from wet cement, lime, dirt, dust etc. during the installation. This lacquer coating shall be removed after installation is complete, if approved by the Engineer-in-Charge and all sections of the windows shall be protected by P.V.C. film covering.

41.5 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 frame and other sections. 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 Engineer-in-Charge.

41.6 FIXING:
The window frames shall be accurately fixed in the brick masonry or R.C.C. work. The fixing of the frame shall be done with cadmium plated brass counter sunk screws driven on the teak wood rough grounds if required or fixed to the wall with holdfasts. All aluminium windows shall be fixed in position as per I.S. 1081-1960 (or any revision thereof): Code of practice for fixing and glazing of aluminium windows. All joints between metal and masonry/rough ground wooden frame shall be fully caulked with mastic or polysulphide compound in order to ensure water tight joints. Joints shall be neatly painted with matching cement and excess materials shall be removed. Hardware shall be fixed in workman like manner all as directed by the Engineer-in-Charge.

41.7 SAMPLES:

The samples of different windows shall be submitted to the Engineer-in-charge, for approval.

41.8 GLAZING:

The glazing shall be of Indian make plain sheet/frosted figured glass of special selected quality and size as mentioned in item description and drawings and shall be of M/S. Triveni/Shree Vallabh/I.A.G. or other approved equivalent. The specifications specified here-in-before shall hold good as far as applicable.

41.9 MODE OF MEASUREMENT:

Similar to as described under chapter “Aluminium Windows, Ventilators, Composite Unit Etc.”

41.10 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.

41.11 TESTING:

All windows shall be tested for water tightness. Any leakage found during testing shall be rectified by the contractor without any extra charge.

42. ALUMINIUM CURTAIN WALL SYSTEM

42.1 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.

42.2 Specification for Materials used for Curtain Wall

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Glazing</td>
<td>Glazing work shall be as specified in the description of the item and / or as described under the chapter Glass &amp; Glazing of this book.</td>
</tr>
<tr>
<td>2 Framing System</td>
<td>Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.</td>
</tr>
<tr>
<td>3 Sealant</td>
<td>As specified in the item or silicon sealant</td>
</tr>
<tr>
<td>4 Insulation</td>
<td>50 mm thick glass wool of minimum density 48 kg/cum sandwiched with black polythene sheet 100 micron on one side and aluminium foil of 100 micron on the other side or as specified by manufacturer at spandrel area. The surface after fixing insulation shall be plain without any distortion</td>
</tr>
</tbody>
</table>
| 5 Heat Reflective Toughened Glass | (a) St. Gobain - Reflectosolar as specified.  
(b) Glaverbel / Glavermass - Super Siliver.  
(c) Visteon Ford Brown or Grey Colour of any shade approved by the Engineer-in-Charge. |

42.3 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.

42.4 Components, General specifications, Glazing, Panelling etc. for Curtain Wall System: These shall be generally as per relevant Chapters in this book.

42.5 Scope of Work

42.5.1 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 complete water tightness in the
(g) Isolation of dissimilar metals and moving parts,

(h) Anticorrosive treatment on all metals used in the system,

(i) Polyester powder coating aluminium sections,

(iv) The contractor shall also be responsible for providing the following:

(a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.

(b) Mock-ups, samples and test units.

(c) Performance testing of the curtain wall framing and glazing assembly.

(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 be designed to accommodate thermal and building movements.

42.5.2 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.

42.5.2.1 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.
42.5.2.2 Quality Consideration and other Activities

(j) 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.
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.

42.5.2.3 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 9 mm total at any location.
3. Change in deviation must not exceed 3 mm for any 3.5 m run in any direction.

42.5.2.4 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).

42.5.2.5 Ancillary Requirements to be fulfilled by the contractor

(i) The contractor / approved specialized agency shall submit a maintenance manual for the curtain wall system.
(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.

42.6 Execution of work –

42.6.1 Performance Testing - 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.

42.6.2 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.

(vi) 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.
The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

42.6.3 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.

42.6.4 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 operable 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.

42.6.5 Test Report: The contractor shall submit five copies of test report to the Engineer-in-charge.

42.6.6 Cost of Performance Test

(i) The contractor shall allow in his tender for the cost of the performance testing 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 instructed and 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 up the 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.

42.6.7 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.

42.6.8 Fabrication and Erection

(i) Frames shall be square and flat, both the fixed and openable frames shall be constructed of sections, 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 the mock-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 itself is 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.

42.7 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.

42.8 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.

42.9 Measurements

(i) The breadth and the height of the finished work including the openable windows shall be measured in metres and cm 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.

42.10 Rate

The rate shall include the cost of all operations described above including the cost of materials, labour, design, shop drawings, erection and testing, mock-up test units, fabrication, erection, finishing, scaffolding, undertaking performance guarantee etc. No other claims of any kind pertaining to this work shall be entertained.

* * *

43- STRUCTURAL GLAZING

43.1 Specification for Materials to be used In Structural Glazing

This shall be same as described for Aluminium Curtain Wall System.

43.2 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.

43.3 General Specification and Tolerances for Aluminium Extrusions

Dimensions and weights of the sections shall be as per approved drawings.

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.

Manufacturing Tolerance: Dimensional extrusions shall be normally as per IS / BSS. Special tolerances shall be mutually agreed upon.
Tolerance on cut length:

i) The standard cut length is 3.66M the tolerance on cut length shall be as follows:

<table>
<thead>
<tr>
<th>Length</th>
<th>Upto 6 metres</th>
<th>Over 6 metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance</td>
<td>+ 5 mm</td>
<td>+ 7 mm</td>
</tr>
</tbody>
</table>

ii) Sections shall also be acceptable in random lengths between 1500 to 5000mm depending upon actual requirements.

Tolerance in Weights: A tolerance of ± 10% shall be acceptable on Sectional weight per metre

43.4 Glazing:

Glazing work shall be as specified in the description of the item and / or as described under chapter : Glass & Glazing.

43.5 Scope of Work

This shall be same as described in the para “Scope of work” for Aluminium Curtain Wall System.

43.6 Execution of Work

(i) This shall be similar to the Specifications for Aluminium Curtain Wall System as far as applicable.

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.

3) A large quantity of sealant has to be used for the execution of the work of structural glazing with the result the cost per sqm. of structural glazing works out to be much on higher side.

4) There is also a slight difference in the actual fabrication of the two systems though quantity of materials required for execution in both the cases is same except the quantity of sealant.

43.7 Representative of the Contractor

These shall be similar to the Specifications for Aluminium Curtain Wall System as far as applicable.

43.8 Performance Guarantee

43.9 Measurements

43.10 Rate

44. CEMENT PLASTERING FOR WALLS & CEILINGS AND SAND FACE / ROUGH CAST PLASTERS:

44.1 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.
44.2 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. 1681 (Pt. III) (Code of practice for cement and cement plaster finish on walls and ceilings). All general precautions as specified in I.S. 1681 (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.

44.3 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, under the relevant masonry / concrete 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 with Tapanis or Thiyyas indicating the thickness of plaster required and which shall be in true line, level and plumb. 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
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 durability of 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.

44.4 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.

44.5 MIX PROPORTIONS:

The mortar for plastering shall be of proportion as specified in the item schedule. The mixes specified in the schedule are volumetric.

44.6 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 at least 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.

6 / 12 / 15 MM. PLASTER:

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.
20 MM PLASTER:

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 levelled 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 as per 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.

44.7 (A) NEERU FINISH:

Wherever specified, the surface rendered shall be finished smooth with good quality lime neeru class 'C' conforming to I.S. 712-1956. The lime shall be tested in an approved testing laboratory for the chemical analysis of the lime and test certificate submitted regarding suitability of lime for plaster work. The cost of testing shall be borne by the contractor. Neeru shall be prepared at site out of best quality pure fat lime slaked at site with fresh water and slaked in accordance with the relevant I.S. code for slaking of lime. The slaked and sifted lime shall be reduced to a fine paste by grinding 150 turns in a mortar mill. Sufficient quantity, which can be used within 10 days only shall be prepared at a time. Chopped hessian or jute fibre in the required quantity may also be added to neeru and properly ground to pure paste as per directions of the Engineer-in-Charge.

An entire unobstructed area shall be plastered in one operation. Neeru shall be applied to the prepared and partially set but somewhat plastic surface with steel trowel to a thickness slightly exceeding 1.5 mm. (1/16") and rubbed down to 1.5 mm. It shall be polished to perfectly smooth and even finish working from top to bottom for at least 3 days. All corners shall be truly brought to desired lines and levels in the base plaster along and the thickness of neeru shall not exceed 1.5 mm., at these locations. Moistening shall be commenced as soon as the plaster has hardened sufficiently and is not susceptible to injury. The surfaces shall be kept sprinkled with water for 7 days to prevent excessive evaporation. On the sunny or wind-ward side of the building in hot dry weather, matting or gunny bags may be hung over on the outside of the plaster and kept them wet. If blow holes are observed in neeru plaster at any time during the contract period and during the defect liability period, the contractor will have to rectify the defective neeru plaster work including redoing of the white washing/colour washing/distempering work etc. as the case may be, entirely at his own cost.

It shall be the contractors responsibility to ensure that cracks do not develop during the execution or subsequently during the defect liability period and the cracks if any observed shall be rectifying including finishing,
white washing/painting as specified, without any extra cost to the Department, to the entire satisfaction of the Engineer-in-charge.

44.7 (B) TEROL FINISH OF TERRACO:

Wherever specified, the surface rendered shall be finished smooth with 0.5 to 3 mm. thick coat of TEROL of TERRACO as per manufacturers specification. It shall be ensured that the surface to be covered is free of loose particles, dust, dirt, grease, oil and paint. TEROL shall be applied on top of finished coat of plaster which should be levelled without any scratch/key marks. Adequate care should be taken that the first coat is levelled well to enable the thin layer TEROL plaster to give smooth finish, substrata/sub base should be moistened with water prior to the application of TEROL thin layer plaster.

1 Mixing: Put water into a clean empty drum. Add TEROL start stirring with paddle. Gradually add water and TEROL alternatively in the required proportion to get desired creamy consistency, convenient for application and stir continuously and ensure that no lumps remain. TEROL should not be allowed to stand without stirring for longer than 60 minutes. In normal condition let TEROL set for 5 minutes then stir and use. Where rapid drying conditions are prevalent, it is advisable to mix TEROL 20 minutes before using.

2 Application: TEROL is sprayed or hand applied and smoothened with a steel float. Smooth finishing shall be achieved with wooden floating or troweling when TEROL has set. The float should be moistened during the smoothening operation.

Curing the surface shall be carried out after 24 hours of application at least for 4 days using light water spray.

44.7 (C) PLASTER OF PARIS (POP – CaSO₄, 1 / 2H₂O) 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 used within 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 unobstructed area 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 with steel 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.

44.7 (D) GYPSUM PLASTERS

1.0 Material:

Requirement of premixed light weight gypsum shall be conforming to IS: 2547, Part-I &II latest revision. Product Package shall be ISI marked and material shall be got approved prior commencement of work. Physical and Chemical requirement, sample testing to be carried out as per the IS: 2547 Part I&II cost of all test shall be born by contractor.

1.1 Surface Preparation for RCC: Smooth RCC surface to be hacked for bonding (50 hacks per Sq. Ft.).

1.1.1 Any mould oil (Release oil) or other agents presents should be washed.
1.1.2 Normal ballast concrete should be given sufficient time to cure prior to application of plaster.
1.1.3 Any kind of loose masonry, foreign material adhering to the surface to be removed.
1.1.4 Recommending to use bonding agents to avoid any issue of debonding.

1.2 Application Methodology: The powder should be mixed with clean water preferably in clean plastic buckets to avoid mixing with impurities.
1.2.1 Mix gypsum plaster powders to water ensure thorough mixing by help of mixing rod has to avoid formation of lumps and unmixed residues.
1.2.2 Material should be thoroughly mixed and free from lumps and impurities before use.
1.2.3 Water to plaster ratio should be as per manufacture recommended.
1.2.4 When the mix has begun to set it should not be further added with additional water or dry material.
1.2.5 Material should always apply above 6" from skirting level.
1.2.6 Can apply gypsum in the thickness range of 3.25 mm. However when applying gypsum plaster in thickness excess of 12-13 mm it has to be applied in layers of 10 mm each and not the whole thickness of 25-30 mm in one single layer.
1.2.7 Similar will be the application process for RCC columns and wall where it has to be applied in layers. However in ceiling it is not recommended to go beyond thickness of 13 mm even it applied on Bond IT or Hacked surface.

1. 3 RATE: - Rate quoted shall be all heights and floors including cost of material, scaffolding, transporting, testing, labour and of additional thickness due to variation in plain and plumb etc.

1.4 MODE OF MEASUREMENT: Mode of measurement will remain same as per 44.10.

SAND FACED CEMENT PLASTER:

44.8.1 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:

44.8.2 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, under the relevant masonry / concrete 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 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 default in 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, mullions, 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.

44.8.3 WORKMANSHIP : The surface to be plastered shall first be dubbed out with cement mortar to cover all irregularities and faces up to 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.

44.9 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/walls etc. fixed by other agency in correct shape, position and to cover the same with required 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.

44.10 MODE OF MEASUREMENT:

44.10.1: 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 the length 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.

44.10.2: 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 narrow widths of plaster over structural as well as non-structural and the line when prepared in the same 
thickness of plaster shall not be measured separately and shall be covered by respective plaster items.

44.10.3 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.

* * *

45. CEMENT POINTING:

45.1 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 thoroughly washed with 
water, cleaned and kept wet before pointing is commenced.

45.2 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.

45.3 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 be 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.

45.4 CURING:

SIGNATURE & SEAL OF TENDERER
The pointing shall be kept wet for at least seven days. During this period it shall be suitably protected from all damages.

45.5 TYPES:

(a) 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.

(b) 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.

(c) 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.

45.6 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.

46. WALL CARE PUTTY

46.1 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.

46.2 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.

46.3 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.
46.4 PREPARATION OF SURFACE:
- Surface should be clean of loose particles, dirt, grease and traces of foreign material. Sandpapering 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.

46.5 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.

46.6 APPLICATION:
- The plastered surface shall be dampened with clean water and excess water shall be allowed to be drained-off.
- Using a steel trowel/blade, the above mix shall be applied to a thickness of about 1 – 2 mm. Then the surface shall be levelled and smoothened. This first coat shall be cured lightly after it dries-up.
- Then second coat shall be applied after first coat is fully dried and set. Second coat shall be cured lightly for two days.
- Over plastered / Coarse putty substrate, fine wall care putty of about 1 to 1.5 mm thickness shall be applied, to smoothen the surface with a steel trowel. Finished surface of wall care putty shall not require any dressing by Emery Paper but if at all it is done, the paper should not be less than 500 number.
- The thickness of each coat should not exceed 1.5mm and total wall putty thickness should not exceed 3mm.
- If specified in the description of item, coarse wall care putty of about 6 to 10 mm thickness shall be applied to remove the undulations and level the surface. More number of coats of coarse putty shall be applied to cover up undulations, only after approval of the Engineer-in-Charge.
- Coverage of wall care putty depends upon surface quality. However, approximate coverage for fine wall care putty shall be 20-22 Sqft/kg and for coarse wall care putty, it shall be 9-10 Sqft/kg.
• Application of primer before painting is not necessary over the surfaces finished with wall care putty.

46.7 SPECIFICATIONS

**Specification of Wall care putty – For smooth Finish**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>PROPERTY</th>
<th>AS PER HDB (HOUSING DEVELOPMENT BOARD), SINGAPORE</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry Adhesion</td>
<td>&gt;=0.8 N/sqmm</td>
<td>EN 1015-12</td>
</tr>
<tr>
<td></td>
<td>Wet Adhesion</td>
<td>&gt;=0.3 N/sqmm</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tensile Adhesion Strength (N/sqmm) @ 28 Days</td>
<td>&gt;=0.8 N/sqmm</td>
<td>EN-1348</td>
</tr>
<tr>
<td>2</td>
<td>Compressive Strength (N/sqmm) @ 28 Days</td>
<td>7-12 N/sqmm</td>
<td>EN 1015-11</td>
</tr>
<tr>
<td>3</td>
<td>Setting Time (Minutes) - Initial &amp; Final</td>
<td>&lt;360 &lt;500</td>
<td>EN 196</td>
</tr>
<tr>
<td>4</td>
<td>Water Absorption Coefficient - Kg/M² - H1/2</td>
<td>&lt;=0.13 for W2 / &lt;=0.26 for W1</td>
<td>EN 1015-18</td>
</tr>
<tr>
<td>5</td>
<td>Water Capillary Absorption (ML) @ 24 Hrs.</td>
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<td></td>
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<tr>
<td>6</td>
<td>Water Retentivity %</td>
<td>&gt;=95%</td>
<td>EN 1015-8</td>
</tr>
<tr>
<td></td>
<td>PH</td>
<td>Alkaline</td>
<td></td>
</tr>
</tbody>
</table>

**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.

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47. PAINTING :

47.1 SCOPE OF WORK :

The work covered under these specifications consist of furnishing the various types of paints and also the workmanship for these items, in strict compliance with these specifications, which are given in detail here-in-after with the item of schedule of quantities.

47.2 MATERIALS :

Paints, oils, varnishes etc. of approved brand and manufacture shall 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, oils or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. 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.

The contractor shall associate the chemist of paint manufacturers before commencement of work, during and after the completion of work who shall certify the suitability of the surface to receive painting and the paint before use etc.

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47.3 COMMENCING WORK:

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.

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 shall not be started until and unless the Engineer-in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work.

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.

47.4 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 in line and level in C.M. 1:1 and cracks & crevices shall be filled with approved filler, by the contractor at no extra cost to the Department. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

47.5 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 moldings 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 at least two days.

In painting doors and windows, the putty around the glass panes must also be painted, but care must be taken 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. Perspex covers of electrical switch boxes have to be painted from inside by removing them. Care shall be taken while removing them in position after painting with respective approved paints. 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.

47.6 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.

47.7 MEASUREMENT:

a) Painting, unless otherwise stated shall be measured by area in square metre. Length and breadth shall be measured correct up to 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, sills, 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.

47.7.1 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.

47.7.2 Explanatory notes on the table of Co-efficients.

1. Where doors, window etc. are of composite types other than those included in para 47.7 (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 for the 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 measured under trellis 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 8mm 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 separately but 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 up to two places of decimal of a metre and area so worked out shall be correct up to 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.

47.8 PRECAUTIONS:

All furnitures, lightings, fixtures, sanitary fittings, glazing, floors etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damage done shall be made good by the contractor at his cost.

47.9 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.

47.10 (A) PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES:

47.10.1 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>
<thead>
<tr>
<th>SN</th>
<th>SURFACES</th>
<th>PRIMER TO BE USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Wood work (hard &amp; soft wood):</td>
<td>Pink conforming to I.S. 3536-1966</td>
</tr>
<tr>
<td>b</td>
<td>Resinous wood and ply wood:</td>
<td>Aluminium primer</td>
</tr>
<tr>
<td>c</td>
<td>Iron &amp; Steel, Aluminium and galvanised Steel</td>
<td>Zinc chromate primer conforming to</td>
</tr>
<tr>
<td>d</td>
<td>Plastered surfaces, cement brick work, Asbestos</td>
<td>Cement Primer</td>
</tr>
</tbody>
</table>

3. The primer shall be ready mixed primer of approved brand and manufacture.

47.10.2 Preparation of surface:

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SIGNATURE & SEAL OF TENDERER
a) **Wood work**: The wood work 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.

(b) **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.

(c) **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.

47.10.3 **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.

47.10.4 **Other Details**: The specifications for Painting (General) shall hold good so far as it is applicable.

47.11 (B): **PAINTING WITH SUPERIOR QUALITY & FLAT OIL READY MIXED PAINTS ON NEW SURFACE**:

47.11.1 **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.

47.11.2 **Preparation of Surface**:

(a) **Wood work**: The surface shall be cleaned and all unevenness removed as in para 47.10.2 (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.

(b) **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.

(c) **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.

47.11.3 **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/semiglossy finish, free from streaks, blisters etc.
47.11.4 Other details: The specifications for Painting (General) specified here-in-before shall hold good in so far as they are applicable.

47.12 (C) PAINTING WITH SYNTHETIC ENAMEL/SEMI GLOSSY PAINT ON NEW WORK:

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: 1932-1964.

2. Preparation of Surface: This shall be as per painting with superior quality ready mixed paint as mentioned here-in-before.

3. Application: The number of coats including the under coat shall be as stipulated in the item.

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 manufacturers recommendations.

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.

4. Other Details: The specifications for “Painting (General)” mentioned here-in-before shall hold good as far as they are applicable.

47.13 (D) PAINTING WITH ACRYLIC EMULSION/PLASTIC EMULSION PAINT:

1. This shall be polyvinyl based Acrylic/plastic emulsion paint of approved manufacture of the required shade, conforming to I.S.5411-1969.

2. Primer: The primer to be used for the painting with acrylic emulsion on cement concrete surfaces, plastered surfaces, A.C. sheets, timber and metal surfaces, if necessary, shall be of approved base and as per recommendations of the manufacturers.

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 putty shall be used. The putty should be made from a mixture of whiting and plastic emulsion paint or as per manufacturers recommendations.

4. Finishing coats: All the finishing coats shall be of matt finish or any other finish as required by the Engineer-in-charge. The number of finishing coats shall be as specified in the item.

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.

JOB REQUIREMENTS:

i) Acrylic emulsion paint is required to be provided on plastered and concrete surfaces in portions of the building. The Department shall reserve the option to delete or increase quantities in full or part from the scope of contract.
ii) All wood surfaces are to be painted with semi glossy synthetic enamel paint with an approved primer.

iii) All shades and colours of paints shall be subjected to review and prior approval of Engineer-in-Charge shall be taken before the application.

47.14 WHITE WASHING WITH LIME

47.14.1 Preparation of Surface: Before new work is white washed, the surface shall be thoroughly brushed 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.

47.14.2 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 of lime with regard to its physical and chemical properties. The cost of testing lime shall be borne by the contractor.

47.14.3 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 finish through 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.

47.14.4 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. Splaschings 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.
47.14.5 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 up to two places of decimal of a metre and areas so worked out shall be correct up to 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>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated asbestos cement sheets</td>
<td>20%</td>
</tr>
<tr>
<td>Semi-corrugated asbestos cement sheets</td>
<td>10%</td>
</tr>
</tbody>
</table>

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.

47.14.6 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above.

47.15 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 of the 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.

47.16 DRY DISTEMPERING:

(a) Distemper: Dry distemper (IS:427-1965) 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 at least 30 minutes before use. The mixture shall be invariably well stirred before and during use to maintain an even consistency.

(b) Preparation of surface: This shall be as for Painting work mentioned here-in-before in so far as it is applicable.

(c) 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.

i) 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.

ii) 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.

47.17 OIL EMULSION (OIL BOUND) DISTEMPERING:

(a) Oil bound distemper (IS:426-1969) 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.

(b) 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.

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 oilbound 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.

c) Other details: The specifications for "Painting (General)" mentioned here-in-before shall hold good as far as it is applicable.

47.18 WATER PROOFING CEMENT BASED PAINT:

(a) Material: Cement based paint (IS:541 0-1 969) of approved manufacture, quality, shade and colour only shall be used.

(b) 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 of its 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. The second 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.

c) 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 the shady 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.

d) Other details: The specifications for Painting (General) mentioned here-in-before shall hold good as far as they are applicable.

e) 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 areas for opening/obstructions 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 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 the following 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 treatment shall be stated in the schedule of quantities. The whole surface shall be applied with approved putty/filler to get uniform and smooth surface at no extra cost to the Department.

Rates: The rate shall include cost of all materials and labour involved in all the operation described above.

47.19 BEES WAXING OR POLISHING WITH READY MADE WAX POLISH:(NEW WORK):

47.19.1 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.

a) 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 0.965 to 0.969 and melting point shall be 63o 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.

47.19.2 Preparation of surface: Preparation of surface will be as mentioned here-in-under para 47.20.2 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.

47.19.3 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.
47.19.4 Other details: The specifications for painting (General) as mentioned here-in-before shall hold good as far as they are applicable.

47.20 FRENCH SPIRIT POLISHING: (ON NEW WORK WITH A COAT OF WOOD FILLER):

47.20.1 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.

47.20.2 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 gluesize 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.

47.20.3 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.

47.20.4 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”.

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47.21 RESIN BASED THERMO PLASTIC PAINT (DECORATIVE AND PROTECTIVE FINISH):

47.21.1 Materials: Resin based thermo plastic paint such as Sandtex Matt or other equivalent approved manufacture, colour and shade shall only be used.

47.21.2 Preparation of Surface & General: The Specifications for Painting (General) described here-in-before shall hold good as far as they are applicable.

47.21.3 Protective Coatings: On surfaces such as ferrous metals, brass, copper and phosphor 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 algal 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.
47.21.4 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 addition of 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.

47.21.5 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.

47.21.6 Mode of Measurement: The 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.

47.21.7 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above.

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48. VINERATEX OR VITROBRITE DECORATIVE TEXTURE COAT:

48.1 GENERAL:

Vineratex or vitrobrite decorative treatment/coating consisting of coating the plaster finished surfaces with decorative textured 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.

