PROPOSED CAMPUS FOR NCSCM
(National Centre for Sustainable Coastal Management)
Anna University, Chennai

Volume 2
Of
TENDER DOCUMENTS

a) Technical Specifications For Civil Works,
b) Technical Specifications For Plumbing Works,
c) Technical Specifications For Electrical Works,
d) Soil Report.

Architects

PHE Consultant

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## INDEX

<table>
<thead>
<tr>
<th>A</th>
<th>TECHNICAL SPECIFICATIONS FOR CIVIL WORK</th>
<th>PAGE No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>List of Indian Standards</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>List of Approved Makes : Civil Works</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Excavations, Fillings &amp; Back filling</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Hardcore/ Soiling under floors/ Foundations</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>Anti-termite Treatment</td>
<td>24</td>
</tr>
<tr>
<td>7</td>
<td>Damp Proof Course</td>
<td>29</td>
</tr>
<tr>
<td>8</td>
<td>Reinforced Concrete and Allied works</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>Formwork</td>
<td>77</td>
</tr>
<tr>
<td>10</td>
<td>Steel Reinforcement</td>
<td>85</td>
</tr>
<tr>
<td>11</td>
<td>Structural Steel</td>
<td>89</td>
</tr>
<tr>
<td>12</td>
<td>M.S Grills/ Railing</td>
<td>94</td>
</tr>
<tr>
<td>13</td>
<td>Brickwork</td>
<td>96</td>
</tr>
<tr>
<td>14</td>
<td>Cement Plastering for Walls and Ceilings &amp; Sand Face Plaster</td>
<td>101</td>
</tr>
<tr>
<td>15</td>
<td>Flooring</td>
<td>107</td>
</tr>
<tr>
<td>16</td>
<td>Painting</td>
<td>117</td>
</tr>
<tr>
<td>17</td>
<td>Water proofing</td>
<td>136</td>
</tr>
<tr>
<td>18</td>
<td>Rubber/ PVC Water stops</td>
<td>145</td>
</tr>
<tr>
<td>19</td>
<td>Road and Pavements</td>
<td>146</td>
</tr>
<tr>
<td>20</td>
<td>Fencing work with barbed wire, Chain link etc.</td>
<td>154</td>
</tr>
<tr>
<td>21</td>
<td>Aluminum windows, ventilators and composite units etc.</td>
<td>158</td>
</tr>
</tbody>
</table>

### B | TECHNICAL SPECIFICATIONS FOR PLUMBING WORK
<p>| 1 | General Requirements | 164 |
| 2 | Internal Sanitary Fixtures | 177 |
| 3 | Internal Water Supply System | 185 |
| 4 | Internal Sanitary System | 198 |
| 5 | External Sewerage System | 203 |
| 6 | Storage Tank Reservoir Inserts | 212 |
| 7 | Pumps and Mechanical Equipment | 214 |
| 8 | Solar Water Heater | 230 |
| 9 | Water Treatment Plant – Technical Specifications | 232 |
| 10 | Waste Water Treatment Plant – Technical Specifications | 247 |
| 11 | List of Recommended Makes of Materials | 259 |
| 12 | Sanitary &amp; CP Fittings | 262 |</p>
<table>
<thead>
<tr>
<th></th>
<th>List of Drawings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>General Notes</td>
<td>267</td>
</tr>
<tr>
<td>2</td>
<td>Phase 11KV 800A Switch Gear</td>
<td>268</td>
</tr>
<tr>
<td>3</td>
<td>11 KV Metering</td>
<td>272</td>
</tr>
<tr>
<td>4</td>
<td>Installation</td>
<td>286</td>
</tr>
<tr>
<td>5</td>
<td>HT Cable</td>
<td>299</td>
</tr>
<tr>
<td>6</td>
<td>LT Panel</td>
<td>305</td>
</tr>
<tr>
<td>7</td>
<td>Earthing</td>
<td>332</td>
</tr>
<tr>
<td>8</td>
<td>Street Lighting</td>
<td>334</td>
</tr>
<tr>
<td>9</td>
<td>Lightening Arrestor</td>
<td>336</td>
</tr>
<tr>
<td>10</td>
<td>Conduit for Communication</td>
<td>339</td>
</tr>
<tr>
<td>11</td>
<td>Wiring System</td>
<td>340</td>
</tr>
<tr>
<td>12</td>
<td>Lighting Filling &amp; Accessories</td>
<td>349</td>
</tr>
<tr>
<td>13</td>
<td>Cable Tray</td>
<td>353</td>
</tr>
<tr>
<td>14</td>
<td>Distribution board</td>
<td>355</td>
</tr>
<tr>
<td>15</td>
<td>Transformer</td>
<td>359</td>
</tr>
<tr>
<td>16</td>
<td>DG Set</td>
<td>369</td>
</tr>
<tr>
<td>17</td>
<td>PVC Conduits</td>
<td>386</td>
</tr>
<tr>
<td>18</td>
<td>Solar PV System</td>
<td>387</td>
</tr>
<tr>
<td>19</td>
<td>List of Approved make of Materials &amp; Equipment</td>
<td>399</td>
</tr>
<tr>
<td>20</td>
<td>List of Drawings</td>
<td>402</td>
</tr>
<tr>
<td>D</td>
<td>SOIL REPORT</td>
<td>403</td>
</tr>
</tbody>
</table>
A. Technical Specifications for Civil Works