48.2 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 corrosion resistant viz. glass, ceramic/marble, chips, granite, quartz and flint, haematites, pyrites or one in natural vitrified, colonied 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.
48.3 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 surfaces should 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 detergent and rinsing thoroughly with clean water and allowed to dry.

48.4 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 applied to the surface evenly with the help of laying on trowel to uniform thickness of about 3 mm. on an area of about 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 shall be 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 is important 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 be avoided. 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.

48.5 MODE OF MEASUREMENT:

Mode of measurement shall be similar to sand faced/roughcast plaster items.

* * *

49. TUBULAR TRUSSES, PURLINS ETC.:

49.1 Structural Steel Tubes: These shall be of:

i) hot finished welded (HFW) type, or
indii) hot finished seamless (HFS) type, or
eii) electric resistance or induction butt welded (ERW), having carbon content less than 0.03%, yield stress of 21.5 kg./mm. (YST 22) type, conforming to the requirement of I.S. 1161-63. The steel tubes when analysed in accordance with the method specified in I.S. 226-1959.

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.

49.2 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 not be less than 4mm. 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.

49.3 FABRICATION:

49.3.1 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.

49.3.2 Straightening: All material before being assembled shall be straightened, if necessary, unless required to be of a curvilinear form and shall be free from twist.

49.3.3 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 shall be provided to allow the nut to be completely tightened.

49.3.4 Welding: Where welding is adopted, it shall be done as per relevant I.S. 820.

49.3.5 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 plate should be true and square to the axis of the column.

49.3.6 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.

49.3.7 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.

49.4 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.

49.5 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.

49.6 RATE : The rate shall include the cost of labour and materials involved in all the operations described above including one coat of approved steel primer and painting as specified in the item.

50. ASBESTOS CEMENT CORRUGATED / TRAFFORD SHEET ROOFING :

A.C. sheets, big six/trafford and accessories shall be supplied by the Department free of cost at Departments Stores as per terms and conditions stipulated in the Schedule A. It shall be the contractors responsibility to take delivery of A.C. sheets and accessories from the Departments stores, transport and handle the same carefully to avoid any damage to A.C. sheets and accessories.

50.1 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 the remaining sheets in the bottomrow 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 Mitre 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.
50.2 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. to any 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.

Wind Ties: Wind ties shall be of 50 x 6 mm. flat iron section or of other size as specified. These shall 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.

Finish: The completed roof shall present a neat and uniform appearance and shall be leak proof.

50.3 MODE OF MEASUREMENT:

The measurements for A.C. 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 A.C. 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.

50.4 RATE:

The rate shall include the cost of all materials, other than those supplied by the Department free of cost, 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
50-A. A.C. RIDGES:

A.C. corrugated ridges shall be supplied in pairs as per schedule A. The ridges in pairs shall be transported to site of work, hoisted, placed and fixed in position at the junction of the two sloping sides of a roof. Care shall be taken to match the corrugations of the sheets with the ridges. The ridges shall be embedded in the end wall to the same extent 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 A.C. ridges shall be as per manufacturers specifications, scaffolding if any shall be provided by contractors at their own cost.

50-A.1 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 up to 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.

50-B. A.C. EAVE CURVES:

A.C. corrugated eave curves shall be supplied by the Department as per schedule A. The eave curves shall be transported to site of work, hoisted, placed and fixed in position in perfect line and level with hooks, nuts, washers etc. with the over laps provided as per manufacturers code of practice. The holes for hooks shall be drilled and not punched. The areas around hooks shall then be made water tight. No damage 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 A.C. sheets. Scaffolding, props etc. if required, shall be provided by the contractors at their own cost.

50-B.1 MODE OF MEASUREMENT:

Measurements shall be taken between the finished surfaces of walls and shall be correct up to two places of decimal of a metre. No laps or embedments shall be measured for payment.

51. MANGALORE PATTERN TILE ROOFING:

51.1 SCOPE OF WORK AND GENERAL:

The item refers to supplying and laying mangalore tile roofing with lime mortar bedding 1:2 over R.C.C. slab. Lime mortar required for this job shall conform to specifications given here-in-before.

51.2 MATERIALS:

Mangalore (Basel mission or equivalent) tile shall be double channeled tiles and shall conform to I.S. 654-1957 for class-AA or class-A type tiles or as specified in the item description. The sample of tiles shall be got approved before procuring materials on mass scale and incorporating in works. Mangalore tiles (Basel mission 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 homogeneous without segregated lumps of clay and shall have a breaking strength of not less than 102 kg. (2 CWT) applied at a centre of span when supported on battens at 350 mm. centres. The absorption co-efficient after 24 hours soaking shall not exceed 1/6th of its own weight.
51.3 LAYING:

Mangalore tiles of approved make and quality shall be well soaked in water for four hours before taking up for laying. The mortar of specified proportion and thickness shall be spread and the mangalore tiles fully embedded thereon, without any air spaces, where the tiles breaking joints.

The tiles shall be laid from the eves towards ridge. Where full tiles are not necessary, half tiles manufactured for the purpose only shall be used. The laying of Mangalore tiles and laying of lime mortar shall go on concurrently. The ridge mangalore tiles shall be of standard type duly approved and shall be set in lime mortar as specified. Finished top slope of roof shall be uniform from ridge to eves. Eves line and the ridge line and all intermediate lines shall be perfectly straight, horizontal and parallel to each other. 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. All joints shall be pointed with lime mortar 1:2 with mixture of red ochre to preserve uniformity of colour and the joints shall be made perfectly secured and water tight.

51.4 CURING:

After laying of Mangalore tiles as specified, roofing shall be watered and cured for a minimum period of 7 days and as per specifications specified for curing for flooring. After curing is over, the roof shall be thoroughly cleaned and all excess stays of mortar etc. shall be scraped off.

51.5 MODE OF MEASUREMENT:

The rate shall be per square meter of actual area of roofing completely finished. The area shall be measured net without any laps. Opening for sky lights, cut outs etc. upto 0.4 sqm. shall not be deducted and where applicable no cutting for forming such openings shall be measured. The linear dimensions shall be measured flat from edge to edge of tilted 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. The rate shall include providing, erecting and removing scaffolding and necessary ladders. Also it shall include all labour, materials, transport, cleaning, curing etc. to complete the job as specified.

52. FALSE CEILING WITH FLEXO BOARDS / A.C. SHEETS:

52.1 SCOPE OF WORK:

The work envisaged under these specifications refer to supplying and fixing in position false ceiling at any floor, any location and at any height.

52.2 MATERIAL:

The plain A.C. sheet or flexo board shall be of the thickness as mentioned in the relevant items of the schedule of quantities and the size of panels and the arrangement of panels etc. for different area of the building shall be as indicated by the Engineer-in-Charge. Plain A.C. sheet or flexo board shall be of approved quality and shall be free from cracks, bends and other defects. Samples of materials to be used on the work shall first be furnished by the contractor and got approved by the Engineer-in-Charge. All materials which are used on the works shall strictly conform to the samples, other-wise the materials shall be summarily rejected.

The plain A.C. sheet or flexo board shall be fixed to the angle iron frames (frame work paid separately) work by means of suitable counter sunk brass self tapping screws not more than 200 mm. centre to centre or as directed, and all holes after fixing the screws be filled with approved filler. Necessary openings in the ceiling shall be left for trap
52.3 ERECTION:

The flexo boards/A.C. sheets when brought to site shall be stacked carefully on floor over wooden sleeper supports. The boards shall be cut to required sizes either by sawing or by score and snap method. The edges shall be smoothened by wood rasp file or with emery paper. Wherever required the edges of each panel may require bevelling which also shall be done carefully to the correct line and dimensions.

The flexo boards/A.C. sheets shall be fixed to ridge frames either wooden or metallic or mentioned in the item description. In case of metallic frame, the flexo boards are held to the frame by means of self tapping screws or by the ordinary machine screws and nuts, as directed by the Engineer-in-Charge.

Teak wood or aluminium beadings if required to be fixed shall be as mentioned in the item description and shall be carried out in best workman-like manner.

Any other treatment for finishing such as gluing of wall papers, cement or oil based paint etc. shall be as specified in the item description and shall be done as per relevant specifications.

52.4 MODE OF MEASUREMENT:

Unless otherwise mentioned, the wooden or metallic-frame work shall be separately measured and paid for. The flexo board/A.C. sheet false ceiling shall be measured in square metre as actually laid over the frame work. The area being worked out correct to two places of decimal with length and breadth measured correct to a centimeter. The rates shall include the cost of all materials, labour, scaffolding etc. as mentioned above and in item description, unless otherwise specified.

52-A A.C.SHEET FALSE CEILING AND MASKING ETC. WITH PRESSED STEEL FRAME WORK/ANODIZED ALUMINIUM FRAME WORK:

52-A-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 A.C. sheet on pressed steel frame work, inter locking, Aluminium frame work suspended by adjustable M.S. suspenders with necessary cut outs in the A.C. 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.

52-A-2 MATERIALS:

All materials which are to be in-cooperated in work shall be got approval prior to bulk procurement.

52-A-2.1 Fabrication of Pressed Steel 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. 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.

52.A-2.1.1 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 anodised aluminium T bars for main runners and cross runners of specified section and pattern as required to suit the span as per drawing.

52.A-2.2 A.C. Sheets: A.C. sheet shall be plain and of specified thickness, approved best quality and shall conform in all respect to the relevant Indian Standard Specifications.

52.A-2.3 M.S. Works: All M.S works shall conform to relevant specification mentioned under Structural Steel here-in-before.

52.A-2.4 Fastening: All bolts, nuts, screws, fittings & fixtures shall be of best quality and of approved manufacture.

52.A-3 FIXING:

The contractor shall take all necessary field measurements before the commencement of 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 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/suspending 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. Approved A.C. sheets 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 clips/pins as per drawing. Holes if required to be provided in A.C. sheets shall be drilled and on no account holes shall be punched. Lock the runner tees and tiles with hold down clips/pins as required. Wherever grouting for frame work, suspenders etc. is required to be done in masonry walls columns/beam etc., the same shall be done after the entire frame work is properly levelled.

The contractor shall take into consideration all wastage in the A.C. sheets, aluminium grid system frame work/pressed steel frame work, M.S. suspenders, screws, nuts, bolts, washers etc. required for fixing A.C. sheet false ceiling and vertical masking while quoting his rates. A.C. sheet 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 A.C. sheets, all holes of screws etc. shall be filled with approved putty, levelled with the A.C. sheets and sand
papered, so that no sign of screw is visible on the A.C. sheets. For all the A.C. sheets false ceiling and vertical masking work, the A.C. sheet 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.

Trap doors/lighting recesses/troughs of approved size and shape with approved matching work, shall be provided 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.

52.A-4 SAFETY PRECAUTIONS :

No person other than workman employed by the false ceiling contractor shall be permitted access to any area over which the sheeting is being laid. The contractor should take protective measures during the progress of work. Catladders or roof boards, scaffolding etc. should invariably be used by men working on the roof/false ceiling/masking etc.

52.A-5 WORK TO INCLUDE :

Cost of all approved A.C. sheets with anodized aluminium/pressed steel frame work, adjustable 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.

52.A-6 MODE OF MEASUREMENT :

A.C. Sheet false ceiling with snap grid pressed steel/anodized aluminium internal grid system frame work completed and accepted as per above specifications shall be measured in square metre upto two places of decimals. The line measurements shall be taken upto two places of decimal of a metre. The width shall be measured, from wall angle to wall angle and length shall be measured as per actual. Areas of trap doors, lighting troughs, Air conditioning diffusers, Air conditioning grills and other openings shall be deducted and net areas of false ceiling so computed shall be paid for unless other wise specified.

Areas of false ceiling with additional horizontal M.S. angle supports as per relevant drawing shall be measured separately between such additional supports. Mode of measurement for this item shall also be in square metre as described above.

52.B 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/M.S.
frame work sections and sizes, as per drawing, shall be fabricated and got approved before fixing in position.

The m.s. lighting troughs along with m.s. frame or aluminium lighting troughs with aluminium frame shall be fixed in position to correct line and level with m.s. 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 m.s. covers of the same gauge as per drawings.

The materials and fabrication of lighting trough, m.s. aluminium frame and suspenders shall conform to the relevant specification given in this tender. The m.s. 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.

52.B-1 MODE OF MEASUREMENT :

The lighting troughs along with 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.

52.C 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 by means 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 6 mm., 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.

52.C-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.

52.D FIBRE GLASS THERMAL INSULATION WORK AT CEILING WITH T.W. BATTENS FRAME WORK AND COVERING WITH A.C. SHEET :

52.D-1 SCOPE OF WORK :

The work envisaged under these specification covers providing and fixing fibre glass thermal insulation to ceiling
52.D-2 MATERIALS :

i) T.W. battens for frame : Battens required for frame work shall be as specified under chapter “Wood work in frames, shutters and panelling”.

ii) 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 °C, 50 mm. thick and density of 24 kg/cum. or as specified in the description of item 1 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.

iii) A.C./Flexo board sheet covering : The plain A.C. sheet or flexo board shall be as specified here-inbefore.

iv) 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 the 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.

52.D-3 ERECTION / FIXING OF INSULATION :

i) 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, tenoning, 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 with fire resisting paint of M/s. Garware Paints Ltd. or any other approved equivalent make before erection of the 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.

ii) Sticking of insulation material & fixing of A.C./flexo board : 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 work and then fibre glass of required thickness shall be stuck 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 A.C./flexo 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 A.C. sheet/flexo board shall be drilled and on no account holes shall be punched. A.C. 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.

52.D-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 up to two places of decimal of a metre for working out the area.

**52.D-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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**53. METAL FALSE CEILING SYSTEM & THERMAL INSULATION:**

**METAL FALSE CEILING SYSTEM [LUXALON 150 C / EQUIVALENT]:**

**53.1 MATERIALS**

Manufacturing and Product: Hunter Douglas India Private Ltd. or equivalent

a) **PRODUCT:** Luxalon 150 C lineal aluminium false ceiling or equivalent

b) **COLOUR:** As specified or as approved by the Engineer-in-Charge

**Material Description:** All components shall be made of aluminium and manufactured by M/s. Hunter Douglas India Private Limited OR Equivalent as per manufacturer's specification.

**LUXALON 150 C METAL CEILING:**

i). **PANEL:** The panel shall be cold roll formed panels 150mm wide and 15.5mm deep 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 up to 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.

ii). **CARRIER:** The carrier on which the panels shall be clipped on to will be 32mm wide, 39mm deep, made of black stove enameled 0.95mm thick aluminium alloy AA5050. When two or more carriers are to be joined, they shall be joined together by means of splices, which will clip on to holes provided for the same.

iii). **WALL TRIM:** The wall trim shall be 15mm deep x 30mm wide x 15mm deep x 0.4mm thick Aluminium Alloy AA5050 with square edges and length of 5mtr.

iv). **ROD HANGER:** The rod hanger of suitable length shall be made of 4mm dia. galvanised steel (Zinc coating 120 gms/Sqm.)

v). **SUSPENSION CLIP:** The adjustment suspension clip shall be made of galvanised spring steel V shaped with two holes to accommodate the rod hanger.

vi). **ANCHOR FASTNERS:** 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.

vii). **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
53.2. 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 colicoating paint line with dried in place roller coated application for pre-treatment. The coils to go 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 coils shall 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.

Pencil Hardness. : pH > F

Light Fastness. : Light fastness of at least 6 according to international wool scale.

Colour Fastness : All finishes shall have a colour fastness of at least 6.

Colour Variation. : Colour diff, Bet batches + 4 units Colour diff. Within one batch + 2 units.

Colour Uniformity : Maximum allowable deviation is 2 NBS units.

Specular Gloss. : 10 deg/00 (matt) ; 25 deg/00 (satin)

Resistance to Salt Spray : After 100 hrs testing under creep from the edges or the Cross, shall test exceed 2mm. Blistering shall not exceed F 8.

Impact resistance : To withstand an impact test of 5mN/mm metal thickness Without loss of adhesion.

Paint adhesion. : Better than or equal rating 1

Humidity Resistance. : No formation of blister.

Chemical Resistance. : No loss of adhesion or gloss and no colour change or Staining.

53.3. FIXING : The panels shall be clipped on to a carrier. The carriers to be suspended with an adjustment spring ofgalvanised spring steel, V shaped with two holes to accommodate the rod hanger. The rod hanger to be made of 4mm dia, galvanised steel and suspended form the ceiling by J hooks fixed at 1.5mm centre to centre.

53.4. 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.

53.5. 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.

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53.6. THERMAL INSULATION

(A) UNDERDECK INSULATION :
I. METHOD OF APPLICATION:

i) Clean the surface and make it free from dust and loose particles.

ii) Apply a coat of Shalicoat to the underside of the roof.

iii) Apply CPRX compound to the underside of each prelaminated Phenolic Foam panel and press the slabs in position. But the joints well together.

iv) Secure panel in position with the help of screws, rawl plug and washers.

v) Deal all the joints with the help of self adhesives Aluminium tapes

(B) INSULATION ABOVE FALSE CEILING:

i) The insulation tiles shall be placed above the A1 carriers, which are one meter c/c.

ii) 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.

iii) The rate quoted shall be inclusive of cutting to the required size, wastage etc.

iv) The tiles shall abut each other to provide a continuous barrier for effective thermal insulation

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.

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54. WATER PROOFING:
GENERAL: The guarantee for waterproofing treatment in prescribed proforma must be given by the specialised agency which shall be countersigned by the contractor in token of his over all responsibility. The guarantee for waterproofing treatment in the prescribed proforma shall also cover Horizontal expansion joint and Vertical expansion joint.

54.1 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 undercoat 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 plasterwork 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.

54.2 BRICK BAT COBA WATERPROOFING ON TERRACE:

54.2.1 Materials: The aggregate for brick bat coba shall be broken from good and thoroughly well burnt bricks. These shall be strong, durable, clean and free from impurities. They shall not contain any soft or powdering materials. The aggregate shall be 20 mm. to 10 mm. size and shall be approved by the Engineer-in-Charge before use.

Lime to be used for preparing brick bat coba shall be of lime class B, conforming to I.S. 712-1959. Lime burnt from lime stone shall be used. All impurities, ashes or pieces improperly burnt shall be screened or picked out before slaking. It shall be in the form of lumps when brought to site of work and not in powder form. The lime shall not be slaked with water less than one week or more than two weeks before use.

54.2.2 Storage: The slaked lime if stored, shall be kept in a weather proof and damp proof closed shed with impervious floor and sides to protect it against rain, moisture, weather and extraneous materials mixing with it, and shall be approved by the Engineer-in-Charge.

54.2.3 Proportion: The proportion for brick bat coba shall be 0.906 cum. (about 32cft.) of brick bat to 0.34 cum. (about 12 cft.) of slaked lime.

54.2.4 Laying: The concrete surface shall be thoroughly rubbed, cleaned of all set mortar, all dirt and dust and slightly wetted. The brick aggregate shall be soaked in water before mixing with lime. The brick bat coba shall be laid in an even layer and to the required thickness and slope so as to form ridge, hip or valley line as may be necessary and as indicated in the drawing or as directed by the Engineer-in-Charge. The compaction shall be started immediately with wooden beaters and during the above process, the surface shall be constantly kept wet by sprinkling water observing the following precautions:

a) Brick bat coba shall not be rammed with heavy iron rammers as brick aggregates are likely to be crushed into powder thereby, but shall be beaten lightly and rapidly with wooden beaters to get the required compaction and to obtain complete integration of brick bats and lime.

b) While beating, fresh fracture may take place which may cause absorption of water from the mortar. Additional water may be sprinkled with beating in such cases as considered necessary by the Engineer-in-Charge. The beating work shall continue for at least 7 days.

c) The average thickness of coba shall be as specified in the items and the top of the coba shall be given slope or made level and edges taken into the brick masonry parapet or rounded off at junctions as shown in the drawing and as directed by the Engineer-in-Charge.
54.2.5 MODE OF MEASUREMENT:

The length and breadth of the surface area shall be measured to two places of decimals of a metre from the finished surface of wall and parapet and cubic contents to be worked out with average thickness of coba provided. Rate shall include cost of preparation of surface, cost of materials, labour, rounding of junctions etc. complete.

54.3 CHINA MOSAIC WATER PROOFING:

54.3.1 General: This type of waterproofing 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 slope and 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 lime mortar screening of specified thickness is laid.

54.3.2 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 in position. 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 glazed tile pieces. The finished work shall be cured for atleast 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 with cement mortar as per drawing and shall be included in the quoted rate.

54.3.3 MODE OF MEASUREMENT:

The length and breadth shall be measured to two places of decimal of a metre, along side 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.

54.4 TAR FELT WATER PROOFING:

54.4.1 General: All materials and workmanship for waterproofing the R.C.C. roof shall conform to I.S. 1346-1959 & 1322-1965 respectively. The tar felt shall be of type and of grade-I as specified in I.S. 1322-1965.

54.4.2 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 gutters drain 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.
54.4.3 Laying: The felt shall be laid in lengths at right angles to run off gradient commencing at the lowest level and working up to the crest, thus providing adequate overlap of the adjacent lower felt.

The bituminous primer shall be brushed at 0.42 ltr./sqm. (1 gallon/100 sqft.) over the roof surface thus prepared and allowed to dry. The bitumen bonding material (60/70 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, 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 is steadily 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 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.

After the specified number of layers of felt have been laid, hot bitumen (60/70 grade) shall be applied over the top surface @ 1.2 kg/sqm. Pea size gravel as mentioned in item description shall be uniformly spread on this hot bitumen layer @ 0.0609 cum. to 0.0761 cum./10 sqm. (2 to 2.5 cft. per 100 sqft.) 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.

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 waterproofing 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 overlap 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 - 1959.

54.4.4 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.

The tenderers may, if they so desire, quote on the basis of their own patent waterproofing treatment with rates and terms and conditions if any and detailed specification if their patent treatment is considered by them to be more effective and competitive. They shall also guarantee their treatment for a minimum period of 10 (ten) years.

54.4.5 MODE OF MEASUREMENT: Only plan dimensions between brick / concrete walls shall be measured insqm. 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
54.5 CEMENT BASED WATER PROOFING OF W.C. AND BATHS AREAS:

54.5.1 General: The water proofing treatment for the Bath and W.C. shall be essentially of cement based water proofing treatment with admixture of proprietary water proofing compound similar to M/s. India water proofing companys treatment or any other equivalent approved cement based water proofing treatment. The waterproofing treatment shall consist of providing cement slurry mixed with proprietary water proofing compound after preparation of surfaces, providing water proofing cement plaster, finishing smooth/rough as required to the required line, level, curing, finishing, guarantee for the water tightness of the water proofing treatment etc.

54.5.2 Preparation of Surface: The surface to receive water proofing treatment shall be thoroughly cleaned of scales, laitance, set mortar etc. for receiving water proofing treatment, and necessary preparation of the surface for providing water proofing treatment shall be done by the contractor. If any honey combs are observed in beams and slabs of Bath and W.C., the same shall be grouted with cement slurry mixed with water proofing compound and the cracks and crevices, filled with injection method.

54.5.3 Sequence of Treatment: All cutting and chasing in the floor and walls for plumbing work shall be done by the plumbing agency. Water proofing agency shall then provide CETROOF or equivalent approved cement based water proofing treatment consisting of cement plaster treatment mixed with the water proofing compound according to the recommended specifications of the waterproofing agency. The thickness of water proof plaster shall be about 35 mm. on floor area of the depression and about 25 mm. thick on the vertical surface of walls/concrete surface in case of sunken slabs, upto the finished floor level. The thickness shall be about 18 mm. for the remaining wall height upto 600 mm. from finished floor level.

The plumbing agency shall then lay and fix the pipes, W.C. pans, traps etc. without disturbing the water proofing treatment. However, the joints of water supply and waste connections including holes drilled for clamps shall be treated by water proofing agency.

Waterproofing agency shall then fill-in the depression in the floor with their 'CETROOF' or equivalent approved waterproof brick bat coba with the admixture of waterproofing compound according to waterproofing agency’s specification and process, which should be furnished in writing to the Engineer-in-Charge for effective supervision of completeness of the process while executing the works.

54.5.4 Finishing: The surface of the exposed plaster shall be finished smooth with neat cement. The plaster surface where tiling is to be provided as well as brick bat coba filling where flooring to be provided, shall be finished to proper line, level, plane and plumb to receive the floor/dado finish. Curing of the waterproofing treatment shall be carried out for 14 days.

54.5.5 Testing and Guarantee: The contractor shall test the surface where waterproofing treatment is provided for the bone dry condition by filling with water inside the depressed plastered portion. No wet patches or leaks shall appear on the surrounding plastered walls or at the under side of the slabs. The testing shall be carried out to the entire satisfaction of the Engineer-in-Charge. The contractor shall furnish guarantee in the Proforma as per Appendix D for the waterproofing treatment for maintaining the under side of the waterproofed surface in bone dry condition for a period of minimum ten years. During this period, contractor shall attend to all leakages, defects etc. if noticed, free of cost, starting his work of checking up and rectification with in a weeks time from the date of receipt of information about such leakages etc. by him.

The contractor shall submit the guarantee bond on appropriate stamp paper and as per the enclosed proforma.
54.5.6 MODE OF MEASUREMENT:

i) Waterproof plaster shall be computed by taking the length and breadth of the area actually plastered correct up to two decimal places of a metre. No deduction shall be made for W.C. pans, pipes etc. in the measurement.

ii) The filling with waterproof brick bat coba shall be computed by noting the levels and dimensions of the filled up depression before and after the filling, up to two decimal places of a metre and also no deductions shall be made for W.C. pans, pipes etc.

54.6 CEMENT BASED WATERPROOFING OF ROOF TERRACES:

54.6.1 General:

The waterproofing treatment shall be essentially a cement based waterproofing treatment similar to that of M/s. India Waterproofing Company's CETROOF or any other equivalent approved 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.

54.6.2 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.

54.6.3 Treatment:

The waterproofing treatment shall be generally as per manufacturers own specifications, method and procedure. A typical cross section of the waterproofing treatment shall generally consist of the following:

i) Applying cement slurry mixed with waterproofing compound for the entire surface to be treated.

ii) Laying of broken brick bat of required thickness over cement mortar bedding to give proper roof drainage, grouted with cement mortar with waterproofing compound.

iii) Laying of jointless cement based waterproofing cement mortar layer of average thickness as specified in the item.

iv) Final rendering to give a smooth finish of cement colour with false lines at 300 x 300 mm. or nearer convenient dimensions. Tenderer shall give complete details of waterproofing treatment proposed by him, in writing viz. details including roof fill material, waterproofing compound, minimum and maximum thickness etc. for effective supervision of the departmental Engineers, while the work is executed at site.

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.

The rain water down take pipes if any, shall be fixed by the other agency prior to commencement of waterproofing operation. Curing of the finished surface by ponding shall be done for 7 days at least.

54.6.4 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 seven days, 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 under side 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 weeks time from the date of receipt of intimation of such leakages etc. by him.

54.6.5 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 deductions 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 115 mm.

54.7 INTERNAL WATERPROOFING FOR OVERHEAD WATER TANK / LIFT PIT / UNDERGROUND SUMP OR TANKS:

54.7.1 General : The waterproofing treatment for overhead water tanks shall be essentially a cement based waterproofing treatment similar to that of M/s. India Water Proofing Company, consisting of providing water proof cement plaster after preparing the surface, filling the cracks and crevices by means of injection and surface method, using proprietary waterproofing compound as per their own specifications and as per recommended proportions etc. and testing of watertightness of the waterproofing treatment and furnishing guarantee as specified.

54.7.2 Preparation of Surfaces: The surface to receive the waterproofing treatment shall be thoroughly cleaned of scales, laitence, 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.

54.7.3 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 cement slurry 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.

54.7.4 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 out after 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 be rectified, with no extra cost, by the contractor.

54.7.5 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.

54.7.6 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 up to 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 all the cost of materials, labour, transportation, testing of water tank for water tightness, furnishing necessary guarantee for waterproofing so provided, all as detailed above.

54.8 WATER PROOFING TREATMENT OF EXPANSION JOINT AT ROOF LEVEL :

54.8.1 Treatment : The expansion joint treatment at roof level shall be provided with approved cement based waterproofing treatment of M/s. India Waterproofing Company or other approved equivalent waterproofing agency. This treatment shall be 20 mm. thick waterproof plaster on top sides and ends of RCC covering hood over expansion joint as shown in the drawing.

54.8.2 Guarantee : The contractor shall carry out the test for waterproof joint provided for expansion joint at roof level by any approved method and furnish a guarantee for the watertightness of the joint in the prescribed proforma as per Appendix D and its maintenance in bone dry condition for a period of ten years. During this period the contractor shall be liable to attend to leakages, defects etc. noticed, free of cost within a weeks time from the date of intimation to him of such leakages.
54.8.3 MODE OF MEASUREMENT:

The measurement for the joints thus waterproofed, shall be made in Running Metres upto two places of decimal of a metre.

55.: INTEGRAL CEMENT BASED WATER PROOFING TREATMENT OF UNDER GROUND WATER TANKS, SWIMMING POOLS, BASEMENTS ETC. FROM OUTSIDE:

55-A: ON HORIZONTAL SURFACES

55.A.1: Preparing the Surface

The water proofing treatment over the lean concrete/levelling course surface should adhere to the surface firmly. The surface of levelling 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 mm thick 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 to roughen the surfaces properly over which plaster or similar coat is to be laid.

55.A.2: Blending Cement/Water with Water Proofing Compound

Mixing water-proofing compound in powder 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 sorted out 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 exceeding 3% 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 the water proofing works, to achieve best results.

Note: Unless otherwise specified, all waterproofing works shall be carried out using blended / PPC cement.

55.A.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 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 and manufactured by reputed approved manufacturer.

(iii) The water thus mixed with water-proofing compound shall be stirred so that the water is blended with 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.

### 55.A.4: Rough Shahabad stone:

(i) 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.

### 55.A.5: Preparation of Cement Slurry

Cement slurry normally prepared and used on general building works with just 1.50 to 2 kg of cement to cover an area of one sqm shall not be applicable for such works instead it should have thick honey like consistency. Each time only that much quantity of slurry shall be prepared 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.

### 55.A.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 and remains unused for more than half an hour shall be totally rejected.

### 55.A.7: Laying Water Proofing Course

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 for laying 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.

(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.

(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.

(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 cu dm/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.

55.A.8: Curing
(a) 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.

(b) 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.

55.A.9: 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.

55.A.10: Rate: The rate shall include the cost of labour & materials involved in all the operations described above.

55.B: ON VERTICAL SURFACES

The vertical water proofing treatment either from inside or outside shall be undertaken only when the entire work is structurally complete.

55.B.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 only alternative method to make the surface rough by“Spatter dash key” (a special hacking tool), 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.

(ii) 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 maximum possible size of stone slabs. Normally the size of stone slabs used for the purpose is 600 x 600mm x 900mm each stone slab weighing approximately 16 kg and 25 kg respectively.

(iii) 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
(v) A 20mm thick clear gap has to be formed between the masonry/concrete surface and the stone slabs 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.

55.B.2: Preparation of Cement Mortar (1:4)

Cement mortar shall be prepared as explained above except that the proportion shall be 1:4 (1 Blended Cement : 4 Coarse sand) instead of 1:3.

55.B.3: Fixing Water Proofing Courses on Vertical Surfaces.

Note:
(i) 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, over which the cement slurry is to be cladded and can be termed as first step for construction.

(ii) 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 by abutting 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 the cement 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 of water 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 2ndlayer 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:
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.

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.

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 (1 blended cement : 4 coarse sand) shall be used for the purpose. Care shall be taken to see that the 20mm thickness of cement plaster over the entire surface is maintained correctly.

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 the joints 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:

(i) 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.

55.B.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 backfilling shall be done before expiry of 14 days from the date of completing the water proofing course from outside.

55.B.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.

55.B.6: Rate: The rate shall include the cost of all labour and materials involved in all the operations described above and for all heights.

55.C: The only difference between treatment of horizontal and vertical surfaces is the thickness and the type of treatment per layer that is to be provided. The same is tabulated below for clear understanding:

<table>
<thead>
<tr>
<th>Horizontal Surfaces</th>
<th>Vertical Surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layers</td>
<td>Details of Layer</td>
</tr>
</tbody>
</table>

SIGNATURE & SEAL OF TENDERER
**56. EXPANSION JOINTS:**

56.1 **SCOPE OF WORK:**

The work contemplated under these specifications consist of supplying the expansion joint fiber boards, sealing compound, aluminium plates etc. strictly as per these specifications and relevant drawings.

56.2 **MATERIALS:**

Materials for expansion joint filler boards shall be of best quality bitumen impregnated performed non-extruding, resilient type of specified thickness in the standard sizes available.

The sealing compound to close the gaps at the edges shall be of best quality rubberized bituminous hot pour, made from special grades of bitumen and shall not show flowing tendency in hot weather and is resilient in the cold weather. The liquid primer shall be made from blown grade bitumen of approved quality.

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.

56.3 **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.

56.4 **WORKMANSHIP:**

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.

After the deshuttering, 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.
If desired by the Engineer-in-charge, the aluminium plates/sheets of specified thickness and sizes shall be fixed to under side/above beams. The plates shall have round holes at 300 mm. c/c. of required diameter on one side of joint through which screws shall be fixed into 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 is laid to the extent of 150 mm., or so as shown in drawing as per procedure laid down here- in- before.

56.5 MODE OF MEASUREMENT:

Unless otherwise mentioned, all the vertical and horizontal expansion joints 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 width being specified in the item.

The rate shall include the cost of all materials, labour, transport, making holes in plates, grouting, making good the surface etc. all operations required to complete the job.

57. RAILING, BALUSTERS AND NEWELS:

57.1 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.

57.2 MATERIALS: The class and quality of wood to be used for hand railing and workmanship shall comply with the requirements specified in wood work wrought and put up and also comply with the I.S. specifications. 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.

57.3 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.

57.4 FABRICATION: The fabrication of wooden hand rail shall follow the standard specification for wood work. The wooden 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 posts as the case may be, shall be fabricated in a workman like manner.

57.5 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 of balusters, posts, railings etc., the damaged tred 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.

57.6 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, newel posts as the case may be up to 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.

* * *

58. RUBBER / P.V.C. WATER STOPS:

58.1 GENERAL: The corrugated Rubber/PVC water stops with centre bulb of specified width, shall be of approved manufacture and shall satisfy all the normal tests such as tensile strength, elongation etc.

58.2 SAMPLE: A sample of Rubber/PVC water stops shall be got approved from the Engineer-in-charge before procurement of bulk quantity.

58.3 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 manufacturer's specifications.

The water stops shall be positioned with suitable temporary supports so as to render adequate rigidity to the water stops while concreting. The exposed surfaces of water stops revealed after first concreting shall be cleaned thoroughly of all the droppings, 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.

58.4 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.

Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc. all as described above.

* * *

59. DISMANTLING AND DEMOLITION:

59.1 SCOPE OF WORK:

The work envisaged under this sub-head is for dismantling and demolition of brick masonry in cement/lime mortar, reinforced cement concrete works, removing wooden chowkhatas of doors, wooden or steel windows.

59.2 GENERAL:

The term Dismantling implies carefully taking up or down and removing without damage. This shall consist of dismantling one or more parts of the building as specified or shown on the drawings.

The term Demolition implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on drawings.

59.3 PRECAUTIONS:
Necessary propping, shoring and/or underpinning shall be provided for the safety of the adjoining work or property, which is to be left in tact, before dismantling and 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 shall also be provided.

Necessary precautions shall be taken to keep the dust- nuisance down as and when necessary.

Dismantling shall be commenced 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 under serviceable materials, rubbish etc. shall be disposed off as directed by the Engineer-in-charge.

59.4 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 chowkhats, unless and otherwise to be treated, shall be plastered in C.M. 1:3 with neeru finish to render true sides, corners, edges etc.

59.5. MODE OF MEASUREMENT :

59.5.1 Brick Masonry & R.C.C. Works : The measurement of brick masonry with or without plaster/painting shall be taken correct to a centimeter and volume calculated in cubic metres upto two places of decimal.

59.5.2 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.

59.5.3 Roof Terracing : Dismantling of roof waterproofing treatment shall be measured in square metre area. Length and breadth shall be measured correct to a centimeter between parapets. No separate measurement shall be taken for gola and khurrah etc.

59.6 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.

60. ROAD AND PAVEMENTS :

SCOPE OF WORK :

The work contemplated under these specifications refers to Earth work in Excavation, Forming Embankments, Soling, W.B.M., Bituminous Macadam, Wearing Course/Sealing Coat etc. for road and pavement works.
Approximate quantities of materials to be used in the work are listed below for reference:

<table>
<thead>
<tr>
<th>SN</th>
<th>MATERIAL</th>
<th>DESCRIPTION</th>
<th>CONSUMPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Soling stone</td>
<td>a) for 230 mm. thick consolidated thickness</td>
<td>2.65 cum./10 sqm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) for 150 mm. thick consolidated thickness</td>
<td>1.725 cum./10 sqm.</td>
</tr>
<tr>
<td>ii)</td>
<td>Stone aggregate 50 mm. nominal size</td>
<td>for 75 mm. thick consolidated W.B.M.</td>
<td>0.975 cum./10 sqm.</td>
</tr>
<tr>
<td>iii)</td>
<td>Murrum</td>
<td>for 75 mm. thick consolidated W.B.M.</td>
<td>0.305 cum./10 sqm.</td>
</tr>
<tr>
<td>iv)</td>
<td>Bituminous macadam</td>
<td>for premix carpets for 38 mm. consolidated thickness</td>
<td>11 sqm./mt.</td>
</tr>
<tr>
<td>j)</td>
<td>Seal coat (Bituminous concrete or wearing course)</td>
<td>for 12 mm. consolidated thickness</td>
<td>33 sqm./mt.</td>
</tr>
</tbody>
</table>

60.1 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.

60.2 FORMING EMBANKMENT:

The work shall include preliminaries of clearing site, setting out and preparing the ground and there after forming embankment for the roads, paths etc. with approved material available form 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 the particular 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 excavated material 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 progress of 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 provided with 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.

MEASUREMENT AND RATE:

The contract rate shall be per cubic metre of the finished embankment. Measurements shall normally be taken by taking cross sections at suitable intervals. The measurements of the section shall be limited to the dimensions shown on the drawing or those ordered by the Engineer-in-Charge in writing. The sectional area shall be worked out correct up to two places of decimal of square metre and the quantity worked out to two places of decimal of cubic metre on lines similar to those specified for earth work here-in-before.

60.2A SUB GRADE:

Preparation of Sub-Grade: The surface of the formation for a width of sub-base, which shall be as per drawings shall first be cut to a depth equal to the combine depth of sub-base and surface courses below 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.

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 an elastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All undulations in the surface that develop due to rolling shall be made good with fresh material or quarry spoils as the case may be and the sub-grade is rerolled.
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:

### PERMISSIBLE TOLERANCES OF SURFACE REGULARITY

<table>
<thead>
<tr>
<th></th>
<th>Longitudinal profile</th>
<th>Cross profile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum permissible undulation when measured with a 3 metre straight edge template.</td>
<td>Maximum permissible variation from specified profile when measured with a camber-</td>
</tr>
<tr>
<td></td>
<td>24mm</td>
<td>15mm</td>
</tr>
</tbody>
</table>

Where the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall be 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.

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 materials and labour required for all the operations mentioned above, unless specified otherwise.

60.3 SUB-BASES:

60.3.1: Water Bound Macadam Sub-base with stone aggregate: Stone aggregate of size 90 mm to 45 mm shall be used. This consists of clean crushed coarse aggregate mechanically interlocked by rolling using power roadroller 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.

### SPECIFICATIONS FOR LAYING:

Quantities of Materials: Quantities of coarse aggregate, screening & blinding material required to be stacked for 100 mm approx. compacted thickness of WBM sub-base course for 10 Sqm. shall be as per table given below:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Size Range</th>
<th>Coarse Aggregate</th>
<th>Net Qty.</th>
<th>Grading/Classification</th>
<th>Stone Screenings</th>
<th>Blinding materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading - I</td>
<td>90mm to 45mm</td>
<td>1.2 Cum. Type A 13.2 mm</td>
<td>0.27 Cum. to 0.30 Cum.</td>
<td>0.08 Cum. to 0.10 Cum.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Net Quantity = Loose Quantity measured in stack minus 7.5%

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.

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 may be 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-
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 of 115 mm compacted thickness. 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 ahead of the rolling and blending of the proceeding section.

**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 edge 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 or removed from it as required and the area rolled until it gives a uniform surface conforming to the desired cross-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.

**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 all voids. 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 bearing of 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 be used under any circumstances.

**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.

**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.

**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.

**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>
<thead>
<tr>
<th>Size of coarse aggregates</th>
<th>Longitudinal profile</th>
<th>Cross profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. permissible undulation when measured with a 3 M straight edge</td>
<td>Max. permissible undulation when measured with a camber template</td>
<td></td>
</tr>
<tr>
<td>45-90 mm</td>
<td>15 mm</td>
<td>12 mm</td>
</tr>
</tbody>
</table>

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.

**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 scarified over 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.

**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.

**60.3.2 RUBBLE SOLING**

Rubble soling for road work including foot paths, culverts, side drains etc. shall be carried out as specified here-in-before under Chapter for Rubble stone soling, so far as they are applicable, with the following additions:

Subgrade for soling shall be prepared by cleaning of all foreign substances including rank vegetation, if any. Any ruts or soft yielding places that appear due to improper drainage conditions, traffic, hauling or from any other cause, shall be corrected by filling/cutting upto 150 mm. and compacted and the subgrade dressed off parallel to the finished profile and the same shall be approved by the Engineer-in-Charge, before laying of soling. Soling shall be laid in regular lines and staggered joints. The stones shall be laid as closely as possible and packed well. The stones shall be so laid as to have their bases and the largest area resting on the subgrade and in contact with each other.

Soling shall be laid to proper gradient and camber which shall be checked frequently to ensure accuracy. Rolling
shall then be carried out by a 8 to 10 tonne power roller and soling consolidated properly shall be lightly sprinkled during rolling, if ordered by the Engineer-in-Charge.

The surface thus prepared shall first be passed by the Engineer-in-Charge, after which 40 mm. to 50 mm. thick layer of selected hard murrum available from excavation shall be spread over the soling as directed by the Engineer-in-Charge, and rolled again such that the hard murrum gets into the interstices. It shall, however, be ensured that a thin layer of murrum/grit shall remain on the finished surface of soling.

The area of soling actually done of specified consolidated thickness limiting to the dimensions as per drawing, shall be measured in square metre upto two decimal places.

60.4 WATER BOUND MACADAM:

a) 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.

b) Collection of metal: Metal shall be of first sort black trap stone and shall be collected in stacks on 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 for voids. 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.

c) 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-Charge and 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.

d) 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 to each 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, the gauges 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 be spread 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 the advancing 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 be avoided.
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 first 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 of the 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 walnut 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.

e) Blinding Course: When the required consolidation has been completed, the blinding 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 blinding 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 or such 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 flat slope and well consolidated together and hump formation must be avoided.

f) 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.

g) MODE OF MEASUREMENT:

The areas of water bound macadam road surfaces of required thickness actually completed as per above specifications limiting to the areas as per drawing shall be measured in square 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 obtained from excavation work under this contract and used as blinding material as above on instructions/approval of the Engineer-in-charge shall not be paid.

60.5 BITUMINOUS MACADAM & BITUMINOUS CONCRETE SURFACING FOR ROAD (GENERAL):

SCOPE OF WORK:
The work covered under these specifications provides for bituminous treatment for roads consisting of providing 38mm thick bituminous macadam and 12 mm 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 his own cost to control and safeguard the traffic.

60.5.0 BITUMINOUS MACADAM OVER WATER BOUND MACADAM:

60.5.1 Preparation of Existing Water Bound Macadam Surface:
The existing water bound macadam surfaces 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 sides shall be cleaned as stated above. The sides and bottom shall then be thoroughly painted with heated 60/70 penetration 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 sideforms having scratch points placed at not less than 200 mm. apart and set to the exact profile of the base 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 bitumen at the rate of 0.75 kg. per sqm. 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.

60.5.2 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.

60.5.3 HOT MIXED HOT LAID BITUMINOUS MACADAM:

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 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
AGGREGATE GRADING: The requirements of base course shall be as under:

<table>
<thead>
<tr>
<th>B.S. Sieve Designation</th>
<th>Equivalent I.S. Sieves</th>
<th>Passing percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 mm. (about 1.25&quot;)</td>
<td>40 mm. (1.5&quot;)</td>
<td>100</td>
</tr>
<tr>
<td>20 mm. (about 3/4&quot;)</td>
<td>20 mm.</td>
<td>50 - 100</td>
</tr>
<tr>
<td>12 mm. (about 1/2&quot;)</td>
<td>12.5 mm.</td>
<td>30 - 60</td>
</tr>
<tr>
<td>6 mm. (about 1/4&quot;)</td>
<td>6.3 mm.</td>
<td>18 - 30</td>
</tr>
<tr>
<td>No. 10</td>
<td>1.7 mm.</td>
<td>10 - 20</td>
</tr>
<tr>
<td>No. 200</td>
<td>75 micron</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

The aggregate/chips shall be entirely dry at the time of mixing.

2 Bitumen: Bitumen to be used shall conform to I.S. 73-1992 for paving bitumen, with 60/70 penetration and shall be from approved manufacturers.

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 (60/70 penetration) content 3.7% to 4.7% by weight of the total mix, shall be used in the mixture.

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 (325°F to 350°F) in a bitumen boiler and the hot bitumen shall be applied evenly to the thoroughly 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.

4 Premixing Chips: The bitumen shall be heated to 163°C to 177°C (325°F to 350°F) in boiler. The aggregate of the approved grading or as decided by the 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 paddle type mixer at a temperature not less than 149°C (about 300°F). The bitumen, the approved 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. Asphalt/bituminous mixing plant proposed to be used by the contractor for the preparation of Asphalt/bituminous mixing shall conform to all of the requirements of the job, which shall produce uniform mixtures of the required quality, and got approved by the Department before mixing.

The temperature of the premix bituminous macadam when leaving the mixer shall not be less than 130°C (about 280°F) and it shall not be less than 121°C (about 250°F) at the time of laying.

Bituminous macadam shall be transported to site of work in suitable tipping vehicle properly insulated and covered with canvas or other suitable materials to protect the mixture from weather conditions and to retain the heat. The road surface shall be suitably marked to ensure correct and uniform application. Width of macadam to be laid shall be slightly more (not exceeding 50 mm. on each side) than the required carriage way as per drawing. Excess on either side shall be neatly cut after full compaction to get final width of carriage way as per drawing. The premixed bituminous macadam shall be laid by a mechanical self-powered spreader and compactor and finished to correct line, level, & final consolidation done by means of power roller not less than 10 tonne. Any irregularities shall be corrected.
5 Compaction: The base bituminous macadam course shall be compacted thoroughly and evenly with 10 to 12 tonne power roller immediately after it is laid. Compacted thickness shall be as specified in schedule of quantity. The surface shall be checked for correct grade during and after rolling. Any irregularities shall be corrected by adding precoated chips or removing the surplus. The disturbed surface shall be well compacted again. If necessary, the roller wheel shall be coated with oil to prevent the coated chip from sticking to the wheels. Rolling shall be continued till no wheel marks are left on the surface. The speed of the roller shall be sufficiently slow to prevent any pushing under the wheels.

60.6 HOT MIXED HOT LAID BITUMINOUS CONCRETE WEARING COURSE (SEAL COAT):

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.

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. Maximum size of the aggregate shall be suitable for the thickness of the seal coat (12mm./15mm. or as specified).

The aggregate grading composition and characteristics of surface (wearing course mix) shall conform to standard code of practice. The mix shall satisfy the following requirements:

<table>
<thead>
<tr>
<th>Bitumen</th>
<th>7.25 (+/-) 0.25% by weight of total mix.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voids of air in total mix</td>
<td>2% by weight of mix and 4% by volume.</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>Not less than 2.3.</td>
</tr>
<tr>
<td>Marshall stability</td>
<td>453.6 kg (1000 lb.) minimum</td>
</tr>
<tr>
<td>Flow</td>
<td>1020.</td>
</tr>
<tr>
<td>Water absorption</td>
<td>0.50%</td>
</tr>
</tbody>
</table>

3 Fine Aggregate: 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.

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.

4 Bitumen: Bitumen shall be of 60/70 penetration or such other grade specified by the Engineer-in-Charge and shall conform to I.S. 73-1961.

The tenderers shall indicate the exact grading, bitumen content, voids, specific gravity etc. which they propose to adopt for type to treatment offered by them.
5 Preparation of Base: Dirt, dust and other foreign materials if accumulated shall be cleared off leaving the surface entirely clean. The prepared surface shall be closed to traffic and so maintained fully clean till the seal coat is applied.

6 Mixing and Laying Wearing Course: Grade 60/70 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 paddle 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.

7 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 opened to traffic on cooling of the concrete to the atmospheric temperature or after a lapse of 24 to 40 hr. after laying.

GENERAL REQUIREMENTS FOR BITUMEN MACADAM & SEAL COAT:

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.

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.

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
61. FENCING WORK WITH BARBED WIRE, CHAIN LINK ETC. :

The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer-in-Charge.

61.1 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. 1:3:6 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.

61.2 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 1:2:4 (1 cement : 2 coarse sand : 4 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.

61.3 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.

61.4 FIXING OF M.S./R.C.C. POSTS AND STRUTS :

4 MODE OF MEASUREMENT :

i) Measurement for bituminous macadam including filling in pot holes and depressions shall be paid by weight measured in metric tonne used on the job, completed satisfactorily, measured up to second place of decimal including preparing surface, applying tack coat and compacting by roller etc. complete as specified.

ii) Measurement for bituminous concrete (seal coat) shall also be paid by weight as measured at site of work, irrespective of the thickness laid, in Metric tonne used on the job, compacted satisfactorily, measured up to second place of decimal including all the relevant items of work specified.

* * *
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, the pits 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 at least 7 days to ensure proper curing.

61.5 BARBED WIRE:

The barbed wire shall be of M.S. or G.I. as specified and it shall generally conform to I.S. 276-1978.