1.0 **GENERAL**

The detailed specifications given hereinafter are for the items of works described in the schedule of quantities attached herein, and shall be guidance for proper execution of work to the required standards. It may also be noted that the specifications are of generalized nature and these shall be read in conjunction with the description of item in schedule of quantities and drawings. The work also includes all minor details of construction which are obviously and fairly intended and which may not have been referred to in these documents but are essential for the entire occupation in accordance with standard Engineering practice.

Unless specifically otherwise mentioned, all the applicable codes and standards published by the Indian Standard Institution and all other standards which may be published by them before the date of receipt of tenders, shall govern in all respects of design, workmanship, quality and properties of materials and methods of testing, methods 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 thereto or revision thereof, if any, up to the date of receipt of tenders.

Wherever brand names and makes are specified in these Technical Specifications below, all or any EQUIVALENT brand or make will also be acceptable. The selected bidder will provide documentary evidence in support of the equivalence of brand(s) and make(s), and will use such equivalent brand(s) and make(s) as and if approved by the Engineer.

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, and requirements of the Engineer-in-Charge.

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.

Samples of various materials, fittings, etc. 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 in placed.

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 buildings, roads, services,
compound wails etc. are to be constructed.

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.

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

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

In case any difference or discrepancy between the specifications and the description in the schedule of quantities, the schedule of quantities all take precedence. In case of any difference or discrepancy between specifications and drawing, the specifications shall take precedence.
# 2.0 LIST OF INDIAN STANDARDS:

Following are the various Indian Standards, relevant to the Civil Engineering work: (Latest Revision to be referred.)