The base metal of the line and point wire shall be of good commercial quality mild steel. 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.

The barbed wire and its weight shall be as given in the table below:

<table>
<thead>
<tr>
<th>Type</th>
<th>Nominal diameter of wire</th>
<th>Nominal distance between two barbs in mm</th>
<th>Mass of complete barbed wire (in gm./m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>line wire (in mm.)</td>
<td>point wire (in mm.)</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>2.50 (12G)</td>
<td>2.50 (12G)</td>
<td>75</td>
</tr>
<tr>
<td>2.</td>
<td>2.50</td>
<td>2.50</td>
<td>150</td>
</tr>
<tr>
<td>3.</td>
<td>2.50</td>
<td>2.00 (14G)</td>
<td>75</td>
</tr>
<tr>
<td>4.</td>
<td>2.50</td>
<td>2.00</td>
<td>150</td>
</tr>
<tr>
<td>5.</td>
<td>2.24 (13G)</td>
<td>2.00</td>
<td>75</td>
</tr>
<tr>
<td>6.</td>
<td>2.24</td>
<td>2.00</td>
<td>150</td>
</tr>
</tbody>
</table>

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. Barbed spacings 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.

TENSILE PROPERTIES:

<table>
<thead>
<tr>
<th>Size of line wire Nominal dia (in mm)</th>
<th>Breaking load of line wire Min. (in Kg.)</th>
<th>Breaking load of complete barbed wire Min. breaking load of (in Kg.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

SIGNATURE & SEAL OF TENDERER
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.

61.5.1 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 or at 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 wires by 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 up and 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.

61.5.2 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 above including 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.

61.6 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. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanised if specified.

61.6.1 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 tightly and 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.

61.6.2 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
62. M. S. CRIMPNET GATE :

62.1 MATERIALS :

All steel work, pipe frame work and crimpnet shall be of sizes and sections as per drawings. They shall generally conform to relevant I.S. specifications. The G.I. crimpnet shall be unless otherwise stated, 25 x 25 mm. x 8 g. and of approved manufacture.

62.2 INSTALLATION :

For each leaf of the gate, the crimpnet 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 easy and proper movement of shutters.

62.3 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.

62.4 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 be valid for areas in variance by about (+/-) 10% in the overall size of the gate.

63. DRAINAGE WORK WITH NP2 CLASS RCC HUME PIPES :

63.1 R.C.C. SPUN PIPES :

The pipes shall be R.C.C. spun pipes NP2 class, conforming to I.S. 458-1971 and shall be approved by the Engineer-in-Charge for soundness before incorporation in the work.
63.2 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 nullah 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. It shall 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.

63.3 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 45o 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 and joints shall be cured for atleast 7 days.

63.4 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.

63.5 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.

63.6 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.

63.7 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.

64. ROUGH / NATURAL FACED SHAHABAD STONE PAVEMENT:

64.1 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.
64.2 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.

64.3 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.

64.4 CURING:

The pavement work shall be kept well wetted for atleast seven days.

64.5 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.

64.6 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 work shall be measured as above and no extra claim on this account will be entertained.

* * *
1. SANITARY FIXTURES & FITTINGS

1. SCOPE

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of following items:

a. Sanitary appliances and fixtures for toilets.

b. Chromium plated brass fittings

c. Stainless steel sinks

d. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.

e. Hand driers, drinking water fountains etc.

Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers as required.

All exposed pipes within toilets and near appliances/fixtures shall be of chromium plated brass or copper unless otherwise specified.

2 GENERAL REQUIREMENT

Sanitary appliances and fixtures for toilets, chromium plated brass fittings, stainless steel sinks, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails coat hooks etc and mirrors, hand driers, drinking water fountains etc as listed in the relevant items in the Schedule of Quantities shall be supplied free of cost by the Owner’s Site Representative. The rates shall be inclusive of accessories (in such case) required for installation. All sanitary fixtures and fittings shall received from the Owner’s Site Representative and thereafter be stored under covered roof and handled carefully to prevent any damage by the Contractor.

All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, drawings. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Architect / Owner’s Site Representative and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect / Interior Designer.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architect requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern as called for.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturer’s recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through
them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

i. Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (The original protective wrapping shall be left in position for as long as possible)

ii. The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.

iii. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

iv. The appliance shall be securely fixed. Manufacturer’s brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.

v. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

vi. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

vii. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

Sizes of sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may vary within ±10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc. in accordance with manufacturer’s instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, collars, compression fittings etc., as required.

Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

2.1 Water Closet

Water Closet shall be wash down or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 5-7 litres of water, flushed by means of a porcelain flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Owner’s Site Representative) 32 mm size CP brass flush valve with regulator valve. Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Owners Site Representative.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

2.2 Urinals

Urinals shall be lipped type half stall with glazed vitreous China of size as called for in the Bill of Quantities.

Half stall urinals shall be provided with urinal sensors, 15mm dia CP spreader, 32mm dia CP domical waste and CP
cast brass bottle trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Owner’s Site Representative.

Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit.

Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet.

2.3 Cisterns
Low level flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer’s specification to the satisfaction of the Owner Site Representative. Provision of flush valve shall be made for Public / Staff toilets.

2.4 Wash Basin
Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.
Each basin shall be provided with painted MS angle or CI brackets and clips (unless otherwise specified) and the basin securely fixed to wall/counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Owner’s Site Representative. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with 32mm dia CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the Schedule of Quantities.
Each basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

2.5 Flow Control Device
Approved / rated flow control fitting in brass body, chrome outer cover, rated for flow / discharge of the fixture.

2.6 Toilet Paper Holder
Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the Schedule of Quantities.
Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement : 2 coarse sand) and fixed in relation to the tiling work.

The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with raw I plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Owner’s Site Representative.

2.7 Towel Rail
Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.
Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Owner’s Site Representative.

2.8 Janitor’s Sink
Janitor’s sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities, provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner’s Site Representative.
2.9 Drinking Water Fountain

Drinking water fountain shall be wall mounting type made of vitreous china, stainless steel or any other material as given in the Schedule of Quantities.

The drinking water fountain shall be with anti-squirt bubble less, self-closing valve type with automatic volume regulator.

The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32mm or 40mm cast brass trap.

2.10 Liquid Soap Dispenser

Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only by key provided.

Liquid soap dispenser body and Shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

The valve shall operate with less than 2.27 Kg (5 lbs) of force.

2.11 Hand Drier

The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).

The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.

The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply.

3. MOCKUP AND TRIAL ASSEMBLY

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/Consultant.

The contractor shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc. which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / Interior Designer.

The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

4. SUPPORTING AND FIXING DEVICES

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly SS:304 Nut Bolts & screw. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

5. FINAL INSTALLATION

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to
facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

6. PROTECTION AGAINST DAMAGE

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

7. MEASUREMENT

7.1. Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

7.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the Owner’s Site Representative.

8. TESTING

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

2. WATER SUPPLY

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

a. Municipal Water supply.
b. Drinking Water Supply.
c. Flushing Water Supply

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Owner.

2. PIPING MATERIALS

The piping system shall consist of copper pipes confirming to BS 2871, class 1, table X, half hard for domestic plumbing and fittings shall confirm to BS 864 Part-II

The piping system shall also consist of CPVC SDR 11.0 piping from 15 mm to 50 mm & Schedule 40 from 65 mm to 150 mm for cold water supply & schedule 80 from 65 mm to 150 mm for hot water supply.

The piping system shall also consist of heavy class galvanized iron pipes and fittings conforming to IS:1239. The sizes and makes is specified in the Schedule of Quantities.

For any internal works, the CPVC pipes / copper pipes / galvanized iron pipes and fittings shall be embedded in the
A  **Copper Pipes & Fittings**

The pipes shall be hard tempered copper pipes and tubes confirming to requirements of EN 1057; BS 2871 Table 'X' Part -1971 and the fittings shall confirm to EN 1252 Part 1 / 2 / 5 & BS 864 Part 2. The flux shall be NSF 6 or equivalent.

The fittings shall be as follows:

a. **Internal Solder Ring (ISR) fitting** : For pipes from 15 mm to 35 mm dia.
b. **Endex Fittings** : For pipes from 42 mm to 54 mm dia.
c. **Endbraze Fittings** : For pipes from 67 mm dia and above.

Fabricated fittings in NO case shall be allowed. Fittings of all types such as Tees, Crosses, Elbows, Reducers, Unions, Off Sets etc. shall be used on the pipes. Suitable fittings of approved type and make shall be used for jointing copper pipes to GI pipes and for jointing copper pipes to CP fittings etc. shall be used. Use of DZR fitting shall be made for all connections.

**Laying and Jointing of Copper Pipes and Capillary Fittings**

The copper pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts, etc. there should be sufficient space to work on the pipes with the usual tools. As far as possible, pipes may be buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the Owner's Site Representative / Architect, pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be covered with a protective tape wrapped around the pipes and fittings. Copper pipes shall be jointed with approved above mentioned fitting conforming to BS 864 Part 2. Care shall be taken to remove any burr from the end of the pipes after cutting. Only fittings of the size suitable to the pipe shall be used. The ends of the tube shall be cut to the correct size using a tube cutter or a file blade hacksaw. Care shall be taken to ensure that the ends of the tube are cut perpendicular to the axis of the tube and that the ends remain undamaged and free of burrs. Any burrs remaining shall be removed with a smooth file. Clean the outside surface of the tube that shall go into the fitting. Flux shall be applied on the pipe surface ensuring even and uniform application. Insert the tube into the fittings and push home until the stop is reached. Wipe off excess flux with a soft cloth. Now the assembled joint shall be heated with a blow torch or any similar appliance that emits a clean, blue, soot free flame. The heat shall be turned off once a complete ring of solder has appeared around the mouth of the fitting.

The joint shall be allowed to cool without disturbance.

All copper pipes to G.I. pipe and connection with the valves and faucets shall be with De-zincified Resistance fittings (DZR).

B.  **CPVC Pipes & Fittings**

The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system with pipes as per CTs SDR -11 at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer &
i. **Joining Pipes & Fittings**

   a. **Cutting:**
      Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

   b. **Deburring / Beveling:**
      Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fittings during assembly.

   c. **Fitting preparation:**
      A clean dry ragcloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

   d. **Solvent Cement Application:**
      Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

   e. **Assembly:**
      After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe 1/4 to 1/2 turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up.

      An even bead of cement should be evident around the joint and if this bead is not continues remake the joint to avoid potential leaks.

   **Set & Cure times:**
   Solvent cement set and cure times shall be strictly adhered to as per the below mentioned table.

   **Minimum Core prior to pressure testing at 150 PSI**

<table>
<thead>
<tr>
<th>Ambient Temperature during Core period</th>
<th>Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>½&quot; - 1&quot;</td>
</tr>
<tr>
<td>Above 15 deg. C</td>
<td>1 Hr</td>
</tr>
<tr>
<td>4-15 deg. C</td>
<td>2 Hrs</td>
</tr>
<tr>
<td>Below 4 deg C</td>
<td>4 Hrs</td>
</tr>
</tbody>
</table>

   Special care shall be exercised when assembling flow guard systems in extremely low temperature (below 4°C) or extremely high temperature (above 45°C) In extremely hot temperatures, make sure that both surfaces to be joined are till wet with cement solvent when putting them together.

   f. **Testing:**
      Once an installation is completed and cored as per above mentioned recommendations, the system
ii. Transition of Flow guard CPVC to Metals

When making a transition connection to metal threads, special Brass / plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torqued Hard tight puts one half turn should be adequate.

iii. Threaded Sealants

Teflon tape shall be used to make threaded connections leak proof.

iv. Solvent Cement

Only CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. Flow guard CPVC cement solvent have a minimum shelf life of 1 year. Aged cement solvent will often change colour or being to thicken and become gelatinous or jelly like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company’s seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used. The CPVC solvent cement usage should be adhered to as given in table below

<table>
<thead>
<tr>
<th>Diameter of pipe in inch</th>
<th>½”</th>
<th>¾”</th>
<th>1”</th>
<th>1¼”</th>
<th>1½”</th>
<th>2”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow guard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approx. nos. of joints which can be made per litre of solvent cement.</td>
<td>200 Nos</td>
<td>180 Nos</td>
<td>150 Nos</td>
<td>130 Nos</td>
<td>100 Nos</td>
<td>70 Nos</td>
</tr>
</tbody>
</table>

v. Hangers and supports

For Horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (1.2m) intervals for larger sizes.

Hangers should not have rough or sharp edges which come in contact with the tubing.

Supports should be as per the below mentioned table:

<table>
<thead>
<tr>
<th>Size of Pipe</th>
<th>21°C</th>
<th>49°C</th>
<th>71°C</th>
<th>82°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch</td>
<td>Ft.</td>
<td>Ft.</td>
<td>Ft.</td>
<td>Ft.</td>
</tr>
<tr>
<td>½”</td>
<td>5.5</td>
<td>4.5</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>¾”</td>
<td>5.5</td>
<td>5.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>1”</td>
<td>6.0</td>
<td>5.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>1¼”</td>
<td>6.5</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>1½”</td>
<td>7.0</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>
### SCHEDULE - 40

**Recommended Support spacing (in feet)**

<table>
<thead>
<tr>
<th>Nom. Pipe Size</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(In)</td>
<td>23</td>
</tr>
<tr>
<td>2 ½</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
</tr>
</tbody>
</table>

### SCHEDULE - 80

**Recommended Support spacing (in feet)**

<table>
<thead>
<tr>
<th>Nom. Pipe Size</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(In)</td>
<td>23</td>
</tr>
<tr>
<td>2 ½</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
</tr>
</tbody>
</table>

C. **Galvanised Iron Pipes & Fittings**

The pipes shall be galvanised mild steel welded (ERW) or (HFW) screwed and socketed conforming to the requirements of IS:1239. The Galvanising shall conform to IS:4736, the zinc coating shall be uniform, adherent reasonably smooth and free from such imperfections as flux, ash and drop inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the pipe.

The fittings shall be malleable iron and comply with all the requirements of the pipes. The sizes of pipes and fitting is specified in the schedule of quantities.

**Laying And Jointing Of GI Pipes**

The galvanised pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface.
Where it is specified to conceal the pipes, chasing may be adopted for pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. As far as possible, pipes may be buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the Owner’s Site Representative, pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be painted with anticorrosive bitumastic paints of approved quality. Under the floors the pipes shall be laid in layer of sand filling.

Galvanised iron pipes shall be jointed with threaded and socket joints, using threaded fittings. Care shall be taken to remove any burr from the end of the pipes after threading. Teflon tape, White lead or an equivalent jointing compound of proprietary make shall be used, according to the manufacturer’s instructions, with a grommet of a few strands of fine yarn while tightening. Compounds containing red lead shall not be used because of the danger of contamination of water. Any threads exposed after jointing shall be painted with bituminous paint to prevent corrosion.

D. Polybutylene pipes and fittings.

Jointing pipes & fittings

The Polybutylene pipes and fittings are joined through a Electro-fusion welding machine and the below mentioned steps need to be adhered to while installing the system:

a. Cutting & edge preparation: First the pipe need to be cut through a sharp cutter and the two end of the pipe need to be cleaned with the tangit cleaner provided by the manufacturer. The pipe cut should be a proper square cut only. Then the corresponding fitting to be connected with the fitting should also be cleaned with the same tangit cleaner. Cleaning removes all the dust particles on the pipe and the fitting for proper jointing. Then use the chamfering tool on the pipe to peel off a thin layer out of the pipe.

b. Fitting: unpack the fitting and position it on the pipe, so that the sleeve end matches the pipe end. Insert the end of the other pipe. Make sure both the ends of the pipe are lined up and secure the fitting and the pipe.

c. Assembly: Fix the electro-fusion machines cables so that the cables do not weigh on the clamps. Connect the clamps to the resistor terminals on the fitting and make sure that the connection is correct. Follow the instructions to the program and operate the welding machine.

d. Testing: Once the assembly is made pressure test it at double the working pressure so as to confirm the leak proof jointing of the system. This pressure testing should be done for 12 hours and then put into operation on regular basis.

e. Minimum cooling time without moving sleeve and pipe:

<table>
<thead>
<tr>
<th>External diameter</th>
<th>minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>16mm</td>
<td>10</td>
</tr>
<tr>
<td>20mm</td>
<td>10</td>
</tr>
<tr>
<td>25mm</td>
<td>10</td>
</tr>
<tr>
<td>32mm</td>
<td>15</td>
</tr>
<tr>
<td>40mm</td>
<td>15</td>
</tr>
<tr>
<td>50mm</td>
<td>20</td>
</tr>
</tbody>
</table>
f. **Supporting structure in Horizontal PB pipes:**

Supporting structures should be steel clamps with rubber fitted inside in order to hold the pipe tightly.

Mentioned below are the distances required to be maintained as per the temperatures:

<table>
<thead>
<tr>
<th>External diameter</th>
<th>Temperature of the Flowing water in degree centigrade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>16mm</td>
<td>75cm</td>
</tr>
<tr>
<td>20mm</td>
<td>80cm</td>
</tr>
<tr>
<td>25mm</td>
<td>85cm</td>
</tr>
<tr>
<td>32mm</td>
<td>100cm</td>
</tr>
<tr>
<td>40mm</td>
<td>110cm</td>
</tr>
<tr>
<td>50mm</td>
<td>125cm</td>
</tr>
<tr>
<td>63mm</td>
<td>140cm</td>
</tr>
<tr>
<td>75mm</td>
<td>155cm</td>
</tr>
<tr>
<td>90mm</td>
<td>170cm</td>
</tr>
<tr>
<td>110mm</td>
<td>190cm</td>
</tr>
<tr>
<td>125mm</td>
<td>225 cm</td>
</tr>
<tr>
<td>160mm</td>
<td>225cm</td>
</tr>
</tbody>
</table>
g. Supporting structures for Vertical Pipes:

The supporting structures for the vertical pipes is more or less similar to horizontal pipes. However in this case we can increase the distance between the supports by approximately by 30%. At branching point at each floor a compensatory arm in the form of u loop should be formed.

3. PIPING INSTALLATION SUPPORT (VALID FOR GI / COPPER PIPING ONLY)

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. All accessories and ancillaries of support system such as brackets, saddles, clamps, hangers etc. shall be hot dip galvanized after fabrication. Further to permit free movement of common piping, support shall be from a common hanger bar, fabricated from galvanised steel sections.

<table>
<thead>
<tr>
<th>Pipe Dia (mm)</th>
<th>Hanger Rod Dia (mm)</th>
<th>Spacing between Supports (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>32 to 50</td>
<td>10</td>
<td>2.7</td>
</tr>
<tr>
<td>80 to 100</td>
<td>12</td>
<td>2.7</td>
</tr>
<tr>
<td>125 to 150</td>
<td>16</td>
<td>3.6</td>
</tr>
<tr>
<td>200 to 300</td>
<td>19</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14 gauge metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending at least 15 cm. on both sides of the clamps, saddles or roller.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes area indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fiberglass and finished with retainer rings.
The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified/approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut by pipe cutting machine to the required sizes in accordance with relevant IS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

All buried pipes for CWS shall be cleaned and coated with two coats of bitumen and then wrapped with two layers of 400 micron polythene sheet coating.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size isolation ball valve. Automatic air valves shall also be provided on hot water risers.

Discharge from the air valves shall be piped through a galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings and included in Bill of Quantities. Care shall be taken to protect pressure gauges during pressure testing.

Temperature gauge as specified shall be provided at the hot water supply and return and as shown on drawings and included in Bill of Quantities.

4. FERRULES

The ferrules for connection with main shall generally conform to IS:2692. It shall be of non-ferrous materials with a bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, as and when required.

4.1 Fixing Ferrules

For fixing ferrule in cast iron mains, the empty main shall be drilled and tapped at 45 deg to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

5. WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

5.1 Installation Of Water Meter And Stop Cock

The G.I. lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be
6. TESTING

The Contractor shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

In addition to the sectional testing carried out during the construction, contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the contractor during the defects liability period without any cost.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Owner’s site representative.

7. DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 liters of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

8. STERILIZATION OF MAIN

After the pipe work has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime.

9. CUTTING CHASES IN MASONARY WALLS

Cold water distribution pipes to fixtures and equipment exposed to view in the bathrooms, kitchens, and sanitary
compartments shall be chased into walls or floors or placed in wall cavities. The Contractor shall be responsible for cutting all notches, chases, and recesses in walls and floors and only a diamond cutter shall be used. The maximum size of conduit or pipe permitted to be concealed in floor slabs shall be 32 mm diameter unless otherwise approved by the Architect.

The chases upto 7.5 x 7.5 cm shall be made in the walls for housing GI pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the Architects. Chases shall be made by chiselling out the masonry to proper line and depth. After the pipes etc are fixed in chases, the chases shall be filled with cement mortar 1:2:4 or as may be specified, and made flush with the masonry surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

Where pipes pass through beams or structural walls, subject to the approval of the Structural Consulting Engineer, the Contractor shall ensure that sizes and locations of openings required are formed in when the relevant beams or walls are cast.

10. VALVES

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian standard IS:780 and IS:2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Globe valves on Hot-water line shall be union bonnet with stem/disc and body seat ring of SS. Suitable for temperature upto 80° C.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of Valve</th>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Isolating Valve</td>
<td>15 mm to 50 mm</td>
<td>Gun Metal</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 mm and above</td>
<td>Gun Metal</td>
<td>Flanged</td>
</tr>
<tr>
<td>b.</td>
<td>Sluice Valve &amp; Butterfly Valve</td>
<td>65 mm and above</td>
<td>Cast Iron</td>
<td>Flanged</td>
</tr>
<tr>
<td>c.</td>
<td>G.M. non return valve</td>
<td>15 mm to 50 mm</td>
<td>Gun Metal</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 mm above</td>
<td>Gun Metal</td>
<td>Flanged</td>
</tr>
<tr>
<td>d.</td>
<td>Flap Type – Non return valve</td>
<td>65 mm and above</td>
<td>Cast Iron</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

All valves shall be suitable for the working pressure involved.

10.1 Pressure Reducing Valve Set
Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges (fix with symphonic check) on inlet and outlet, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set downstream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of replaceable porous sintered metal type.

10.2 Pressure Relief Valves
Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.
Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.
Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

10.3 Pressure Gauge
The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg/cm² and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.
Calibration certificate shall be obtained and submitted for each pressure gauge.

11. WATER FITTINGS
Unless otherwise specified all Gunmetal fittings such as gate, globe, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak-proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.
12. **PAINT:**

Used paints and coatings that comply with the following limits for VOC content and the following chemical restrictions:

- Non-Flat Paints and Coatings: VOC not more than 150 g/L.
- Anti-Corrosive Coatings VOC not more than 250 g/L.
- Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
- Paints and coatings shall not contain any of the following:
  - Acrylic
  - Acrylonitrile
  - Antimony
  - Benzene
  - Butyl benzyl phthalate
  - Cadmium
  - Di (2-ethylhexyl) phthalate
  - Di-n-butyl phthalate
  - Di-n-octyl phthalate
  - 1,2-dichlorobenzene
  - Dibutyl phthalate
  - Dibutyl phthalate
  - Ethyl benzene

**Painting:**

Water supply pipes in exposed, in shafts shall be painted with two or more coats of ready mix Low-VOC oil paint to give an even shade before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner’s site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

Water supply pipes below ground and covered in cement concrete shall not be painted.

13. **CONNECTIONS TO VARIOUS MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES**

All inlets, outlets, valves, piping and other incidental work connected with installation of mechanical equipment supplied by other agencies all be carried out by the contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturers instructions and the directions of the Owner’s site representative / Architect. The equipments to be supplied by the other agencies consist mainly for Kitchen, Back-of-the-House area and other similar areas. The work of connections to the various equipments shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of the Owner’s site representative / Architect. The various aspects of connection work shall be executed in a similar way to the work of respective trade mentioned elsewhere in these specifications.
14. CONNECTIONS TO RCC WATER TANKS

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from MS/GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of an approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

The floor and the walls of the tank shall be tiled with glazed tiles up to the overflow level. Alternatively, food grade epoxy to be applied.

Tiling of Walls

The floor and the walls of the tanks shall be tiled with glazed tiles up to the overflow level. Alternatively, food grade epoxy to be applied to the floor and the walls of the tanks.

15. MEASUREMENTS

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include pipe and fittings such as coupling, bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions.

Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

All pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions. Deduction for valves shall be made rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chase and making good all item mentioned in Bill of Quantities.

16. LAWN HYDRANTS

Lawn hydrants shall be of 25mm size unless otherwise indicated. All hydrants shall be provided with gate valves and threaded nipple to receive hose pipes. Lawn hydrant valves shall be of approved make and design. Where called for lawn hydrants shall be located in masonry chambers of appropriate size.

17. PIPE PROTECTION (FOR COLD WATER PIPES BURIED IN TRENCHES / GROUND / EARTH)

All buried pipes shall be cleaned with zinc chromate primer and bitumen paint, wrapped with three layers of fiber glass tissue, each layer laid in bitumen and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. The pipes where laid under floor shall be encased with 100 mm thick jamuna sand all around in addition to protective coating as described above. Alternatively, pyrocoat / coatek insulation for protection of pipe would also be acceptable as per final approval of project engineer / consultant.

18. THRUST BLOCKS

In case of bigger pipes (80 mm dia and above), thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by the Owner’s site representative.

19. MASONRY CHAMBER

i. All masonry chambers for stop cocks, sluice valves and meter etc. shall be built as per supplied drawings.

ii. The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by
iii. Concrete shall be of cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size.

iv. Brick shall be of class designation 75 in cement mortar 1:5 (1 cement : 5 fine sand)

v. Inside Plastering not less than 12 mm thick shall be done in cement mortar 1:3 (1 cement : 3 fine sand) finished with a floating coat of neat cement.

20. SHIFTING OF EXCAVATED SURPLUS MATERIAL

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Owner’s site representative at free of cost within time limit.

04. INTERNAL DRAINAGE (SOIL, WASTE, VENT & RAIN WATER PIPES)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the schedule of quantities.

2. BASIC PIPING SYSTEM

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of heavy class GI.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner’s site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with molten lead as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under ‘painting’. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 50mm clear of wall. Waste pipes and fittings shall be of cast iron or galvanised mild steel pipes. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that atleast one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron or galvanised mild steel pipes, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron or galvanised mild steel pipes as specified. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipes.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using

SIGNATURE & SEAL OF TENDERER
Pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4m upto it connection to the main drain or manhole shall be provided with a 80 / 100 mm vent pipe.

3. PIPING MATERIALS

3.1 Cast Iron Pipes

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS:3989 / IS:1729 as called for. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base.

The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively a test certificate from manufacturers be obtained before dispatch of material to site.

Cast Iron Specialities

If required, Cast iron speciality items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

Lead Caulked joints with pig lead:

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

<table>
<thead>
<tr>
<th>Nominal size of Pipe (mm)</th>
<th>Lead per Joint (Kg)</th>
<th>Depth of Lead Joint (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.77</td>
<td>25</td>
</tr>
<tr>
<td>80</td>
<td>0.88</td>
<td>25</td>
</tr>
<tr>
<td>100</td>
<td>0.99</td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>1.5</td>
<td>38</td>
</tr>
</tbody>
</table>

Drip Seal Joints:

Drip seal (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition.
Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

3.2 Galvanised Iron Pipes

Waste pipes of 50mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of IS:1239 of heavy grade. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws, laminations and other defects. All screw thread shall be clean and well cut. All pipes and fittings shall bear manufacturer's trade mark and conform to the IS as specified.

3.3 UPVC Pipes and Fittings

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to IS:4965-1981 or IS:13592. The pipes shall be of Class-III; 6 Kg/sqm pressure rating or type B.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to IS:14735.

Laying and Jointing

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and ‘O’ rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the Owner’s site representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Owner’s site representative.

Supports

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

Repairs

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

HDPE PIPES AND FITTINGS

Materials
All pipes and fittings to be HDPE manufactured to DIN 19535, DIN 19537, DIN 8074, DIN 8075 fittings to carry a BBA certificate No. 92/2796.

All materials should be manufactured under a BS 5750 / ISO 9000 approved scheme.

All component parts of the system shall be covered by a manufacturer’s warranty.

Installation

All pipes and fittings to be fusion welded by either electro sleeve coupling or butt weld.

Fixed points must be provided at a maximum of 5 metre intervals and / or changes in direction.

Intermediate sliding supports must be provided in accordance with the manufacturer recommendations/ application technique manual

All operatives to be trained in welding and jointing techniques by the manufacturer.

Inspection & testing

The work shall be inspected and tested during installation at agreed stages. All work which will be concealed shall be tested before it is finally enclosed.

Work to be inspected regularly by the manufacturer who is to verify compliance with manufacturer’s installation guidelines

3.4 Cast Iron Class (LA) pipes

All drainage passing under building floor and passing through retaining wall shall be cast iron class (LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS:1536-1976

Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to IS:1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with drip seal / lead joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the drip seal. Lead to be poured in.

Laying

i. Fittings used for CI drainage pipe shall conform to IS:1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee.

Drip Seal Joints :

Drip seal (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition.

Application Procedure:
Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (*) The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

ii. **Lead Caulked joints with pig lead:**

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

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<tbody>
<tr>
<td>80</td>
<td>1.8</td>
<td>45</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
<td>45</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
<td>45</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
<td>50</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
<td>50</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
<td>50</td>
</tr>
</tbody>
</table>

iii. The spigot of pipe of fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tared gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten Lead shall then be poured to the remainder of the socket.

iv. For lead wool joints the socket shall be caulked with tared gasket, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home skin by skin with suitable tools and hammers of not less than 2 Kg weight until joint is filled.

### 4. PIPES HANGERS, SUPPORTS, CLAMPS ETC.

All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.
Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g., trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

5. INSTALLATION OF SOIL, WASTE & VENT PIPES

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be GI pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling, shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

All cast iron pipes and fittings shall be jointed with drip seal / Best Quality pig lead free from impurities confirming to IS 27.

Before jointing, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The depth of the lead joints for the cast iron pipes shall be 45mm for the pipes upto 100mm dia and 50mm for the pipes beyond 100mm dia respectively.

The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

All open terraces shall be drained by rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. AHU’s pump rooms, waste water sumps shall connected to sewers after traps and not in the storm water drainage systems.
Balcony / Planter drainage
Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

6. TRAPS

6.1 Floor Traps
Floor traps where specified shall be siphon type full before P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

6.2 Floor Trap Inlet /Hopper
Bath room traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fabricated from GI pipe, with one, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be drip seal/Lead Caulked. Inlet shall be connected to a CI “P” trap. Floor trap inlet and the traps shall be set in cement concrete blocks where buried in floors without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Owner’s site representative. All fabricated hopper shall be hot dip galvanized.

6.3 Floor Trap Grating
Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner’s site representative.

6.4 Cleanout Plugs

Floor Clean Out Plug
Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, “Y” and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be drip seal joined/Lead Caulked to the drain pipes.

Cleanout on Drainage Pipes
Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner’s site representative. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.
Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

7. PIPE SLEEVES
Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

8. PIPE PROTECTION
Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be
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Proposed Interior for KRIOS/TALOS TEM Lab at IITB, Powai

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Encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate of 12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

9. Cutting and Making Good

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally they shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

10. Painting

Used paint and coatings that comply with the following limits for VOC content and the following chemical restrictions:

- Non-Flat Paints and Coatings: VOC not more than 150 g/L.
- Anti-Corrosive Coatings: VOC not more than 250 g/L.
- Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
- Paints and coatings shall not contain any of the following:
  - Acrolein
  - Acrylonitrile
  - Antimony
  - Benzene
  - Butyl benzyl phthalate
  - Cadmium
  - Di (2-ethylhexyl) phthalate
  - Di-n-butyl phthalate
  - Di-n-octyl phthalate
  - 1,2-dichlorobenzene
  - Diethy phthalate
  - Dimenthyl phthalate
  - Ethyl benzene

Soil, waste, vent and rain water pipes in exposed location, in shafts shall be painted with two or more coats of ready mix Low – VOC oil paint to give an even shade. Before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner’s site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

11. Testing

Testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the
installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests, All materials obtained and used on site must have manufacturer’s hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. rectify and replace where required.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase in plastered or the pipe encased or buried.

12. PIPING MATERIAL

12.1 RCC pipes

All pipes shall be centrifugally spun RCC pipes NP2. Pipes shall be true and straight with uniform bore throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS:458-1971.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Laying

RCC spun pipes shall be laid on cement concrete bed of cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.

Jointing

Semi flexible type collar joint.

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but not to be soft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cement mortar added until the space of the collar has been filled completely with tightly caulked mortar.
Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

**Curing:**

The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

**Cement Concrete for Pipe Supports:**

a. Unless otherwise directed by the Project Manager cement concrete for bed, all round or in haunches shall be as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Upto 1.5 m Depth</th>
<th>Upto 3 m Depth</th>
<th>Beyond 3 m Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoneware pipes buried in open ground (no sub soil water)</td>
<td>All round (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
</tr>
<tr>
<td>RCC or SW in sub soil water</td>
<td>All round (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
</tr>
<tr>
<td>PVC / HDPE pipe</td>
<td>All round (1:2:4)</td>
<td>In Haunches (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
</tr>
<tr>
<td>CI Pipes (in all conditions)</td>
<td>All round (1:4:8)</td>
<td>In Haunches (1:4:8)</td>
<td>In Haunches (1:4:8)</td>
</tr>
<tr>
<td>All pipes under building</td>
<td>All round (1:2:4)</td>
<td>All round (1:2:4)</td>
<td>All round (1:2:4)</td>
</tr>
</tbody>
</table>

b. Pipes may be supported on brick masonry or precast RCC or in situ cradles. Cradles shall be as shown on the drawings.

c. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

**Measurement:**

a. **Excavation**

Measurement for excavation of pipes trenches shall be made per linear meter.

b. **Trenches**

Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. **RCC pipes**

Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.
12.2 UPVC Pipes and Fittings

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter.

**Fittings**

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

**Laying in Trenches**

UPVC pipes shall be laid on cement concrete bed of width 300mm over the outside diameter of pipe, and 100 mm thickness. Fine sand shall be carefully filled around the lower half of the pipes so as to buttress them to the sides of the trench.

The filling shall then be continued to 150mm over the top of the pipe using fine sand, watered and rammed on both sides of the pipes. The process of filling and ramming with fine hand picked material shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line.

12.3 Cast Iron Class (LA) Pipe:

All drainage line passing under building, floors and roads with heavy traffic shall be Cast Iron Class (LA) Pipe.

Cast Iron Class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses; provide that the specified mechanical properties are satisfied.

**Material**

Cast iron pipe shall be centrifugally spun cast iron pipes and conforming to IS:1536-1976.

**Fittings**

Fittings shall be used for Cast Iron Class (LA) Pipes shall conform to IS:1538-1976. Whenever possible junction from branch pipe shall be made by Wyes.

**Laying**

Fittings used for C.I drainage pipe shall conform to IS:1538-1976. Whenever possible junction from branches pipes shall be made by Wyes.

All cast iron pipes and fittings shall be jointed with best quality soft pig lead (conforming to IS 782-1966) which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra will be paid for lead wool joints. Depth of pig lead and weight for joints shall be as given in table below.

**Lead caulked Joints with Pig Lead**

The approximate depth and weights of Pig Lead for various diameters of C I pipes and specials shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Size of Pipe</th>
<th>Lead per joint Kg</th>
<th>Depth of Lead Joint mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.8</td>
<td>45</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
<td>45</td>
</tr>
</tbody>
</table>
The spigot of pipe of fittings shall be centred in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighting not less than 2 Kgs.

**Drip Seal Joints:**

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

**Application Procedure:**

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. *Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (*The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

**Measurement:**

a. **Excavation**

   Measurement for excavation of pipes trenches shall be made per linear meter.

b. **Trenches**

   Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities. Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. **C.I class (LA) pipes**

   Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

   Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

**12.4 Salt Glazed Stoneware Pipes**

Stoneware pipes shall be new and of First Class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall comply with IS:651 and have the manufacturers name marked on them.

**Laying of Salt Glazed Stoneware Pipes:**

 Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe
shall be examined carefully on arrival at site. Each pipe shall be lightly struck with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes shall be segregated, marked in a conspicuous manner and their use in the works prevented by expeditiously removing them from the work site.

The pipes shall be laid with sockets leading uphill and shall rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipes laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried to low it shall be made up with cement concrete 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate 20mm nominal size) at the Contractor's cost and charges

### Jointing of Salt Glazed Stoneware Pipes:

Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

The remainder of the socket shall be filled with stiff mix of cement mortar (1cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be of 45 degrees with the barrel of that pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

After the joint has been made any extraneous materials shall be removed from the inside of the joint with a suitable scarper of "badger". The newly made joints shall be protected until set, from the sun, drying winds, rain or dust. Sackling or other materials which can be kept damp shall be used. The joints shall be exposed and space left all around the pipes for inspection by the Project Manager. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

### S.W. Gully Trap

Gully trap shall be stoneware conforming to IS:651. These shall be sound and free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300mm the cover weighing not less than 4.5 kg and the frame not less than 2.7kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

### Fixing of S.W. Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Project Manager /Consultant / Architect. The gully traps shall be fixed on cement concrete foundation 65cm square and not less than 10cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of S.W. Pipes described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

CI cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

### Measurements

Gully traps shall be measured by the number and rate which shall include all excavation, foundation, concrete, brick...
13. CONSTRUCTION OF MANHOLE

Where manholes are to be constructed, the excavation, filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and Bill of Quantities.

The manhole shall be built on a base concrete 1:3:6 of 150mm thickness for manholes upto 1500mm depth and 250mm thickness for manholes from 1500 to 2500mm depth and 300mm thickness manholes of depth greater than 2500mm. Reinforcement as shown shall be provided in the base slabs.

The walls shall be of brick work of thickness as shown in drawings built in cement mortar 1:5. The joints of brick work shall be raked and plastered internally in cement mortar 1:3 (at least 12 mm thick) and finish with a coat of neat cement, external plaster shall be rough plaster in 1:3, PCC benching & semi circular channels of the same diameter as the pipes shall be provided and finished with neat cement coating.

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided with polypropylene coated steel reinforced foot rest. The polypropylene shall confirm to ASTM D-4101 specification, injection moulded around 12 mm dia IS-1786 grade FE-415 steel reinforcing bar. These rungs shall be set at 30cms interval in two vertical runs at 380mm apart horizontally. The top rung shall be 450mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS:4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75mm radius with cement plaster 20mm thick. The benching at the side shall be carried out in such a manner so as to provide no lodgment for any splashing in case of accidental flooding. Manhole cover with frame shall be of cast iron of an approved make. The covers and frame shall generally be double seal as specified in the Bill of Quantities.

13.1 Measurements

Manhole shall be measured in numbers as indicated in the Bill of Quantity. The depth of manhole shall be measured from invert of channel to the top of manhole cover.

Manhole with depth greater than specified under the main item shall be paid for under ‘Extra Depth’ and shall include all items as given for manholes depth will be measured to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel. The following are inclusive in the cost of manhole viz;

i. Bed concrete
ii. Brick work.
iii. Plastering (inside & outside)
iv. R C C top slab, benching and channeling including drop connections.
v. Supply and fix foot rests.
vi. Keeping holes and embedding pipes for all the connections.
vii. Excavation, refilling, necessary de-watering and disposing off surplus soil to a places as directed by Project Manager.
viii. Curing.
ix Cost of angle frame and embedding the frame in concrete bed.
x Testing.
xi De-watering of chambers.
13.2. Drop Connection

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when
the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main
sewer in rectangular shall be made inside the manholes and shall have CI special types door bend on to top and heel rest
bend at bottom connected by a CI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with
atleast one clamp for each drop connection. All joints shall be lead caulked joints 25mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with CI / CI class LA pipe,
connection, vertical pipe and bend at the bottoms. The top of the tee shall be finished upto the surface level and provided
with a CI hinges type frame and cover 30cms x 30cms. The connection and tee upto the surface chamber of the tee.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

13.3 Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls benching and restoring them to
the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection.
Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

14. GREASE TRAP

14.1 Size of Grease Trap

The size given in Bill of Quantities and drawings shall be internal size of chamber. The work shall be done strictly as per
standard drawing and following specifications.

14.2 Bed Concrete

Shall be in 1:4:8 cement concrete 150 mm thick.

14.3 Brick work

Brick work shall be with best quality bricks in I:5 CEMENT MORTAR.
Baffle walls shall be of R.C.C and of size as mentioned in Bill of Quantities. Brick partition constructed of best quality
table moulded bricks in cement mortar 1:5 shall be provided for the entire height of chamber.

14.4 Plaster

The walls of chamber shall be plastered from inside with 12 mm thick cement plaster 1:3 and finished smooth with a
floating coat of neat cement & rough plaster on outside in cement mortar 1:3.

14.5 Chamber Covers

Covers shall be of size and duty as mentioned in Bill of Quantities. Covers shall be of cast iron as per the details given in
the drawing and shall be fixed on frame embedded in concrete.
C. I steps shall be provided at two corners of the chamber.
All Cast Iron and MS items shall be painted with two coats of bitumastic paint.

14.6 Cast iron Manhole cover and Frame

The Cast Iron Manhole Cover and Frame shall conform to IS:1726 and the grade and types have been specified in the
Bill of Quantities. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold
shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage,
gas inclusion or other causes. Covers shall have a raised checkered design on the top surface to provide an adequate
non-slip grip.
The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

15. TESTING

All rights of the sewer and drain shall be carefully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of water. The test pressure will however, not exceed 6 meters head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

Sewer lines shall be tested for straightness by :

i. Inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball shall roll down the invert of the pipe and emerge at the lower end.

ii. means of a mirror at one end a lamp at the other end. If the pipe is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.

iii. The contractor shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the Owner’s site representative.

iv. A test register shall be maintained which shall be signed and dated by contractor and Owner’s site representative.

05. FIRE PROTECTION SYSTEM

1. SCOPE

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of the fire protection system. The philosophy of the system is as follows :

a. The Fire Suppression System shall comprise the Fire Hydrants System & Hand Appliances.

b. Water from the underground 1 nos RCC Fire Water Storage Tank of 50cum capacity, shall be supplied for the uses listed below.

i. Fire Hydrant System (Pressurised) both for the external hydrants, the internal landing valves and the hose reels at landings.

ii. The Hydrant System under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pump.

iii. The Hydrant System shall be provided with two pump sets, one of which will be diesel engine driven and the other electric motor driven.

iv. The piping and valve connections shall be done so that the water from the discharge of the Hydrant Pump sets is able to supply water.

v. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.

vi. The electric motor driven Hydrant Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the Hydrant Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven Hydrant Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Hydrant Pump starts at the preset pressure.

vii. The Hydrant Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.

viii. Contractor shall ensure Hydro Testing for the complete system.
j. The Contractor shall obtain the necessary approval of the drawings and the schemes from the local authority / TAC as called for. The contractor shall also take care of any other requirement so that insurance cover can be obtained, if required at minimum premium at a later date.

k. The contractor shall design and after approval of Project Manager display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO’s and DON’T’s for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, colour scheme etc shall be as directed by the Project Manager.

2. PIPE WORK

2.1 GENERAL REQUIREMENTS

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work. All pipe work shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

2.2 PIPING

Pipes of following types are to be used:

Mild steel black pipes as per IS:1239 heavy grade(for pipes of sizes 150 mm N.B. and below) suitably lagged on the outside to prevent soil corrosion. M.S. pipes buried below ground shall also be suitably be lagged with 4mm thick protection coating over 2 coats of primer.

Steel pipelines upto 150 mm dia shall be as per IS: 1239, Part-II (heavy grade) while pipelines above 150 mm dia shall be as per I.S.:3589.

All pipe clamps and supports shall be fabricated from MS steel sections and shall be factory galvanised before use at site. Welding of galvanized clamps and supports shall not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

Hangers and supports shall be thoroughly galvanised after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultants.

The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut-off pressure, whichever is highest including testing for water hammer effects for a period of 4 hr. minimum.

Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of
pipelines of strategic points to facilitate erection and subsequent maintenance work.

For pipes underground installation the pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry or concrete supports at least 300 mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement : 4 coarse sand : 8 stone aggregate) of size 380x380x75 thick resting on firm soil.

Mains below ground level shall be supported at regular intervals not exceeding 3.0 metres and shall be laid at least 2.0 metre away from the building.

2.3 PIPING INSTALLATION & SUPPORT

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

<table>
<thead>
<tr>
<th>Pipe Dia (mm)</th>
<th>Hanger Rod Dia (mm)</th>
<th>Spacing between Supports (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>32 to 50</td>
<td>8</td>
<td>2.5</td>
</tr>
<tr>
<td>65 to 80</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>80 to 100</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>125 to 150</td>
<td>10</td>
<td>3.0</td>
</tr>
<tr>
<td>200 to 300</td>
<td>12</td>
<td>3.5</td>
</tr>
</tbody>
</table>

The end of the steel rods shall be threaded and not welded to the threaded bolt.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves. Automatic air valves shall be provided on hot water risers.

Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

2.4 PIPE FITTINGS

Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc and all such connecting devices that are needed to complete the piping work in its totality.

Ductile Iron / Cast Iron / Forged steel screwed type fitting shall be used for pipes of 50 mm dia & below.

Fabricated fittings shall not be permitted for pipes diameters 50mm and below.

Fabricated fittings used on pipe size 65 mm & above shall be fabricated , welded in workshops. They shall be inspected by Project Manager before dispatch from the workshop. For “T” connection, pipes shall be drilled and reamed. Cutting by gas or electrical welding shall not be permitted.

2.5 PROCEDURE FOR PYPKOTE / COATEK APPLICATION

A) Surface Preparation - The pipe surface shall be cleaned by a wire brush.

B) Application of Primer - Primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.

C) Application of 4 mm bitumastic Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 15.0 mm.

D) Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.

E) A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

2.6 JOINTING

2.6.1 Welded Joints :

Joints between MS pipes and fittings shall be butt joint made with the pipes and fittings having “V” groove and welded with electrical resistance welding in an approved manner. But welding without “V” groove shall not be permitted.

2.6.2 Grooved Joints

2.6.2.1 Remove all loose dirt scale & grease from the pipe surface.
2.6.2.2 Wrap the tape around the pipe, make sure the take is not twist & make the groove by machine as per the requirement of coupling manufacturer.

2.6.2.3 Joints between the pipes and grooved fitting shall be made with the pipe by making square groove by grooving machine with out reducing the thickness of pipe wall and fixed with the help of grooved coupling, nut, bolts & gasket etc.

2.6.3 Grooved Mechanical Couplings for Joining Carbon Steel Pipe

2.6.3.1 Grooved Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard.

a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.

b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Couplings shall be placed in close proximity to the vibration source.

2.6.3.2 Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 125 / 150 flanges.

2.6.3.3 Grooved couplings shall meet the requirements of ASTM F-1476.

2.6.3.4 Gasket: Synthetic rubber, wide width, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

Grooved End Fittings

Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, with grooved ends for direct connection into grooved piping systems with steel forged steel conforming to ASTM A-234, Grade WPB 0.375” wall (9.53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153 with fire lock arrangement. Zinc electroplated fittings and couplings conform to ASTM B633.

2.6.4.1 Grooved Hole-Cut Branch Outlets:

a. Bolted Branch Outlet: Branch reductions on 21/2”(DN65) through 6”(DN150) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with fire lock type synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.

b. Strapless Outlet: 1/2”(DN15) or 3/4”(DN20) NPT outlet on 4” (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

c. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4”-18 NEF 2B extra fine thread and 6” (152mm) nominal bulb length on 4” (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

Lubricant for fixing the Gasket on pipe should be oil free by manufacture and capable to give the ceresthetic as required.

2.6.4 Flanged joints (65 mm dia and above)

Flanged joints with flanges conforming to IS: 6392 shall be provided on

a. Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the
2.6.5 Unions ( upto 50 mm dia)  
Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smaller dia, in locations similar to those specified for flanges.

3. AIR VESSEL  
The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure surges, whenever the pumping sets come into operation. Air vessel shall be made up of heavy steel plate 8 mm thick, suitable for normal operation, to handle an excess pressure of 1.5 times the maximum pressure. It shall be provided with a 100mm dia flanged connection from pump, a 25mm drain with valve, one water level gauge and 25mm sockets for pressure switches. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

4. AIR CUSHION TANK  
Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, a 20mm dia drain pipe, drain valve and shut off valve.

5. FIRE BRIGADE CONNECTION  
The storage tank shall be provided with a 150mm fire brigade connection to discharge at least 2275 litres / minute into it. This connection shall not be taken directly into the side of the storage tank, but arranged to discharge not less than 150mm above the top edge of the tank such that the water flow can be seen. The connection shall be fitted with stop valve in a position approved by the Project Manager. An overflow connection discharging to a drain point shall be provided from the storage tank. The fire brigade connection shall be fitted with four numbers of 63mm instantaneous inlets in a glass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with “FIRE BRIGADE INLET” painted on the inner face of the glass in 50mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets to a hydrant with a sluice valve. Location of these valve shall be as per the approval of the Project Manager.

6. SYSTEM DRAINAGE  
The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

7. VALVE CHAMBERS  
Provision of suitable brick masonry chambers in cement mortar 1:5 (1 cement : 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement:5 fine sand : 10 graded stone aggregate 20 mm nominal size ) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.
8. VALVES

8.1 SLUICE VALVES
Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of the particular duty and design called for. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS : 780-1969 and IS : 2906.

8.2 BUTTERFLY VALVE
The butterfly valve shall be suitable for waterworks and rated for 300 P.S.I. The body shall be of cast iron to IS:210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti-corrosive epoxy or nickel coating. The valve seat shall be replaceable of high grade elastomer EPDM or nitrile rubber with hard backing. The valve is closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

8.3 BALL VALVE
The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon. The handle shall be provided with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

8.4 GUN METAL VALVES
Gun metal Valves shall be used for smaller dia pipes, and for threaded connections. The Valves shall bear certification as per IS:778.

The body and bonnet shall be of gun metal to IS:318. The stem gland and gland nut shall be of forged brass to IS:6912. The hand wheel shall be of cast iron to IS:210.

The Hand wheel shall be of high quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall be non rising type.