<table>
<thead>
<tr>
<th>No</th>
<th>Indian</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carriage of materials</td>
<td>4082-1977: Recommendations on stacking &amp; storage of construction materials at site.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4081-1986: Anti-termite measures in buildings (Part II - Pre-constructional chemical treatment).</td>
</tr>
<tr>
<td>3</td>
<td>Mortar :</td>
<td>196-1966: Atmospheric conditions for testing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>269-1989: Ordinary, rapid hardening and low heat Portland cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>383-1970: Coarse and fine aggregates from natural sources for Concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>455-1989: Portland blast furnace slag cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>650-1991: Standard sand for testing of cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>712-1984: Building Lines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1489-1991: Portland Pozzolana cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1514-1990: Methods of sampling &amp; Test for quick lime and Hydrated lime</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1542-1992: Sand for plastering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1727-1967: Methods of tests for pozzolanic materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2386 pt. I-1977: Particle size and shape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2386 pt. II-1977: Estimation of deleterious materials and organic impurities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2386 pt. III-1977: Specific gravity, density, voids, absorption and bulking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2686-1977: Cinder as fine aggregate for use of lime concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3025-1987: Methods of sampling and test (physical and chemical) water used in industry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4031-1988: Methods of physical tests for hydraulic cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4032-1985: Method of chemical analysis of hydraulic cement</td>
</tr>
<tr>
<td>4</td>
<td>Concrete work:</td>
<td>383-1970: Coarse and fine aggregates from natural sources for Concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>515-1959: Specifications for natural and manufactured aggregate for use in mass concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>516-1959: Method of test for strength of concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1198-1959: Method of sampling and analysis of concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200(pt.II)-1974: Methods of measurements of cement concrete work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1322-1982: Bitumen felt for water proofing and damp proofing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2386-1977: Methods of test for aggregate for concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2386(pt.I)-1977: Test for particle size and shape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2386(pt.III)-1977: Test for specific gravity, density, voids, absorption an bulking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>238686(pt.IV)-2645-1975: Mechanical properties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2645-1975: Specification for integral water proofing compounds</td>
</tr>
<tr>
<td>Code</td>
<td>Title</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>2686-1977</td>
<td>Specification for cinder aggregate for use in lime concrete</td>
<td></td>
</tr>
<tr>
<td>3812-1981</td>
<td>Fly ash</td>
<td></td>
</tr>
<tr>
<td>3812(pt.I)</td>
<td>Fly ash for use as pozzolana for concrete</td>
<td></td>
</tr>
<tr>
<td>3812(pt.II)</td>
<td>Fly ash for use as admixture for concrete</td>
<td></td>
</tr>
<tr>
<td>3812(pt.III)</td>
<td>Fly ash for use as fine aggregate for mortar and concrete</td>
<td></td>
</tr>
<tr>
<td>7861-1975(pt.I)</td>
<td>Hot weather concreting</td>
<td></td>
</tr>
<tr>
<td>7861-1981(pt.II)</td>
<td>Cold weather concreting</td>
<td></td>
</tr>
<tr>
<td>9103-1979</td>
<td>Admixture for concrete</td>
<td></td>
</tr>
<tr>
<td><strong>5. RCC Work:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>432-1982</td>
<td>Mild steel and medium tensile steel bars and hard drawn steel wire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>for concrete reinforcement</td>
<td></td>
</tr>
<tr>
<td>432(pt.I)-1982</td>
<td>Mild steel and medium tensile steel bars</td>
<td></td>
</tr>
<tr>
<td>456-1978</td>
<td>Code of practice for plain and reinforced concrete</td>
<td></td>
</tr>
<tr>
<td>457-1957</td>
<td>Code of practice for general construction of plain an reinforced</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concrete for dams and other massive structure</td>
<td></td>
</tr>
<tr>
<td>516-1959</td>
<td>Methods of test for strength of concrete</td>
<td></td>
</tr>
<tr>
<td>1139-1966</td>
<td>Hot rolled mild steel, medium tensile steel and high yield</td>
<td></td>
</tr>
<tr>
<td></td>
<td>strength steel deformed bars for concrete reinforcement</td>