8.5 FLAP TYPE - NON-RETURN VALVE
Non-Return valves shall be cast iron double flanged with cast iron body and gun metal/ S.S. internal parts conforming to IS:5312.

8.6 PRESSURE RELIEF VALVE
Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be constructed of bronze and provided with an open discharge orifice for releasing the water. The Valve shall be open lift type.
9. PRESSURE SWITCH

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:55 water and environment protection.

10. PRESSURE GAUGE

Pressure gauge shall be provided near all individual connections of the hydrant system with isolation valves. Pressure gauge shall be 50 mm dia gunmetal bourdon type with gunmetal isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability.

11. PAINTING

All Hydrant pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as “TO RISER NO.1” etc.

Painting shall be expertly applied, the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

12. EXCAVATION

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried with a minimum cover of 1 meter or as shown on drawings.

Wherever required Contractor shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.

On completion of testing in the presence of the Project Manager and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.

Contractor shall dispose off all surplus earth as directed by the Project Manager.

3. ANCHOR / THRUST BLOCK

Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to work hammer and high pressure

Thrust blocks shall be provided at all bends, tees and such other location as determined by the Project Manager.

Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Project Manager prior to execution of work.

14. FIRE HYDRANTS

14.1 EXTERNAL HYDRANTS

a. Contractor shall provide external hydrants. The hydrants shall be controlled by a cast iron sluice valve. Hydrants shall have instantaneous type 63mm dia outlets. The hydrants shall be double outlet conforming to IS:908 with CI duck foot bend and flanged riser or required height to bring the hydrant to correct level above ground.

b. Contractor shall provide for each external fire hydrant two numbers of 63mm dia. 15 m long controlled percolation hose pipe with gunmetal male and female instantaneous type couplings machine wound with GI wire (hose to IS:636 type certification), gunmetal branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

c. Each external hydrant hose cabinet shall be provided with a drain in the bottom plate.
d. Each external hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman’s Axe. This shall be measured and paid for separately.

e. Each hose cabinet shall be conspicuously painted with the letters “FIRE HOSE”.

14.2 Internal Hydrants

a. Contractor shall provide on each landing and other locations as shown on the drawings double headed gunmetal landing valve with 100 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b. Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

c. Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine would with GI wire (hose to IS:636 type 2 and couplings to IS:903 with IS certification), fire hose reel, gunmetal branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

d. Contractor shall provide standard fire hose reels of 20mm dia high pressure dunlop rubber hose 36 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets. Hose reel shall be connected directly to the wet riser with an isolating valve. Hose reel shall conform to IS:884 and shall be mounted vertically. This shall be measured and paid for separately.

e. Each internal hydrant hose cabinet shall be provided with a drain in the bottom plate. The drain point shall be lead away to the nearest general drain.

f. Each internal hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman’s Axe. The cabinet shall be recessed in the wall as directed. This shall be measured and paid for separately.

g. Each hose cabinet shall be conspicuously painted with the letters “FIRE HOSE”.

14.3 Hose Reel

Hose reel shall conform to IS : 884, heavy duty, 20 mm dia length shall be 36 metre long fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing upto 170 degree with wall brackets of cast iron finished with red and black enamel complete.

14.4 Fire Hose

All hose pipes shall be of 63 mm diameter RRL/CP as required, conforming to IS : 636 or IS : 8423. The hose shall be provided with copper alloy delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

14.5 Branch Pipe, Nozzle

Branch pipes shall be of gun metal with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

14.6 Hose Cabinet

Hose cabinet shall be provided for all internal and external fire hydrants. Hose cabinets shall be fabricated from 16 gauge MS/SS (as per SOQ) powder coated sheet of fully welded construction with hinged double front door partially glazed (3 mm glass panel) with locking arrangement, stove enamelled fire red paint (shade No. 536 of IS:5) with “FIRE HOSE” written on it prominently (size as given in the schedule of quantities). Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

14.7 Internal Hose Cabinet
Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick MS/SS (as per SOQ) sheet and spray painted to shade No. 536 of IS:5. The hose cabinet shall be of size to accommodate the following:

i. Landing Valves (Single/double headed)
ii. Hose pipe (2 or 4 length of 15M)
iii. Hose reel (36.5 mtr.)
iv. Branch pipes, nozzles (1/2 sets)
v. Fire man's axe and hand appliances

### 14.8 External Hose Cabinet

The hose cabinet shall be of size to accommodate the following:

i. Single/Double headed yard hydrant valve
ii. Hose pipe (2 length of 15 m)
iii. Branch pipes, nozzles (1/2 sets)
iv. Fire man's axe

### 15. HAND HELD FIRE EXTINGUISHERS

#### 15.1 HAND APPLIANCES

15.1.1 Scope

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification of various authorities.

Without restricting to the generality of the foregoing, the work shall consists of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

#### 15.2 GENERAL REQUIREMENTS

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

Distribution / installation of fire extinguisher to be in accordance to IS:2190.

#### 15.3 MEASUREMENT

Fire extinguishers shall be counted in numbers and include installation of all necessary items required as given in the specifications.

#### 15.4. ABC TYPE DRY POWDER EXTINGUISHER

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, Part II, shall be 5 Kg +/-2% or 10 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS 2190 – 1992.
It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with Dry Nitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm².

Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall also be mild steel and welded to the body. The discharge valve body, shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzle shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtrs, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity, it shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm² for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

15.5 WATER TYPE EXTINGUISHER (Gas Pressure Type)

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.

The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%

The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.

The cap shall be of leaded tin bronze, and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm². It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS 940).

15.6 CARBON DIOXIDE EXTINGUISHER

The Carbon Dioxide Extinguisher shall be as per IS: 2878

The body shall be constructed of seamless tube conforming to IS:7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanism shall be through a control valve conforming to IS:3224. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm² and shall be
approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness.

The gas shall be conforming to IS:307 and shall be stored at about 85 Kg/cm². The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs.

The extinguisher shall fulfill the following test pressures:

- Cylinder: 236 Kg/cm²
- Control Valve: 125 Kg/cm²
- Burst Pressure of Hose: 140 Kg/cm² minimum

It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

The Extinguisher including components shall be IS marked.

16. FIRE PUMPS AND ALLIED EQUIPMENTS

16.1 SCOPE

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by drawings and specified hereinafter or given in the schedule of rates.

- a. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.
- b. Automatic starting system with all accessories, wiring and connections and pressure switches.
- c. Motor control centre.
- d. Annunciation system with all accessories wiring and connections.
- e. Pressure gauges with isolation valves and piping, bleed and block valves.
- f. Suction strainers and accessories.
- g. Vibration eliminator pads and foundation bolts.
- h. Leak-off drain shall be led to the nearest floor drain.

16.2 GENERAL REQUIREMENTS

Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

Pumps and motors shall be truly aligned by suitably instruments. Record of such alignment shall be furnished to the Project Manager.

All pump connections shall be standard flanged type with number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps.

Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

Contractor shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The contractor shall provide facilities to the Project Manager & Consultant for inspection of equipment during manufacturing and also to witness various tests at the manufacturer’s works without any cost to the Project Manager or Consultant.
Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

The contractor shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a separate submittal / annexure.

16.3. ELECTRIC FIRE PUMP

General

The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phase, 50 Hz. A.C. system. Both the motor and the pump shall be assembled on a common base plate, fabricated M.S. channel type or cast iron type. The fire pump efficiency shall be in acceptable range of 65 – 70%

Drive

The pump shall be directly driven by means of a flexible coupling. Coupling guard shall also be provided.

1.4. FIRE PUMP

The fire pump shall be horizontally mounted single/ multistage, single/ multioutlet centrifugal type. It shall have a capacity to deliver _______ lpm as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made.

Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water. The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

Provision of Jockey Pump for low and high zone shall be made. The pump shall be vertical SS type and of detail as in schedule of quantity. Contractor shall verify that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

Motor

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 1500/ 2900 RPM as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

Motor Starter

The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system.

16.5. DIESEL FIRE PUMP

General

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on
a common base plate.

**Drive**

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified.

**Fire Pump**

The fire pump shall be horizontally mounted centrifugal single/multi stage, single/multi outlet. It shall have a capacity to deliver as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be single/multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

**Diesel Engine**

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, aircooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

a. **Engine Accessories** - The engine shall be complete with the following accessories:

   - Fly wheel dynamically balanced
   - Direct coupling for pump and coupling guard
   - Corrosion Resistor
   - Air cleaner
   - Fuel service tank support, and fuel oil filter with necessary pipe work
   - Elect. starting battery (2X24 v)
   - Exhaust silencer with necessary pipe work
   - Governor
   - Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting)
   - Necessary safety controls

b. **Fuel System** - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket.
fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 4 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.

c. **Lubricating Oil System**- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

d. **Starting System**- The starting system shall comprise necessary batteries (2x24v). 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

e. **Exhaust System** - The exhaust system shall be complete with silencer suitable for outdoor installation and silencer piping including bends and accessories needed for a run of 15 metre from the engine manifold. (Adjustment rates for extra lengths shall also be given). The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

f. **Engine shut down mechanism**- This shall be auto/ manually operated and shall return automatically to the starting position after use.

g. **Governing System**- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

h. **Engine Instrumentation**- Engine instrumentation shall include the following:-

i) Lub. oil pressure gauge.

ii) Lub. oil temperature gauge.

iii) Water pressure gauge.

iv) Water temperature gauge.

v) Tachometer.

vi) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

**Engine Protection Devices**- Following engine protection and automatic shut down facilities shall be provided:-

i) Low lub.oil pressure.

ii) High cooling water temp.

iii) High lub.oil temperature.
iv) Over speed shut down.

i. **Pipe Work** - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

j. **Anti Vibration Mounting** - Suitable vibration mounting duly approved by Project Manager shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

k. **Battery Charger** - Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

16.6. **PUMP SETS ASSEMBLY**

On the main fire hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rota meter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

16.7. **FLEXIBLE CONNECTORS**

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1.5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

16.8. **INTERLOCKING**

The following inter-locking between the two main fire pumps (i.e. wet riser pump the jockey pump and the diesel engine driven pump.

Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser can come up at a time) or diesel driven pump.

<table>
<thead>
<tr>
<th>JOCKEY PUMP</th>
<th>WET RISER PUMP</th>
<th>DIESEL DRIVEN PUMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>ii. OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>iii. OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>iv. OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
</tbody>
</table>

16.9. **ANNUNCIATION PANEL**

One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate:

a. Flow condition in any flow switch indicating the area of distress and fire alarm.

b. Starting and stopping of each hydrant pump.

c. Starting and stopping of each jockey pump.

d. Failure of Hydrant pump to start.

e. High level in fire water storage tank compartment.
f. Low level in fire water storage tank compartment.
g. Low level in HSD day tank of the fire pump.

The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender.

The annunciation panel shall be located in the security office / reception on the ground floor or as instructed by the Project Manager.

16.10. VIBRATION ISOLATION

The pumpset shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100 mm thick concrete plinths. The spring mountings shall have a maximum deflection of 15 mm. Reference shall be made to the section on “Nose and Vibration” for further technical requirements.

SECTION-6 :: ELECTRICAL INSTALLATION

1. SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

2. GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply system.

3. CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) electrical panels shall be sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be 3b construction. The control panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors with Neoprene gasket. Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to relevant BIS Codes.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of control panel and the lowest unit.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.
4. **WIRING SYSTEM**

All L T power cabling between MCC and motors shall be carried out with 1100 volts grade PVC insulated, overall PVC sheathed aluminium conductor armoured cables. Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring shall be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit.

5. **CIRCUIT COMPARTMENT**

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the "ON" position. Safety interlocks shall be provided to prevent the breaker from being drawn-out when the breaker is in 'ON' position. The door shall not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6. **INSTRUMENT ACCOMMODATION**

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar 'ON' lamps shall be provided on all outgoing feeders.

7. **BUS BAR CONNECTIONS**

Bus bar and interconnections shall be of high conductivity electrolytic aluminium complying with requirement of grade E91E of IS:5082-1981 and shall be of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid aluminium strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.0 amps/mm² cross section area.

8. **TEMPERATURE - RISE LIMIT**

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per relevant IS Codes.

9. **CABLE COMPARTMENTS**

Cable compartment of adequate size shall be provided in the control panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables as per approved for construction shop drawing.

10. **MOULDED CASE CIRCUIT BREAKER (MCCB)**

All MCCBs shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's rated 200 Amps and above shall have adjustable Magnetic short circuit pick up. The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimise the let thru’ energies and capable of achieving discrimination up to full short circuit capacity of...
downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB’s shall be asked for in the schedule of quantities. The breaking capacities specified will be ICU=ICS i.e type-2. Co-ordination as per relevant IS and IEC Codes.

The MCCB’s shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of ‘ON’, ‘OFF’ or ‘Tripped’ thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

### 11. MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with relevant IS Codes and shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 Vac. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

### 12. PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per relevant BIS code.

### 13. LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

### 14. METERS

i. All voltmeters and indicating lamps shall be through MCB's.

ii. Meters and indicating instruments shall be plug type.

iii. All CT’s connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

### 15. CURRENT TRANSFORMERS

Current transformers shall be provided for Control panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

### 16. SELECTOR SWITCH

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.
17. STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant IS Codes. All Star Delta and ATS Starters shall be fully automatic.

18. CONTACTOR

Contactors shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils shall be of Class “E”.

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply.

19. THERMAL OVERLOAD RELAY

Thermal overload relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5°C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal overload relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

20. TIME DELAY RELAYS

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

21. INDICATING LAMP AND METERING

All meters and indicating lamps shall be in accordance with IS:1248 and IS-1258. The meters shall be flush mounted type. The indicating lamp shall be of low wattage. Each MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 MCB. Other indicating lamps shall be backed up with fuses as called for in Schedule of Quantities.

22. TOGGLE SWITCH

Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS Codes and shall be of 5 amps rating.

23. PUSH BUTTON STATIONS

Push button stations shall be provided for manual starting and stopping of motors / equipment. Green and Red colour push buttons shall be provided for ‘Starting’ and ‘Stopping’ operations. ‘Start’ or ‘Stop’ indicating flaps shall be
provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for ‘Stop’ push buttons. The push button contacts shall be suitable for 6 amps current capacity.

24. **CONDUITS**

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16 gauge upto 32 mm dia and 14 gauge above 32 mm dia conduit. Screwed G.I. Conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or G.I. Conduits are given below:

<table>
<thead>
<tr>
<th>Size of wires Nominal Cross section Area (Sq. mm.)</th>
<th>Maximum number of wires within conduit size(mm)</th>
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<tr>
<td></td>
<td>20</td>
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<tr>
<td>1.5</td>
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</table>

25. **CABLES**

M.V. Cables shall be PVC insulated aluminium conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

26. **CABLE LAYING**

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimise the loss in current carrying capacity.
Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

27. WIRE AND WIRE SIZES

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

For all single phase/3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring, cabling shall be of the following sizes:

i. Upto 5 HP motors/5 KW heaters 3 x 4 sq. mm copper conductor wires.
ii. From 6 HP to 10 HP motors 3 x 6 sq. mm copper conductor wires
6 KW to 7.5 KW heaters

iii. From 12.5 HP to 15 HP wires 2 Nos. 3 x 6 sq. mm copper conductor wires
iv. From 20 HP to 25 HP motors 2 Nos. 3 x 10 sq. mm copper conductor wires
v. From 30 HP to 35 HP motors 2 nos. 3 x 16 sq. mm aluminium conductor armoured cable.

vi. From 40 HP to 50 HP motors 2 Nos. 3 x 25 sq. mm aluminium conductor armoured cable.

vii. From 60 HP to 75 HP motors 1 No. 3 x 70 sq. mm aluminium conductor armoured cable.

viii. 100 HP motors conductor 1 No. 3 x 150 sq. mm aluminium armoured cable

ix. 200 HP motor conductor 2 No. 3 x 150 sq. mm aluminium armoured cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer’s recommendation.

<table>
<thead>
<tr>
<th>TYPE OF</th>
<th>CONTACOR OVERLOAD</th>
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</table>

SIGNATURE & SEAL OF TENDERER
STAIDER | CURRENT RELAY | CAPACITY RANGE

-----------------------------------------------------------------------------------------------------------------
5 HP Motors | D O L | 16 amps | 6-10 amps
7.5 HP motors | D O L | 16 amps | 9-15 amps
10 HP Motors | D O L | 25 amps | 9-15 amps
12.5 HP Motors Star Delta | 16 amps | 9-15 amps
15 HP Motors | Star Delta | 25 amps | 9-15 amps
20 HP Motors | Star Delta | 32 amps | 14-23 amps
25 HP Motors | Star Delta | 32 amps | 14-23 amps
200 HP Motors | DOL | 325 amps | CT Operated relay

Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

28. EARTHING

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips/wires. The main panel shall be connected to main earthing system of the power supply. All single phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires/tapes as follows:

i. Motor upto and including 10 HP rating.
   Motor 12.5 HP to 40 HP capacity
   Motor 50 to 75 HP capacity.
   Motor above 75 HP.

ii. 2 Nos. 3 mm dia copper wires.
    2 Nos. 4 mm dia copper wires
    2 Nos. 6 mm dia copper wires
    2 Nos. 25 mm x 3 mm copper tapes.

iii. 3 phase switches and control panels upto 60 amps rating.
     3 phase switches, and control panels 63 amps to 100 amps rating.
     3 phase switches and control panels 125 amps to 200 amps rating.
     3 phase switches, control panels, bus ducts, above 200 amps rating.

iv. 2 Nos. 3 mm dia copper wires.
    2 Nos. 4 mm dia copper wires
    2 Nos. 6 mm dia copper wires
    2 Nos. 3 mm x 25 mm copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires/tapes as follows:

i. 3 phase switches and control panels upto 60 amps rating.
     3 phase switches, and control panels 63 amps to 100 amps rating.
     3 phase switches and control panels 125 amps to 200 amps rating.
     3 phase switches, control panels, bus ducts, above 200 amps rating.

ii. 2 Nos. 3 mm dia copper wires.
    2 Nos. 4 mm dia copper wires
    2 Nos. 6 mm dia copper wires
    2 Nos. 3 mm x 25 mm copper tapes.
The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

29. DRAWINGS

Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of Architect/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete 'As-installed' drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

30. TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Project Manager. Testing of the panels shall be as per relevant BIS Codes:

31. PAINTING

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.

32. MEASUREMENT OF ELECTRICAL CONTROL PANELS

Panels shall be counted as number of units. Quoted rates shall include as lumpsum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for interlocking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate of panel shall also include all accessories, switchgear, contactors, indicating meters and lights as per the Specifications and Schedule of Quantities.

33. RUBBER MAT

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

SECTION-7 :: COMMISSIONING & GUARANTEE

1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters.
2. PRECOMMISSIONING

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:
   - Remove oil, grease and foreign residue from the pipe work and fittings;
   - Pre-condition the metal surfaces to resist reaction with water or air.
   - Establish an initial protective film;
   - After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
   - Details and procedures of the pre-treatment shall be submitted to the Architect for approval.

d. Check all clamps, supports and hangers provided for the pipes.

e. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

Fire Protection System

a. Check all hydrant valves by opening and closing : any valve found to be open shall be closed.

b. Check all the piping under hydro test.

c. Check that all suction and delivery connections are properly made for all pump sets.

d. Check rotation of each motor after decoupling and correct the same if required.

e. Test run each pump set.

f. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

Commissioning and Testing

a. Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then
b. Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

c. Open hydrant valve and allow the water to below into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts,

d. Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump,

e. When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.

f. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replace by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

g. Check all annunciations by simulating the alarm conditions at site.

3. STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect. The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

4. FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

5. REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any
6. WARRANTY AND HANDOVER
The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

7. HANDING OVER OF DOCUMENTS
All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. PIPE COLOUR CODE:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Pipe Lines</th>
<th>Ground / Base Colour</th>
<th>First Colour Band</th>
<th>Second Colour Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cooling Water</td>
<td>Sea Green</td>
<td>French Blue</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Boiler feed</td>
<td>Sea Green</td>
<td>Gulf Red</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Condensate</td>
<td>Sea Green</td>
<td>Light Brown</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Drinking Water (All cold water lines after filter)</td>
<td>Sea Green</td>
<td>French Blue</td>
<td>Single Red</td>
</tr>
<tr>
<td>5</td>
<td>Treated Water (Soft Water)</td>
<td>Sea Green</td>
<td>Light Orange</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Domestic Hot Water</td>
<td>Sea Green</td>
<td>Light Grey</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Compressed air up to 15/Kg/Sqcm</td>
<td>Sky Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Steam Medium pressure low pressure (Less than 1 Bar)</td>
<td>IS 2339</td>
<td>Conary Yellow</td>
<td>IS 2339</td>
</tr>
<tr>
<td>9</td>
<td>Drainage (Storm Water)</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Drainage (Sewage Water)</td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Gas</td>
<td>Canary Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Fire Pipe</td>
<td>Fire Red (Shade No 536 of IS-5)</td>
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<td></td>
</tr>
</tbody>
</table>

9. CHECK LIST FOR COMMISSIONING

Fire Protection System

1) Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.
2) Check all clamps, supports and hangers provided for the pipes.
3) All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).
4) Fire Hydrant System - Pressureise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then
Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts.

Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.

Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

Check air cushion tanks on the terrace for proper functioning.

Submersible Sump Pumps
1) Fill the sump with water, while observing the level.
2) Keep the pump starter switch on ‘OFF’ position to check for start of pump.
3) By keeping the starter switch on ‘Auto’ position, both the pumps should start. As the water level starts recession, one pump should switch off by itself. The second pump should switch off on further reduction in water level.
4) Fill the sump with a little water and check both the pumps in ‘Manual’ position momentarily.
5) Leave the switches in ‘Auto’ position for both the pumps.
PREAMBLE:

1) All materials shall conform to relevant technical specifications of Volume – 2 of the Tender document. The materials shall be further subjected to tests in the recognized laboratories at the sole discretion of the Engineer-in-Charge and shall be at contractor’s cost.

2) Materials bearing appropriate IS marking shall be given preference while selecting for the work.

3) In case of materials which are not widely available with IS marking in the market but conform to the technical specifications mentioned in the Tender Documents, the same shall be procured from any of the manufacturer listed below after prior written approval of the EIC.

4) Reinforcement steel shall be procured from any vendors who have the license for at least last 5 years for manufacture of BIS or Tor allies, subject to prior written approval of the EIC. Steel samples of all the lots procured shall be subject to testing through recognized laboratories and shall be at contractor’s cost.

5) Cement for work shall have relevant IS marking and every lot shall be subject to tests in the recognized laboratories and shall be at contractor’s cost.

6) EIC can approve any other brand subject to verification of the adherence to the relevant technical specifications.
### A. Civil, Interior Finish Work

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Approved Makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cement (Grey)</td>
<td>ACC/L&amp;T/J.K / Birla / Vasvdatta, Ambuja and other ISI marked make</td>
</tr>
<tr>
<td>2.</td>
<td>Cement (White)</td>
<td>Birla / J.K.</td>
</tr>
<tr>
<td>3.</td>
<td>T.M.T. Steel</td>
<td>SAIL/TATA/RINL/IISCO/ Vizag</td>
</tr>
<tr>
<td>4.</td>
<td>Structural steel</td>
<td>SAIL/TATA/RINL/IISCO/ Vizag</td>
</tr>
<tr>
<td>5.</td>
<td>Ready Mixed Concrete</td>
<td>ACC/L&amp;T/Ultratech/ Lafarge /RMC / Godrej</td>
</tr>
<tr>
<td>6.</td>
<td>Precast Concrete Products</td>
<td>Siporex Ind.; B.G. Shirke &amp; Co.; Supreme Concrete Minato Blocks</td>
</tr>
<tr>
<td>7.</td>
<td>Antitermite Treatment</td>
<td>Chemical and agency - Approved by IPCA.</td>
</tr>
<tr>
<td>8.</td>
<td>Stainless Steel</td>
<td>Jindal/SAIL/Golden</td>
</tr>
<tr>
<td>9.</td>
<td>Ceramic Tiles</td>
<td>Nitco / Kajaria / Euro</td>
</tr>
<tr>
<td>10.</td>
<td>Vitrified Tiles</td>
<td>R.A.K. / Kajaria / Euro</td>
</tr>
<tr>
<td>11.</td>
<td>Terrazzo &amp; Cement Tiles</td>
<td>NITCO; Automatic Tiles; NIMCO; GICO Tiles, Kolkata; National Tiles, Delhi;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alankar Tiles Pvt. Ltd., Indore; Super Tiles; Shirwadkar Tiles; Kirti Tiles, Pune</td>
</tr>
<tr>
<td>12.</td>
<td>Kotah Stone</td>
<td>As approved by Architect</td>
</tr>
<tr>
<td>13.</td>
<td>Telephone Black Granite</td>
<td>As approved by Architect</td>
</tr>
<tr>
<td>14.</td>
<td>ABD Paint</td>
<td>Asian Paints / Nerolac / ICI</td>
</tr>
<tr>
<td>15.</td>
<td>Texture Paint - External</td>
<td>Nitco</td>
</tr>
<tr>
<td>16.</td>
<td>Enamel Paint</td>
<td>Asian Paints / ICI</td>
</tr>
<tr>
<td>17.</td>
<td>Glass for Window</td>
<td>Saint Gobain / Modi / Ashi</td>
</tr>
<tr>
<td>18.</td>
<td>Aluminium Sections For Doors, Windows &amp; Wall Spans</td>
<td>Indal, Jindal, Hindalco; Geeta; Bengal Rolling Shutters-Kolkata</td>
</tr>
<tr>
<td>19.</td>
<td>Anodized aluminum fittings for doors/windows</td>
<td>Crown/ALANS/Classic/Bharat/ Argent</td>
</tr>
<tr>
<td>20.</td>
<td>Laminate</td>
<td>Formica / Greenlam / Merinolam</td>
</tr>
<tr>
<td>21.</td>
<td>Flush Doors</td>
<td>Duraboard / Kit ply / Merino Ply / Shreeji Doors, Anand Wood Craft and other ISI marked make</td>
</tr>
<tr>
<td>22.</td>
<td>Steel Doors, Windows &amp; Pressed</td>
<td>Sen Harvic; AGEW; Hopes Metal; Multwyn; R.L. Vala &amp; Sons; Modern</td>
</tr>
<tr>
<td>S. No.</td>
<td>Description</td>
<td>Approved Makes</td>
</tr>
<tr>
<td>--------</td>
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<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>23</td>
<td>PVC / FRP Doors &amp; Frames</td>
<td>Deep Doors; Fibroplast-Latur</td>
</tr>
<tr>
<td>24</td>
<td>Polycarbonate Sheet</td>
<td>Danpalon / Alcoa / Polygal / Sabic and other ISI marked make</td>
</tr>
<tr>
<td>25</td>
<td>Mild Steel Butt Hinges/Piano Hinges</td>
<td>Jolly/Garg/AMIT/ASI Supreme</td>
</tr>
<tr>
<td>26</td>
<td>Water Proof cement paint</td>
<td>Snowcem/Asian Paints/Berger</td>
</tr>
<tr>
<td>27</td>
<td>Nuts Bolts /Screws</td>
<td>Kundan/Puja/Atul</td>
</tr>
<tr>
<td>28</td>
<td>Mineral Fiber Ceiling</td>
<td>Lloyd/Nittobo/ Armstrong</td>
</tr>
<tr>
<td>29</td>
<td>Welding Rods</td>
<td>ADOR/ Cosmos/ Esab/ Super Bond ('S')</td>
</tr>
<tr>
<td>30</td>
<td>Fastner</td>
<td>Fisher/ Hilti</td>
</tr>
<tr>
<td>31</td>
<td>A.C. Sheet</td>
<td>Asbestos Cement Ltd. (Everest); Charminar.</td>
</tr>
<tr>
<td>32</td>
<td>Expansion Joint &amp; Tarfelt Waterproofing</td>
<td>Shalitex; Tiki Tar Industries; STP Ltd., (Shalimar Tar Products); Lloyd Insulation (l).</td>
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<tr>
<td>33</td>
<td>Integral Water Proofing Compound</td>
<td>Accoproof; Cico; Impermo; Pdlite; Roff.; Mc Bouchmie; Fosroc.</td>
</tr>
<tr>
<td>WALL FINISHES</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>1 Corridor walls</td>
<td>Synthetic Plaster with acrylic paint</td>
<td></td>
</tr>
<tr>
<td>2 Staircase Lobby Columns and Beams</td>
<td>Synthetic Plaster with acrylic paint</td>
<td></td>
</tr>
<tr>
<td>3 New walls in Brick</td>
<td>15mm plaster with POP finish</td>
<td></td>
</tr>
<tr>
<td>4 New walls Siporex</td>
<td>Gyp-plaster</td>
<td></td>
</tr>
<tr>
<td>5 Wash Areas and Pantry</td>
<td>Base plaster and Vitrified tile Dado above platform and Ceramic tile below plaform</td>
<td></td>
</tr>
<tr>
<td>6 Slag Characterisation/ Process Visualisation</td>
<td>Existing Raw concrete treated with transparent sealing finish</td>
<td></td>
</tr>
<tr>
<td>7 SEM, Research Area, Corridor</td>
<td>Gypsum Plaster</td>
<td></td>
</tr>
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### CEILING

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corridor</td>
<td>Acrylic emulsion on existing ceiling surface</td>
</tr>
<tr>
<td>2</td>
<td>Staircase Lobby</td>
<td>Gypsum Ceiling with metal access panels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>India Gypsum, Saint Gobain, Armstrong</td>
</tr>
<tr>
<td>3</td>
<td>Seminar Room, Computer Room</td>
<td>Gypsum Ceiling with laminate plywood box with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eurocel Stretch Ceiling light boxes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>India Gypsum, Saint Gobain, Eurocel</td>
</tr>
<tr>
<td>4</td>
<td>TEM laboratory</td>
<td>Gypsum Ceiling with access panels as required</td>
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<tr>
<td></td>
<td></td>
<td>India Gypsum, Saint Gobain</td>
</tr>
<tr>
<td>5</td>
<td>SEM</td>
<td>Gypsum Ceiling with access panels as required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>India Gypsum, Saint Gobain</td>
</tr>
<tr>
<td>6</td>
<td>Slag Characterisation/ Process Visualisation</td>
<td>Gypsum Ceiling with ply strengthening for High wall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AC mount &amp; Existing Raw concrete treated with</td>
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<td></td>
<td>transparent sealing finish</td>
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<tr>
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<td>India Gypsum, Saint Gobain</td>
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### CARPENTRY & FURNITURE

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>1</td>
<td>Full Height &amp; Overhead Storage</td>
<td>All Plywood shall be of grade IS303 commercial unless specified. All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>units shall be treated with terMiguard or any equivalent anti termite</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and borer solution. Ply with laminate finish. Shutters- Laminated with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>matching PVC edge banding</td>
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<tr>
<td></td>
<td></td>
<td>Laminate: Merino, Greenlam, Royale Plywood: Greenlam, Anchor</td>
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<tr>
<td>2</td>
<td>Wood</td>
<td>For Door Frame finish over existing frames- BTC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For new Door Frames- well seasoned teak</td>
</tr>
<tr>
<td>3</td>
<td>Concealed Hinges</td>
<td>Blum, Hafelle, Hettich, Enox</td>
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<tr>
<td>4</td>
<td>Handles</td>
<td>304 SS</td>
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<tr>
<td></td>
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<td>Kich, Dorset,</td>
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### B. Electrical Work

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
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<tr>
<td>Switches</td>
<td>MK (Wrap round plus)/ Legrand (Arteor)</td>
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<tr>
<td>Sockets</td>
<td>MK (Wrap round plus)/ Legrand (Arteor)</td>
</tr>
<tr>
<td>Ceiling Rose</td>
<td>Anchor / Vinay</td>
</tr>
<tr>
<td>Wires</td>
<td>Finolex (FRLS) / Havells (FRLS) / RR Kabel (FRLS) / Vinay</td>
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<tr>
<td>Casing Caping/Conduit</td>
<td>Precision / Polycab</td>
</tr>
<tr>
<td>Call Bell</td>
<td>Edison / Anchor</td>
</tr>
<tr>
<td>Bakelite Sheet</td>
<td>Hylam / Formica / Anchor</td>
</tr>
<tr>
<td>Armoured Cables</td>
<td>Finolex / Havells / RR Kabel</td>
</tr>
<tr>
<td>Unarmoured Cables</td>
<td>Finolex / RR Kabel / Polycab</td>
</tr>
<tr>
<td>Lugs</td>
<td>Dowells / Jainson / 3D / Braco</td>
</tr>
<tr>
<td>Comet</td>
<td>Comet / Braco</td>
</tr>
<tr>
<td>Tube Fittings (LED)</td>
<td>Philips / Wipro / Bajaj / Havells</td>
</tr>
<tr>
<td>Exhaust Fans</td>
<td>GEC / Bajaj / Crompton / Havells</td>
</tr>
<tr>
<td>Ceiling Fan</td>
<td>Crompton (BLDC) / Haells (BLDC) / Atomberg (Gorilla) BLDC</td>
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<tr>
<td>MCBs/ MCB DBs</td>
<td>Legrand (Lexic) / Hager (H3)</td>
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<td>RCCB/RCBO</td>
<td>Legrand (Lexic) / Hager (H3)</td>
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<td>MCCBs</td>
<td>Legrand / L&amp; T / Siemens / ABB / Hager</td>
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<td>Switch Disconnector</td>
<td>L&amp; T</td>
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<tr>
<td>Change Over Switch</td>
<td>L&amp; T / Havells / Siemens</td>
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<tr>
<td>Time Switch</td>
<td>Legrand / Hager</td>
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<tr>
<td>Cat 6 Cable</td>
<td>Systimax / D-Link / Legrand</td>
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<td>RJ-45</td>
<td>Systimax / D-Link / Legrand</td>
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<td>Telephone Cable</td>
<td>Finolex / Delton / Legrand</td>
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<td>RJ-11</td>
<td>MK / Legrand</td>
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<td>TV Cable RG-6</td>
<td>Finolex / Havells</td>
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<tr>
<td>Fire Alarm Panel</td>
<td>Honeywell (Notifier) / L&amp;T</td>
</tr>
<tr>
<td>Energy Meter</td>
<td>L&amp;T Secure</td>
</tr>
<tr>
<td>PIR Sensor</td>
<td>Anchor (Panasonic) / MK / Legrand</td>
</tr>
<tr>
<td>CTs</td>
<td>AE / Indcoil / Prescise</td>
</tr>
<tr>
<td>Fuses</td>
<td>L&amp;T / Siemens</td>
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<tr>
<td>Indicating Lamp</td>
<td>Teknic / Vaishno / Siemens</td>
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<tr>
<td>Plug-in-Boxes</td>
<td>GE (EE)</td>
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<td>Screws</td>
<td>Nettle fold GI-Plated / Equivalent</td>
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<tr>
<td>UPS Battery</td>
<td>Exide (Power Safe Plus) / Amar raja (Quanta)</td>
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<td>UPS</td>
<td>Emerson (Vertiv) / APC</td>
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This list may be referred in addition to the description of items in schedule of works.
## C. Plumbing Work

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Approved Makes</th>
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<tbody>
<tr>
<td>1</td>
<td>W.C.</td>
<td>Parryware / Cera / Neycer</td>
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<tr>
<td>2</td>
<td>WC Connectors</td>
<td>Prince / Supreme</td>
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<td>3</td>
<td>Urinal</td>
<td>Parryware / Cera / Neycer</td>
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<td>4</td>
<td>Flush Valve</td>
<td>Jaguar</td>
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<td>Toilet Paper Holder</td>
<td>Jaguar</td>
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<td>6</td>
<td>Wash Basin</td>
<td>Parryware / Cera / Neycer</td>
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<td>7</td>
<td>Jet Spray</td>
<td>Jaguar</td>
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<td>8</td>
<td>Pillar Tap</td>
<td>Jaguar</td>
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<td>9</td>
<td>Bottle Trap</td>
<td>Jaguar</td>
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<tr>
<td>10</td>
<td>Urinal Sensors</td>
<td>Jaquar</td>
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<tr>
<td>11</td>
<td>Auto Urinal Flush System</td>
<td>AOS Auto Robo Flushing System / Askon Engineers / Euronics / Toshi / UTEC System</td>
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<tr>
<td>12</td>
<td>CP Brass Fittings</td>
<td>Ess-Ess / Gem / Jaguar / Crabtree / Parko / Kingston</td>
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<tr>
<td>13</td>
<td>Floor Drain Fixture, Rain Water Outlets</td>
<td>ACO / GMGR / Geberit / Viega</td>
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<tr>
<td>14</td>
<td>C.P. Grating for Floor Trap</td>
<td>Chilly / GMGR / Neer</td>
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<tr>
<td>15</td>
<td>Cast Iron Pipes &amp; Fittings</td>
<td>Manhole covers and frames</td>
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<tr>
<td></td>
<td>a. As per IS:3989 (Pipes &amp; Fittings)</td>
<td>NECO / Kapilash</td>
</tr>
<tr>
<td></td>
<td>b. As per IS:1729 (Manhole covers and frames)</td>
<td>NECO / SRIF / Raj Iron Foundry Agra</td>
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<tr>
<td></td>
<td>c. As per IS:1536 (CIClass LA Pipes)</td>
<td>Electro Steel Calcutta / IISCO / NECO / Kesoram Calcutta</td>
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<td></td>
<td>d. D.I. Manhole Covers &amp; Frames</td>
<td>Kartar valves &amp; fittings / NECO</td>
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<td></td>
<td>e. CILA fittings</td>
<td>Kartar valves &amp; fittings</td>
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<tr>
<td></td>
<td>f. Suspended Manhole and Gully</td>
<td>Patel Pattern</td>
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<td>16</td>
<td>Drip Seal</td>
<td>ACQUA Bond / Vinod Cement Co. Chandigarh</td>
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<tr>
<td>17</td>
<td>GI / M.S Pipes (IS : 1239 and IS : 3589)</td>
<td>Jindal / Tata Steel / Surya / AST Pipes / Hitech Swastik</td>
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<tr>
<td>18</td>
<td>GI pipes fittings</td>
<td>Jain Sons / Kirti / Unik / Zoolo M</td>
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<td>19</td>
<td>GI pipe sealant</td>
<td>Henkel - LOCTITE 55</td>
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<td>22</td>
<td>Pipe clamp &amp; supports</td>
<td>Chilly / Euroclamp / Easyflex / Gripple</td>
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<td>23</td>
<td>D. I. Pipes</td>
<td>Electro Steel / Jindal / Lanco Kalahasthi</td>
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<td>24</td>
<td>Copper Pipes &amp; Fitting</td>
<td>Flowflex – Rajco / Viega – Max flow</td>
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<tr>
<td>25</td>
<td>UPVC Pipe</td>
<td>Astral / Finolex / Prince / Supreme</td>
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<td>26</td>
<td>CPVC pipes</td>
<td>Ajay / Ashirwad / Astral</td>
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<tr>
<td>27</td>
<td>HDPE Pipe</td>
<td>Duraline / Kimplas / Reliance</td>
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<tr>
<td>28</td>
<td>PB Pipe</td>
<td>Flexalen – Thermafex / George Fisher</td>
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<tr>
<td>29</td>
<td>RCC Pipe</td>
<td>K K / Local &amp; Approved Pranali</td>
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<tr>
<td>30</td>
<td>Stoneware Pipes, Gully Traps</td>
<td>Perfect Potteries, JABALPUR / Rajura</td>
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<tr>
<td>31</td>
<td>SS Pipes</td>
<td>Remi / Viega</td>
</tr>
<tr>
<td>32</td>
<td>GM / Forged Brass Ball Valves</td>
<td>CIM / Danfoss / Jayhiwa / Kitz / RB / Sant / Tiemme / TSB / Zoloto</td>
</tr>
<tr>
<td>33</td>
<td>Sluice Valves</td>
<td>IVC / Kirloskar</td>
</tr>
<tr>
<td>34</td>
<td>Butterfly Valve</td>
<td>Audco / Danfoss / Honeywell / Jayhiwa</td>
</tr>
<tr>
<td>35</td>
<td>Check Valve – WaferType</td>
<td>Advance / Danfoss / Kirloskar / Jayhiwa</td>
</tr>
<tr>
<td>36</td>
<td>Check Valve – Dual Plate</td>
<td>Advance / SKS</td>
</tr>
<tr>
<td>37</td>
<td>Check Valve Forged Screwed</td>
<td>CIM / Leader / RB / Sant / TBS / Zoloto</td>
</tr>
<tr>
<td>38</td>
<td>Pressure Reducing Valve</td>
<td>Fouress / Honeywell / RB / SKS / OR / Zoloto</td>
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<tr>
<td>39</td>
<td>Solenoid Valve</td>
<td>Avcon / Danfoss</td>
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<tr>
<td>40</td>
<td>Thermostatic valve</td>
<td>Oventrop</td>
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<tr>
<td>41</td>
<td>Air Release Valve</td>
<td>Arco / CIM / Fouress OR / SKS</td>
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<tr>
<td>42</td>
<td>Ball Float Valve</td>
<td>Esseti / HBD / Zoloto</td>
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<tr>
<td>43</td>
<td>NRV – Ball type – Sewage application</td>
<td>Danfoss / Silverspark</td>
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<tr>
<td>44</td>
<td>Y Strainer CI</td>
<td>Emerald / Sant / SKS / Zoloto</td>
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<tr>
<td>45</td>
<td>Self-Priming Pumps</td>
<td>Johnson / Kirloskar</td>
</tr>
<tr>
<td>46</td>
<td>Drinking Water Cooler</td>
<td>Blue Star / Usha / Voltas</td>
</tr>
<tr>
<td>47</td>
<td>Anti Vibration Mounting &amp; Flexible Connections</td>
<td>Cori / Dunlop / Flexionics / Kanwal Industrial Corporation / Resistoflex / VIMPA</td>
</tr>
<tr>
<td>48</td>
<td>Pressure Gauge</td>
<td>Emerald / Fiebig / H Guru / Wika</td>
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<tr>
<td>S. No.</td>
<td>Description</td>
<td>Approved Makes</td>
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<tr>
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<td>-----------------------------------------</td>
<td>-----------------------------------------------------</td>
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<tr>
<td>49</td>
<td>Water Meter (Mechanical Type)</td>
<td>Actaris / Capstan / Kaycee / Kranti / Kent</td>
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<tr>
<td>50</td>
<td>Electronic Flow Meter</td>
<td>Krohne (Forbes Marshall) / Rockwin</td>
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<tr>
<td>51</td>
<td>Level Controller &amp; Indicator (Water)</td>
<td>Auto Pump / Cirrus Engineering / Elegant Controls / Technika / Techtol</td>
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<tr>
<td>52</td>
<td>Paints</td>
<td>Asian Paints / Berger / ICI / Shalimar Paints</td>
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<tr>
<td>53</td>
<td>MH / Water Tank Plastic Steps</td>
<td>KGM / Patel / Pranali Industries</td>
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<tr>
<td>54</td>
<td>Fastner</td>
<td>Fisher / Hilti</td>
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<tr>
<td>55</td>
<td>Fire Sealant</td>
<td>Birla 3 M / Hilti / Promat / STI (USA) / Fire master</td>
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<tr>
<td>56</td>
<td>Manhole (Prefabricated)</td>
<td>OK Play / Supreme</td>
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<tr>
<td>57</td>
<td>Temperature Sensor/ Gauge</td>
<td>Forbes Marshall / Danfoss / Wika</td>
</tr>
</tbody>
</table>

Note:
1. Make of Electrical Accessories for Plumbing work to be followed as specified in the List of Approved Make of Electrical Work.
### Fire Fighting Work

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<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fire / Sprinkler Main Pump / Jockey</td>
<td>Aurora / Armstrong / Grundfos / ITT (A-C Pumps) / Kirloskar</td>
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<tr>
<td>2</td>
<td>Diesel Engine</td>
<td>Cummins / Greaves / KOEL</td>
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<tr>
<td>3</td>
<td>Motor</td>
<td>ABB / Bharat Bijlee / Kirloskar / Siemens</td>
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<tr>
<td>4</td>
<td>GI / M.S Pipes (IS : 1239 and IS : 3589)</td>
<td>APL-Apollo / Jindal / Tata Steel / Surya / AST Pumps / Hitech / Swastik</td>
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<td>5</td>
<td>Standard M.S. Fittings</td>
<td>Seamless Fittings / Pipeline Products</td>
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<td>6</td>
<td>DI / CI / Forged Steel Fittings</td>
<td>Jainsons Industries / VS</td>
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<tr>
<td>7</td>
<td>DI Grooved Fitting &amp; Coupling</td>
<td>Tyco / Victaulic / Viking</td>
</tr>
<tr>
<td>8</td>
<td>C.I. Class LA Pipes</td>
<td>Electro Steel Calcutta / IISCO / NECO / Kesoram Calcutta</td>
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<tr>
<td>9</td>
<td>RCC Pipe</td>
<td>K K / Local &amp; Approved Pranali</td>
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<td>D.I. Manhole Covers &amp; Frames</td>
<td>Kartar valves &amp; fittings / NECO / Raj Iron Foundry Agra</td>
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<td>Paints</td>
<td>Asian Paints / Berger / ICI / Shalimar Paints</td>
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<td>12</td>
<td>Double / Single Headed Landing Valve</td>
<td>New Age / Safeguard / Shah Bhogilal</td>
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<td>Fire Hose</td>
<td>CRC / Jayashree / New Age / Padmini / Safeguard / Safefire</td>
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<td>14</td>
<td>First Aid Hose Reel (LPCB Approved)</td>
<td>Monsher / New Age / Padmini / Safeguard / Safefire</td>
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<td>Gun Metal Brach Pipe</td>
<td>New Age / Safeguard</td>
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<td>Fireman Axe</td>
<td>New Age / Safeguard</td>
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<td>Installation Control Valve</td>
<td>HD / Newage / Tyco / Viking</td>
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<td>18</td>
<td>Sprinkler Heads</td>
<td>Tyco / Viking / HD / Newage</td>
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<td>19</td>
<td>Flexible Drop Connection (UL Listed)</td>
<td>Flexhead / Newage / Tyco</td>
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<td>20</td>
<td>AFF Solutiona &amp; Oscillating Nozzle (UL Listed)</td>
<td>Ansol / Newage</td>
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<td>21</td>
<td>Electrical panel Detection &amp; Suppression System</td>
<td>Avec India / Fire Trace</td>
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<td>22</td>
<td>Fire Extinguishers</td>
<td>Alert – Tyco / Minimax / Safefire / Safeguard</td>
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<td>23</td>
<td>Water Flow Switch</td>
<td>Honeywell</td>
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<td>24</td>
<td>Pipe Protection Wrapping</td>
<td>IWL – Pypkote / Rustech – Coatek</td>
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<td>Pipe clamp &amp; supports</td>
<td>Chilly / Euroclamp / Easyflex / Gripple</td>
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<td>Check Valve – WaferType</td>
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<td>Check Valve – Dual Plate</td>
<td>Advance / SKS</td>
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<td>Pressure Reducing Valve</td>
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<td>Air Release Valve</td>
<td>Arco / CIM / Fouress OR / SKS</td>
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<td>Ball Float Valve</td>
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<td>Y Strainer Cl</td>
<td>Emerald / Sant / SKS / Zoloto</td>
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<td>Mechanical Seal</td>
<td>Burgmann / Sealol</td>
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<td>Couplings</td>
<td>Lovejoy</td>
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<td>37</td>
<td>Anti Vibration Mounting &amp; Flexible Connections</td>
<td>Cori / Dunlop / Flexionics / Kanwal Industrial Corporation / Resistoflex / VIMPA</td>
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<td>Pressure Gauge</td>
<td>Emerald / Fiebig / H Guru / Wika</td>
</tr>
<tr>
<td>39</td>
<td>Level Controller &amp; Indicator (Water)</td>
<td>Auto Pump / Cirrus Engineering / Elegent Controls / Technika / Techtrol</td>
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<tr>
<td>40</td>
<td>Welding Rods</td>
<td>B-Type Project / Cosmos / Super Bond (S)</td>
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<td>41</td>
<td>Fastner</td>
<td>Fisher / Hilti</td>
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<td>42</td>
<td>Fire Sealant</td>
<td>Birla 3 M / Hilti / Promat / STI (USA) / Firemaster</td>
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Note:
1. Make of Electrical Accessories for Fire Fighting work to be followed as specified in the List of Approved Make of Electrical Work.
## THEORETICAL STANDARD REQUIREMENT OF CEMENT FOR VARIOUS ITEMS OF WORK

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>BRIEF DESCRIPTION OF ITEM</th>
<th>UNIT</th>
<th>CEMENT IN BAGS</th>
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<tr>
<td>1</td>
<td>Cement Concrete 1:5:10</td>
<td>Cum</td>
<td>2.60</td>
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<tr>
<td>2</td>
<td>Cement Concrete 1:4:8</td>
<td>Cum</td>
<td>3.40</td>
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<tr>
<td>3</td>
<td>Cement Concrete 1:3:6</td>
<td>Cum.</td>
<td>4.40*</td>
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<tr>
<td>4</td>
<td>Cement Concrete 1:2:4</td>
<td>Cum</td>
<td>6.40*</td>
</tr>
<tr>
<td>5</td>
<td>Reinforced Cement Concrete 1:2:4</td>
<td>Cum</td>
<td>6.40*</td>
</tr>
<tr>
<td>6</td>
<td>Reinforced Cement Concrete 1:1.5:3</td>
<td>Cum.</td>
<td>8.00*</td>
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<td>7</td>
<td>Reinforced Cement Concrete 1:1:2</td>
<td>Cum</td>
<td>12.20*</td>
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</table>