<td></td>
</tr>
<tr>
<td>1199-1959</td>
<td>Methods of sampling ad analysis of concrete</td>
<td></td>
</tr>
<tr>
<td>1200(pt.II)-1974</td>
<td>Methods of measurement of cement concrete work</td>
<td></td>
</tr>
<tr>
<td>1200(pt.V)-1982</td>
<td>Method of measurement of form work</td>
<td></td>
</tr>
<tr>
<td>1343-1980</td>
<td>Code of practice for priestesses concrete</td>
<td></td>
</tr>
<tr>
<td>1566-1985</td>
<td>Hard drawn steel wire fabric for concrete reinforcements</td>
<td></td>
</tr>
<tr>
<td>1780-1961</td>
<td>Specifications for cold twisted steel bars for concrete reinforcement</td>
<td></td>
</tr>
<tr>
<td>1785-1983</td>
<td>Specifications for plain hard draw steel wire for pre-stressed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concrete</td>
<td></td>
</tr>
<tr>
<td>1786-1985</td>
<td>Cold twisted steel bars for concrete reinforcement</td>
<td></td>
</tr>
<tr>
<td>2080-1980</td>
<td>Specifications for high tensile steel bars used in pre-stressed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concrete</td>
<td></td>
</tr>
<tr>
<td>2204-1962</td>
<td>Code of practice for construction of reinforced concrete shell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>roof.V- Page 6 of 197</td>
<td></td>
</tr>
<tr>
<td>2210-1962</td>
<td>Criteria for the design of steel structure and folded plates.</td>
<td></td>
</tr>
<tr>
<td>2502-1963</td>
<td>Code of practice for bending and fixing of bars for concrete</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reinforcement</td>
<td></td>
</tr>
<tr>
<td>2751-1979</td>
<td>Code of practice for welding of mild steel bars used for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reinforced concrete construction</td>
<td></td>
</tr>
<tr>
<td>2911-1979</td>
<td>Code of practice for design and construction of pile foundations</td>
<td></td>
</tr>
<tr>
<td>2911(pt.I)-1979</td>
<td>Load bearing concrete piles</td>
<td></td>
</tr>
<tr>
<td>2911(pt.III)-1980</td>
<td>Under reamed pile foundations</td>
<td></td>
</tr>
<tr>
<td>3201-1988</td>
<td>Criteria for design and construction of precise concrete trusses</td>
<td></td>
</tr>
<tr>
<td>3370(part I to IV)-1965</td>
<td>Code of practice for concrete structures for storage of liquids</td>
<td></td>
</tr>
<tr>
<td>3385-1986</td>
<td>Code of practice for measurement for Civil Engineering works.</td>
<td></td>
</tr>
<tr>
<td>3414-1968</td>
<td>Code of practice for design and installation of joints in buildings</td>
<td></td>
</tr>
<tr>
<td>3588-1987</td>
<td>Code of practice for use of immersion vibrators for consolidating concrete</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>3935-1966</td>
<td>Code of practice for composite construction</td>
<td></td>
</tr>
<tr>
<td>4990-1981</td>
<td>Specifications for plywood for concrete shuttering work 10262 Code of practice for design mix</td>
<td></td>
</tr>
<tr>
<td>6 Equipments:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>460-1985</td>
<td>Specification for test sieves</td>
<td></td>
</tr>
<tr>
<td>1791-1985</td>
<td>Specification for batch type concrete missed</td>
<td></td>
</tr>
<tr>
<td>2430-1986</td>
<td>Specification for roller pan mixer</td>
<td></td>
</tr>
<tr>
<td>2585-1968</td>
<td>Specification for concrete vibrators, immersion type</td>
<td></td>
</tr>
<tr>
<td>2806-1964</td>
<td>Specification for screen board concrete vibrators</td>
<td></td>
</tr>
<tr>
<td>2514-1963</td>
<td>Specification for concrete vibrating tables</td>
<td></td>
</tr>
<tr>
<td>3366-1965</td>
<td>Specification for pan vibrators</td>
<td></td>
</tr>
<tr>
<td>4656-1968</td>
<td>Specification for form vibrators for concrete</td>
<td></td>
</tr>
<tr>
<td>2722-1964</td>
<td>Specification for portable swing weight batchers for concrete (single and double bucket type)</td>
<td></td>
</tr>
<tr>
<td>2750-1964</td>
<td>Specification for steel scaffolding.</td>
<td></td>
</tr>
<tr>
<td>7 Brick work:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1077-1986</td>
<td>Common burnt clay building bricks</td>
<td></td>
</tr>
<tr>
<td>1200(pt.III)-1976</td>
<td>Method of measurements of brick work</td>
<td></td>
</tr>
<tr>
<td>2116-1980</td>
<td>Sand for masonry mortars</td>
<td></td>
</tr>
<tr>
<td>2212-1962</td>
<td>Code of practice for brick work</td>
<td></td>
</tr>
<tr>
<td>3102-1971</td>
<td>Classification of burnt clay solid bricks</td>
<td></td>
</tr>
<tr>
<td>3495(pt.IV)-1976</td>
<td>Method of test for clay building work</td>
<td></td>
</tr>
<tr>
<td>5454-1978</td>
<td>Method for sampling for sampling of clay building bricks</td>
<td></td>
</tr>
<tr>
<td>8 Stone Work:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1121-(pt.I)-1974</td>
<td>Methods for determination of compressive, transverse and shear strengths of natural building stones</td>
<td></td>
</tr>
<tr>
<td>1122-1974</td>
<td>Methods for determination of specific gravity and porosity of natural building stones</td>
<td></td>
</tr>
<tr>
<td>1123-1975</td>
<td>Methods of test for water absorption of natural building stones</td>
<td></td>
</tr>
<tr>
<td>1124-1974</td>
<td>Methods of test for absorption of natural building stones</td>
<td></td>