* 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 | 0.23
   (b) 40mm. thick (smooth/broom finish) | Sqm | 0.30
   (c) 50mm. thick | Sqm | 0.36
   (+) 20mm. thick skirting/dado in cm.1 :3 | Sqm | 0.30
14. Hardonate flooring -50mm. thick (C.C. 1:2:4, finished smooth) | Sqm | 0.41
15. Kota stone:
   (a) Flooring (with lime mortar bedding pointed with matching cement slurry) | Sqm | 0.13
   (b) Skirting with 20mm. thick C.M. 1:3 backing | Sqm | 0.27
   (c) Coping | Sqm | 0.13
16. Terrazzo tile:
   (a) Flooring (with lime mortar bedding & pointed with cement slurry) | Sqm | 0.18
   (b) Skirting with 20mm. thick C.M. 1:3 | Sqm | 0.28
   (c) Treads, hydraulically pressed with C.M. 1:3 bedding | Sqm | 0.37
   (d) Treads in one piece | Sqm | 0.28
   (e) Risers, hydraulically pressed with C.M. 1:3 backing | Sqm | 0.28
   (f) Risers in one piece | Sqm | 0.23
17. Cast-in-situ terrazzo
<table>
<thead>
<tr>
<th>S.NO.</th>
<th>BRIEF DESCRIPTION OF ITEM</th>
<th>UNIT</th>
<th>CEMENT IN BAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Flooring, 40mm. th. (28mm C.C. 1:2:4 + 12mm with marble chips &amp; powder)</td>
<td>Sqm</td>
<td>0.26</td>
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<tr>
<td>(b)</td>
<td>Skirting, 20mm. thick (12mm C.M.1:3+ 8mm marble chips with cement &amp; marble powder)</td>
<td>Sqm</td>
<td>0.25</td>
</tr>
<tr>
<td>18.</td>
<td>White glazed tile flooring and dado over 20mm. C.M.1:3 bedding</td>
<td>Sqm</td>
<td>0.31</td>
</tr>
</tbody>
</table>
| 19.   | **Cement tile:**  
| (a)   | flooring (lime mortar bedding). | Sqm  | 0.18 |
| (b)   | skirting with 20mm thick C.M. 1:3 | Sqm  | 0.28 |
| 20    | Plaster skirting, 20mm. thick in C.M.1 :3. | Sqm  | 0.30 |
| 21.   | Cuddapah stone kitchen platform over 20mm. thick C.M. 1:4 | Sqm  | 0.30 |
| 22    | Cuddapah stone window sill over 20mm. thick C.M. 1:4 | Sqm  | 0.27 |
| 23    | Fixing hold fasts in CC 1:3:6 of size 300x100x150 mm. for doors & windows | 100 Nos | 2.20 |
| 24.   | Cement Plaster in C.M. 1:4/1:5 with neeru finish |  |  |
| (A)   | **Cement Mortar 1:4**  
| (a)   | 12 mm. thick | Sqm  | 0.11 |
| (b)   | 15 mm. thick | Sqm  | 0.13 |
| (c)   | 20 mm. thick | Sqm  | 0.17 |
| (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 |
| 25.   | Cement plaster in C.M. 1:4 in two coats with neat cement punning  
| a)   | 15 mm. thick.10mm + 5mm (for ceiling) | Sqm  | 0.18 |
| (b)   | 20 mm. thick.15mm + 5mm (for internal walls) | Sqm  | 0.22 |
| 26    | Cement plaster in C.M. 1:4, 20mm. thick rough finish (for external brick/concrete surfaces) | Sqm.  | 0.17 |
| 27.   | Sand faced plaster, 20mm. thick (12mm C.M. 1:4 + 8 mm C.M. 1:3) | Sqm  | 0.21 |
| 28.   | Rough cast plaster, 25 mm thick (12mm C.M. 1:4 + 13 mm C.M.1 :3) | Sqm  | 0.27 |
| (+)   | (+) 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 with water proofing compound finished smooth with neat cement  
| (a)   | 12mm. thick | Sqm  | 0.19 |
| (b)   | 20mm. thick | Sqm  | 0.27 |
| 30.   | **Cement pointing in C.M. 1:3**  
<p>| (a)   | Ruled pointing (groove pointing) | Sqm  | 0.02 |
| (b)   | Raised &amp; cut pointing | Sqm  | 0.04 |</p>
<table>
<thead>
<tr>
<th>S.NO.</th>
<th>BRIEF DESCRIPTION OF ITEM</th>
<th>UNIT</th>
<th>CEMENT IN BAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.</td>
<td>Cement based waterproofing works (Through the agency approved by the Department)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Terrace type average 115 mm. thick</td>
<td>Sqm</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(b) Basement type (Box type)</td>
<td>Sqm</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>(c) Basement type (surface)</td>
<td>Sqm</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>(d) In sunken floor of toilets, chajjas, parapets</td>
<td>Sqm</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>(e) Brickbat coba in toilets, extra in roof terrace</td>
<td>Cum</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>(f) O.H. Water tanks</td>
<td>Sqm</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>(g) Expansion joints.</td>
<td>R.M</td>
<td>0.50</td>
</tr>
<tr>
<td>32.</td>
<td>Damp proof course in C.C. 1:2:4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 25mm. thick</td>
<td>Sqm</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>(b) 38mm. thick</td>
<td>Sqm</td>
<td>0.24</td>
</tr>
<tr>
<td>33.</td>
<td>Laying R.C.C. spun pipes in C.M. 1:1/1:2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 100 mm dia.</td>
<td>10m</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>(b) 150 mm dia</td>
<td>10m</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>(c) 250 mm dia</td>
<td>10m</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>(d) 300 mm dia</td>
<td>10m</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>(e) 450 mm dia</td>
<td>10m</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>(f) 600 mm dia</td>
<td>10m</td>
<td>0.64</td>
</tr>
<tr>
<td>34.</td>
<td>Cement mortar 1:4 screed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 20mm. thick</td>
<td>Sqm</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>(b) 50mm. thick</td>
<td>Sqm</td>
<td>0.38</td>
</tr>
<tr>
<td>35.</td>
<td>Chain link fencing/barbed wire fencing - C.C. 1:2:4 pockets of 450x450x600 mm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Angle iron posts</td>
<td>m</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>(b) Cement Concrete 1:2:4 posts</td>
<td>m</td>
<td>0.37</td>
</tr>
<tr>
<td>36.</td>
<td>Kerb stone in CC 1:3:6 of size 125x375mm</td>
<td>m.</td>
<td>0.21</td>
</tr>
<tr>
<td>37.</td>
<td>Shahabad stone paving, pointed in C.M.1 :3, 15x10 mm groove.</td>
<td>Sqm</td>
<td>0.02</td>
</tr>
<tr>
<td>38.</td>
<td>Pointing &amp; grouting stone pitching in C.M. 1:3</td>
<td>Sqm</td>
<td>0.14</td>
</tr>
</tbody>
</table>
### CONSUMPTION OF PAINT FOR SOME PAINTING ITEMS:
(Para 47.7.1 of Painting)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of Paint</th>
<th>Area coverage for one coat (Old work)</th>
<th>Area coverage for two coats (New Work)</th>
<th>Area coverage per addl. coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Synthetic enamel paint</td>
<td>14 m² per Ltr.</td>
<td>8.5 m² per Ltr.</td>
<td>1.8 m² per Ltr.</td>
</tr>
<tr>
<td>2</td>
<td>Plastic emulsion paint</td>
<td>14 m² per Ltr.</td>
<td>8.5 m² per Ltr.</td>
<td>1.8 m² per Ltr.</td>
</tr>
<tr>
<td>3</td>
<td>Oil Bound distemper</td>
<td>10 m² per Ltr.</td>
<td>6.0 m² per Ltr.</td>
<td>1.2 m² per Ltr.</td>
</tr>
<tr>
<td>4</td>
<td>Dry Distemper</td>
<td>10 m² per kg</td>
<td>6.5 m² per kg</td>
<td>1.2 m² per kg</td>
</tr>
<tr>
<td>5</td>
<td>White wash</td>
<td>5 m²/kg of lime</td>
<td>3.5 m²/kg of lime</td>
<td>10 m²/kg of lime</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> Following things to be added in lime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Adhesive (DDL/SDL) – 5% of lime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) Neel (Blue) – 3 gm per kg of lime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iii) Water – 5 kg of water per kg of lime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cement based paint</td>
<td>4.5 m² per kg</td>
<td>2 m² per kg</td>
<td>6 m² per kg</td>
</tr>
<tr>
<td>7</td>
<td>Aluminium paint</td>
<td>20 m² per Ltr.</td>
<td>12.5 m²/Ltr.</td>
<td>28 m² per Ltr.</td>
</tr>
<tr>
<td>8</td>
<td>Bitumen Paint/Black Japan</td>
<td>14 m² per Ltr.</td>
<td>14 m² per Ltr.</td>
<td>28 m² per Ltr.</td>
</tr>
<tr>
<td>9</td>
<td>Neeru (or lime punning with slacked lime) over plaster</td>
<td>0.5 m² per kg of slacked lime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Red oxide metal primer</td>
<td>16 m² per Ltr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Cement primer</td>
<td>12 m² per Ltr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Wood primer</td>
<td>13 m² per Ltr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Wax polishing of new wood work with ready made polish</td>
<td>20 m² per kg</td>
<td>20 m² per kg</td>
<td>20 m² per kg</td>
</tr>
<tr>
<td>14</td>
<td>French or spirit polish</td>
<td>10.5 m²/Ltr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Varnish</td>
<td>14 m² per Ltr.</td>
<td>8.5 m² per Ltr.</td>
<td>18 m² per Ltr.</td>
</tr>
<tr>
<td>16</td>
<td>Requirement of paint per coat in Structural steel work on tonnage basis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Truss and Lattice girder work – 4.5 litres per tonne.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) Plane Beam/plane girder work – 2.5 litres per tonne</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX – “C-2”

**CO-EFFICIENT FOR EQUIVALENT PLAIN AREAS FOR PAINTING ITEMS:**

*(PARA REFERRED TO CHAPTER 47 - PAINTING)*

<table>
<thead>
<tr>
<th>SN</th>
<th>DESCRIPTION OF WORK</th>
<th>MULTIPLYING CO-EFFICIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td><strong>WOOD WORK : DOORS, WINDOWS ETC.</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Panelled or framed and braced doors, windows etc.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Ledged &amp; battened or ledged, battened &amp; braced doors, windows etc.</td>
<td>1.30 (for each side)</td>
</tr>
<tr>
<td>3</td>
<td>Flush doors etc</td>
<td>1.20 (for each side)</td>
</tr>
<tr>
<td>4</td>
<td>Part panelled and part glazed or gauzed doors, windows etc.</td>
<td>1.00 (for each side)</td>
</tr>
<tr>
<td>5</td>
<td>Fully glazed or gauzed doors, windows etc.</td>
<td>0.80 (for each side)</td>
</tr>
<tr>
<td>6</td>
<td>Fully venetioned or louvered doors, windows etc.</td>
<td>1.80 (for each side)</td>
</tr>
<tr>
<td>7</td>
<td>Trellis (or Jaffri) work one way or two way.</td>
<td>2.00 (for painting all over)</td>
</tr>
<tr>
<td>8</td>
<td>Carved or enriched work:</td>
<td>2.00 (for each side)</td>
</tr>
<tr>
<td>9</td>
<td>Weather boarding:</td>
<td>1.20 (for each side)</td>
</tr>
<tr>
<td>10</td>
<td>Wood shingle roofing:</td>
<td>1.10 (for each side)</td>
</tr>
<tr>
<td>11</td>
<td>Boarding with cover fillets and match boarding.</td>
<td>1.05 (for each side)</td>
</tr>
<tr>
<td>12</td>
<td>Tile and slate battening:</td>
<td>0.80 (for painting all over)</td>
</tr>
<tr>
<td>II.</td>
<td><strong>STEEL WORK: DOORS, WINDOWS ETC.</strong></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Plain sheeted steel door or windows:</td>
<td>1.10 (for each side)</td>
</tr>
<tr>
<td>14</td>
<td>Fully glazed or gauzed steel doors and windows</td>
<td>0.50 (for each side)</td>
</tr>
<tr>
<td>15</td>
<td>Partly panelled and partly gauzed or glazed doors and windows</td>
<td>0.80 (for each side)</td>
</tr>
<tr>
<td>16</td>
<td>Corrugated sheeted steel doors or windows.</td>
<td>1.25 (for each side)</td>
</tr>
<tr>
<td>17</td>
<td>Collapsible gates</td>
<td>1.50 (for painting all over)</td>
</tr>
<tr>
<td>18</td>
<td>Rolling shutters of inter locked laths.</td>
<td>1.10 (for each side)</td>
</tr>
<tr>
<td>III.</td>
<td><strong>GENERAL WORKS :</strong></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings in guard bars, balusters, railings, partitions and m.s. bars in window frames.</td>
<td>1.00 (for painting all over)</td>
</tr>
<tr>
<td>20</td>
<td>Open palisade fencing and gates including standards, braces, rails, stays etc. in timber or steel.</td>
<td>1.00 (for painting all over)</td>
</tr>
</tbody>
</table>

**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) up to the top of palisades but not up to the top of standards, if they are higher than the palisades.

<table>
<thead>
<tr>
<th>SN</th>
<th>DESCRIPTION OF WORK</th>
<th>MULTIPLYING CO-EFFICIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Corrugated iron sheeting in roofs, side cladding etc.</td>
<td>1.14 (for each side)</td>
</tr>
<tr>
<td>22</td>
<td>A.C. Corrugated sheeting in roofs, side cladding etc.</td>
<td>1.20 (for each side)</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Rate (for each side)</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>23</td>
<td>A.C. Semi-corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets.</td>
<td>1.10</td>
</tr>
<tr>
<td>24</td>
<td>Wire gauze shutters including painting of wire gauze.</td>
<td>1.00</td>
</tr>
</tbody>
</table>

***
APPENDIX – “D”

PROFORMA 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).

(PARAGRAPH 7.7 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).

Whereas 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 foundation system 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 by him 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)
### SCHEDULE OF TECHNICAL DATA

#### 1. FIRE PROTECTION SYSTEM

#### 1.1 FIRE PUMPS & MOTOR

#### 1.1.1 Electrical Driven Main Fire & Sprinkler Pumps

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make / Manufacturer</td>
<td>:</td>
</tr>
<tr>
<td>Quantity</td>
<td>:</td>
</tr>
<tr>
<td>Liquid Handed</td>
<td>:</td>
</tr>
<tr>
<td>Liquid Temp deg.C</td>
<td>:</td>
</tr>
<tr>
<td>Special Gravity of Liquid</td>
<td>:</td>
</tr>
<tr>
<td>Suction</td>
<td>:</td>
</tr>
<tr>
<td>Rated Discharge at Low Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Rated Discharge at High Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Actual Discharge at Low Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Actual Discharge at High Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Model</td>
<td>:</td>
</tr>
<tr>
<td>Horizontal / Design</td>
<td>:</td>
</tr>
<tr>
<td>Speed / No. of Stages</td>
<td>:</td>
</tr>
<tr>
<td>Impeller Dia (Maximum)</td>
<td>:</td>
</tr>
<tr>
<td>Suction / Delivery Size</td>
<td>:</td>
</tr>
<tr>
<td>Efficiency at Rated Capacity &amp; Head</td>
<td>:</td>
</tr>
<tr>
<td>KW required at rated capacity &amp; head</td>
<td>:</td>
</tr>
<tr>
<td>Shut Off Head</td>
<td>:</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>:</td>
</tr>
<tr>
<td>Pump Casing</td>
<td>:</td>
</tr>
<tr>
<td>Impeller</td>
<td>:</td>
</tr>
</tbody>
</table>
Pump Shaft : 
Shaft Sleeve : 
Casing Wearing Ring : 
Base Plate : 
Mechanical Seal : 
Make of Mechanical Seal : 

Whether pumps is capable of discharging 150% of rated capacity at a head not less than 65% of rated head.

Whether automatic priming arrangement included

Description of Motors

Make : 
Model No. : 
Type : 
Frame size : 
Speed (RPM) : 
Rated Capacity (Power) : 
Full load current : 
Enclosure : 
Coupling / Pulley : 

Class of Insulation

Size of Foundation
For complete coupled set mounted over MS base frame

1.1.2 Diesel Engine Driven Pump
<table>
<thead>
<tr>
<th>Make / Manufacturer</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>:</td>
</tr>
<tr>
<td>Liquid Handed</td>
<td>:</td>
</tr>
<tr>
<td>Liquid Temp deg.C</td>
<td>:</td>
</tr>
<tr>
<td>Special Gravity of Liquid</td>
<td>:</td>
</tr>
<tr>
<td>Suction</td>
<td>:</td>
</tr>
<tr>
<td>Rated Discharge at Low Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Rated Discharge at High Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Actual Discharge at Low Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Actual Discharge at High Zone Head</td>
<td>:</td>
</tr>
<tr>
<td>Model</td>
<td>:</td>
</tr>
<tr>
<td>Horizontal / Design</td>
<td>:</td>
</tr>
<tr>
<td>Speed / No. of Stages</td>
<td>:</td>
</tr>
<tr>
<td>Impeller Dia (Maximum)</td>
<td>:</td>
</tr>
<tr>
<td>Suction / Delivery Size</td>
<td>:</td>
</tr>
<tr>
<td>Efficiency at Rated Capacity &amp; Head</td>
<td>:</td>
</tr>
<tr>
<td>KW required at rated capacity &amp; head</td>
<td>:</td>
</tr>
<tr>
<td>Shut Off Head</td>
<td>:</td>
</tr>
</tbody>
</table>

**Material of Construction**

| Pump Casing                  | : |
| Impeller                     | : |
| Pump Shaft                   | : |
| Shaft Sleeve                 | : |
| Casing Wearing Ring          | : |
| Base Plate                   | : |
Mechanical Seal

Make of Mechanical Seal

Whether pumps is capable of discharging 150% of rated capacity at a head not less than 65% of rated head.

Whether automatic priming arrangement included

Description of Engine

Make

Model No.

Type

Frame size

Speed (RPM)

Rated Capacity (Power)

Full load current

Enclosure

Coupling / Pulley

No of Cylinder

Fuel Pump & Water pump detail

Engine Cooling & Oil System

Diesel Oil tank capacity

Fuel Oil storage shall ensure working of pump for number of hours

Size of Foundation

For complete coupled set mounted over MS base frame

1.1.3 **Jockey Pump**

*(Please submit separate data sheet for each type of pump)*
<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Handed</td>
<td></td>
</tr>
<tr>
<td>Liquid Temp deg.C</td>
<td></td>
</tr>
<tr>
<td>Special Gravity of Liquid</td>
<td></td>
</tr>
<tr>
<td>Suction</td>
<td></td>
</tr>
<tr>
<td>Rated Discharge at Low Zone Head</td>
<td></td>
</tr>
<tr>
<td>Rated Discharge at High Zone Head</td>
<td></td>
</tr>
<tr>
<td>Actual Discharge at Low Zone Head</td>
<td></td>
</tr>
<tr>
<td>Actual Discharge at High Zone Head</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>Horizontal / Design</td>
<td></td>
</tr>
<tr>
<td>Speed / No. of Stages</td>
<td></td>
</tr>
<tr>
<td>Impeller Dia (Maximum)</td>
<td></td>
</tr>
<tr>
<td>Suction / Delivery Size</td>
<td></td>
</tr>
<tr>
<td>Efficiency at Rated Capacity &amp; Head</td>
<td></td>
</tr>
<tr>
<td>KW required at rated capacity &amp; head</td>
<td></td>
</tr>
<tr>
<td>Shut Off Head</td>
<td></td>
</tr>
<tr>
<td>Material of Construction</td>
<td></td>
</tr>
<tr>
<td>Pump Casing</td>
<td></td>
</tr>
<tr>
<td>Impeller</td>
<td></td>
</tr>
<tr>
<td>Pump Shaft</td>
<td></td>
</tr>
<tr>
<td>Shaft Sleeve</td>
<td></td>
</tr>
<tr>
<td>Casing Wearing Ring</td>
<td></td>
</tr>
<tr>
<td>Base Plate</td>
<td></td>
</tr>
<tr>
<td>Mechanical Seal</td>
<td></td>
</tr>
</tbody>
</table>
Make of Mechanical Seal : 

Description of Motor

Make : 

Model No. : 
Type : 
Frame size : 
Speed (RPM) : 
Rated Capacity (Power) : 
Full load current : 
Enclosure : 
Coupling / Pulley : 

Size of Foundation
For complete coupled set mounted over MS base frame

1.2. PIPING
15 NB TO 50 NB : 
15 TO 50 NB Fittings : 
65 NB TO 150 NB Pipes : 
65 NB TO 150 NB Fittings : 
200 NB ONWARDS Pipes : 
200 NB ONWARDS Fittings : 
Flanges : 
Gaskets : 

1.3. HYDRANT VALVES

1.3.1 Technical Specifications : 

Item :
1.3.2 Construction Features

Type of Stem
Type of Inlet
Type of Outlet
Flange Drilling

1.3.3 Material of Construction

Body and Bonnet : 
Stop Valve, Valve Seat : 
Check nut & gland nut : 

1.4 Pressure Gauge

1.4.1 Technical Specifications:

Working Pressure :
Code for Design Mft. :
Scale range :

1.4.2 Construction Features

Case :
Pointer :
Dial Size :
Dial Lettering :
Process Connection :

1.4.3 Material of Construction

Case :
Movement :
1.5. PRESSURE SWITCHES

1.5.1 Technical Specifications:

Item: 
Working Pressure: 
Scale range: 

1.5.2 Construction Features:

Protection: 
Cable Entry: 
Process Connection: 
Repeatability: 
Switch Type: 
No. of contacts: 
Contact Rating: 

1.5.3 Material of Construction:

Enclosure: 
Pressure element: 
Wetted Parts: 

2. ELECTRICAL ACCESSORIES

2.1 Make of the following:

a. Motor Control Centre (Electrical Panel)

b. Vacuum circuit breaker

c. Air circuit breaker

d. MCCB

e. MCB
f. Rotary switch
g. Soft Starter
h. Auto-transformer Starter
j. Automatic Star Delta Starter
k. Direct on line Starter
l. Contactor
m. Current Transformer (cast resin type)
n. Single phase preventor
o. Push Button
p. Change over switch
q. Ammeter & Voltmeter
   KWH meter
r. Relay
s. Indication lamp
t. Cables
u. Wires
v. Variable Frequency Drive.
### 2.2. ELECTRICAL TECHNICAL DATA SHEETS

**For MCC +PDBs+MLDBs/SLDBs/DBs (To be filled by the bidders)**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Recommended Specification</th>
<th>Confirmation by the Bidders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type of Panel</td>
<td>a. MCC non drawout type compartmentalized.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Panels non drawout type, non compartmentalized</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Type of Mounting</td>
<td>Free standing Floor Mounted</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fault kA</td>
<td>50kA -1 Sec for MCC</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Thickness of CRCA sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Structural members</td>
<td>3mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Covers and doors</td>
<td>2mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Base channel</td>
<td>MCC - ISMC 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Gland plate</td>
<td>3mm</td>
<td></td>
</tr>
<tr>
<td>5a.</td>
<td>Painting/ Process</td>
<td>Synthetic Enamel Paint</td>
<td>As per seven tank process</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oven baked.</td>
</tr>
<tr>
<td></td>
<td>b. Paint shade;</td>
<td>RAL – 7032</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Inside</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Outside</td>
<td>RAL - 7032</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Details of busbars</td>
<td>Electrolytic grade Copper of specified rating for details see constructional features mentioned in specifications</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cable Entry</td>
<td>For MCC &amp; other Panels</td>
<td>Top or Bottom depending upon location of Panel.</td>
</tr>
<tr>
<td>8</td>
<td>Enclosure</td>
<td>For MCC – IP -52 with louvers for Ventilation.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Control Wiring/ Power Wiring</td>
<td>Insulated 660Volts Cu wire.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Voltage Circuit</td>
<td>1.5 sq mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Current Circuit</td>
<td>2.5 sq mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Minimum size of Power wiring CKt</td>
<td>16 sq mm</td>
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</tr>
<tr>
<td>10</td>
<td>Maximum Operating Height</td>
<td>2100</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Mounting height of Relays/Meters</td>
<td>Range 350mm to 1900mm</td>
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</tr>
<tr>
<td></td>
<td>Control Switches</td>
<td></td>
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</table>
# LIST OF MAIN DOCUMENTS AND SUBMITTALS

## PLUMBING & FIREFIGHTING WORKS

<table>
<thead>
<tr>
<th>Sr.no.</th>
<th>Items</th>
<th>Clause No.</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>1.</td>
<td>4-Copies of Proforma Invoice 4- sets of Technical Literature</td>
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<tr>
<td></td>
<td>Packing Specifications</td>
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<tr>
<td>2.</td>
<td>Performance Guarantee</td>
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<tr>
<td>3.</td>
<td>All Permits / Licenses</td>
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<td>4.</td>
<td>Technical Data</td>
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<tr>
<td>5.</td>
<td>Manufacturer’s Drawings, Catalogues &amp; Pamphlets &amp; Other Documents</td>
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<tr>
<td>6.</td>
<td>Variation in Quantity Statement.</td>
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<tr>
<td>7.</td>
<td>Electrical Installation Certificate</td>
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<tr>
<td>9.</td>
<td>Soft water &amp; Power Requirement</td>
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<tr>
<td>10.</td>
<td>Appendix - IV</td>
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<tr>
<td>11.</td>
<td>Testing, Adjusting and Balancing</td>
<td></td>
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</tbody>
</table>

**Note:** The above list is only for guide line of the contractor. The contractor shall thoroughly check all document and submittals required as per the tender document and submit them in time as per the requirement.