</tr>
<tr>
<td>1125-1974</td>
<td>Methods of test for weathering of natural building stones</td>
<td></td>
</tr>
<tr>
<td>1126-1974</td>
<td>Methods of test for durability of natural building stones.</td>
<td></td>
</tr>
<tr>
<td>1129-1972</td>
<td>Dressing of natural building stones</td>
<td></td>
</tr>
<tr>
<td>1200(pt.IV)-1976</td>
<td>Method of measurement of stone masonry.</td>
<td></td>
</tr>
<tr>
<td>1597-1967</td>
<td>Code of practice for construction of rubble stone masonry</td>
<td></td>
</tr>
<tr>
<td>1805-1973</td>
<td>Glossary of items relating to stone quarrying and Dressing</td>
<td></td>
</tr>
<tr>
<td>4101(pt.I)-1967</td>
<td>Stone facing</td>
<td></td>
</tr>
<tr>
<td>9 Marble work:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1122-1974</td>
<td>Methods for determination of specific gravity and porosity of natural building stones</td>
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<td>1124-1974</td>
<td>Methods of test for water absorption of natural building stones</td>
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</tr>
<tr>
<td>1130-1969</td>
<td>Marble (blocks, slabs and tiles)</td>
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<td>10 Wood work:</td>
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<tr>
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<td>205-1992</td>
<td>Non-ferrous metal butt hinges</td>
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<tr>
<td>206-1992</td>
<td>Tee and strap hinges</td>
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<tr>
<td>207-1964</td>
<td>Gate and shutter hooks and eyes</td>
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</tr>
<tr>
<td>208-1987</td>
<td>Door handles</td>
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<td>281-1991</td>
<td>Mild steel sliding door bolts for use with padlocks</td>
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<td>287-1973</td>
<td>Recommendation for maximum permissible moisture contents of timer used for different purposes.</td>
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<td>303-1989</td>
<td>Plywood for general purpose</td>
<td></td>
</tr>
<tr>
<td>362-1991</td>
<td>Parliament hinges</td>
<td></td>
</tr>
<tr>
<td>363-1993</td>
<td>Hasps and staples</td>
<td></td>
</tr>
<tr>
<td>364-1993</td>
<td>Fanlight catch</td>
<td></td>
</tr>
<tr>
<td>401-1982</td>
<td>Code of practice for preservation of timber</td>
<td></td>
</tr>
<tr>
<td>451-1973</td>
<td>Technical supply condition for wood screws</td>
<td></td>
</tr>
<tr>
<td>452-1973</td>
<td>Door springs, rail-tail type</td>
<td></td>
</tr>
<tr>
<td>453-1993</td>
<td>Double acting spring hinges</td>
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</tr>
<tr>
<td>723-1972</td>
<td>Steel counter sunk head wire nails</td>
<td></td>
</tr>
<tr>
<td>729-1979</td>
<td>Drawer locks, cup board locks and box locks</td>
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<tr>
<td>848-1974</td>
<td>Synthetic resin adhesive for plywood (phenolic and amino plastic)</td>
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<tr>
<td>851-1978</td>
<td>Synthetic resin adhesive for construction work</td>
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<td>852-1994</td>
<td>Specifications for animal glue for general wood working purposes</td>
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<td>1003</td>
<td>Timer paneled and glazed shutters</td>
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<td>1003(pt.I)-1991</td>
<td>Door shutters</td>
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<tr>
<td>1003(pt.-II)-1994</td>
<td>Window and ventilator shutters</td>
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</tr>
<tr>
<td>1019-1974</td>
<td>Rim latches</td>
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</tr>
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<td>1141-1993</td>
<td>Code of practice for seasoning of timer</td>
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</tr>
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<td>1200</td>
<td>Method of measurement and Building of Civil Engineering Works</td>
<td></td>
</tr>
<tr>
<td>1200(pt.XIV)-1984</td>
<td>Glazing</td>
<td></td>
</tr>
<tr>
<td>1200(pt.XXI)-1973</td>
<td>Wood work and joinery</td>
<td></td>
</tr>
<tr>
<td>1322-1993</td>
<td>Bitumen felts for water proofing and damp proofing</td>
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<tr>
<td>1328-1982</td>
<td>Veneered decorative plywood</td>
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<tr>
<td>1341-1992</td>
<td>Steel Butt hinges</td>
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<td>1378-1987</td>
<td>Oxidized copper finished</td>
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<td>1568-1970</td>
<td>Wire cloth for general purposes</td>
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<td>1629-1960</td>
<td>Rules for grading of out size of timer</td>
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<tr>
<td>1658-1977</td>
<td>Fiber hard board</td>
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<tr>
<td>1659-1990</td>
<td>Block boards</td>
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</tr>
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<td>1823-1980</td>
<td>Floor door stoppers</td>
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</tr>
<tr>
<td>1868-1982</td>
<td>Anodic coating on Aluminum</td>
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</tr>
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<td>1911-1967</td>
<td>Schedule of unit weights of building materials</td>
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<tr>
<td>2191-1983</td>
<td>Wooden flush door shutter (cellular and hollow core type)</td>
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<tr>
<td>2191(pt.I)-1983</td>
<td>Plywood face panels</td>
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<td>2191(pt.II)-1983</td>
<td>Particle board face panels for wooden flush door shutters</td>
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<td>2202</td>
<td>Wooden flush door shutters (solid core type)</td>
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<td>2202(pt.I)-1991</td>
<td>Plywood face panels for wooden flush door shutters</td>
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<td>2202(pt.II)-1983</td>
<td>Particle board face panels for wooden flush door shutters</td>
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</tr>
<tr>
<td>2209-1976</td>
<td>Mortise locks (vertical type)</td>
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<tr>
<td>2380-1981</td>
<td>Method of test for wood particle board and boards from lignocelluloses materials</td>
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<tr>
<td>2681-1993</td>
<td>Non-ferrous metal sliding door bolts for use with pad locks</td>
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<tr>
<td>2835-1987</td>
<td>Flat transparent sheet glass (3rd revision)</td>
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<td>3087-1985</td>
<td>Wood particle boards (medium density) for general purpose</td>
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<td>Number</td>
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<td>3097-1980</td>
<td>Veneered particle boards (1&lt;sup&gt;st&lt;/sup&gt; Revision)</td>
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<td>3400</td>
<td>Method of test for vulcanized rubbers</td>
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<td>3400(pt.II)-1980</td>
<td>Hardness</td>
<td></td>
</tr>
<tr>
<td>3400(pt.IV)-1987</td>
<td>Accelerated aging</td>
<td></td>
</tr>
<tr>
<td>3400(pt.IX)-1978</td>
<td>Relative density and density</td>
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</tr>
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<td>3564-1986</td>
<td>Door closers (hydraulically regulated)</td>
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<td>3618-1966</td>
<td>Phosphate treatment of iron and steel of protection against corrosion</td>
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<td>3813-1987</td>
<td>“C” hooks for use with swivels</td>
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<tr>
<td>3818-1992</td>
<td>Continuous (piano) hinges</td>
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<td>3847-1992</td>
<td>Mortise night latches</td>
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<td>4020-1967</td>
<td>Methods of tests for wooden flush doors (type tests)</td>
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<td>4021-1983</td>
<td>Timber door, windows and ventilator frames</td>
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<td>4827-1983</td>
<td>Electroplated coating of nickel and chromium on copper and copper alloys.</td>
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<td>4948-1974</td>
<td>Welded steel wire fabric for general use</td>
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<td>4992-1975</td>
<td>Door handles for mortise locks (vertical type)</td>
<td></td>
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<tr>
<td>5187-1972</td>
<td>Flush bolts</td>
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</tr>
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<td>5523-1983</td>
<td>Method of testing anodic coating on aluminum and its alloys</td>
<td></td>
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<tr>
<td>5930-1970</td>
<td>Mortise latch (vertical types)</td>
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<td>6318-1971</td>
<td>Plastic window stays and fasteners</td>
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<tr>
<td>6607-1972</td>
<td>Rebated mortise locks (vertical type)</td>
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<td>6760-1972</td>
<td>Slotted countersunk head wood screws</td>
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</tr>
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<td>7196-1974</td>
<td>Hold fasts</td>
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<td>7197-1974</td>
<td>Double action floor springs (without oil check for heavy doors)</td>
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<tr>
<td>7534-1985</td>
<td>Mild steel bolts with holders for padlocks</td>
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**11 Steel Work:**

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>63-1978</td>
<td>Whiting for paints</td>
</tr>
<tr>
<td>198-1978</td>
<td>Varnish, gold size</td>
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<tr>
<td>226-1975</td>
<td>Structural steel (standard quality)</td>
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<tr>
<td>277-1985</td>
<td>Specification for galvanized steel sheets (plain and corrugated)</td>
</tr>
<tr>
<td>278-1978</td>
<td>Galvanized steel barbed wire for fencing</td>
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<tr>
<td>800-1984</td>
<td>Code of practice for use of structural steel in General building construction</td>
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<tr>
<td>806-1968</td>
<td>Code of practice for use of steel tube in general building construction</td>
</tr>
<tr>
<td>813-1986</td>
<td>Scheme of symbols for welding</td>
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<td>814-1991</td>
<td>Covered electrodes for metal are welding of structural steel.</td>
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<tr>
<td>814(pt.I)-1974</td>
<td>For welding products other than sheets</td>
</tr>
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<td>814(pt.II)-1974</td>
<td>For welding sheets</td>
</tr>
<tr>
<td>815-1974</td>
<td>Classification and coding of covered electrodes for metal are welding of mild steel and low alloy high tensile steel.</td>
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<tr>
<td>817-1966</td>
<td>Code of practice for training and testing of metal are welders</td>
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<tr>
<td>818-1968</td>
<td>Code of practice for safety and healthy requirements in electric and gas welding and cutting operation</td>
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<tr>
<td>1038-1983</td>
<td>Steel doors, windows and ventilators</td>
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<td>1081-1960</td>
<td>Code of practice for fixing and glazing of metal (steel and aluminum) door, windows and ventilators</td>
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<tr>
<td>1148-1982</td>
<td>Hot rolled steel river bars (up to 40mm diameters) for structural purposes</td>
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<td>1161-1979</td>
<td>Steel tubes for structural purposes</td>
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<tr>
<td>1182-1983</td>
<td>Recommended practice for radiographic examination of fusion welded joints in steel plates</td>
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<tr>
<td>1200-1974</td>
<td>Method of measurements of steel work and iron works</td>
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<td>1363-1984</td>
<td>Hexagon bolts, nuts and lock nuts (dia 6 to 39mm) and black hexagon screws (dia 6 to 24 mm)</td>
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<td>1599-1985</td>
<td>Method for bend test for steel products other than sheet, strip, wire and tube</td>
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<td>1608-1972</td>
<td>Method for tensile testing of steel products</td>
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<td>1821-1987</td>
<td>Dimensions for clearance holes for metric bolts</td>
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<td>1852-1985</td>
<td>Rolling and cutting tolerance for hot rolled steel products</td>
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<td>1894-1972</td>
<td>Method for tensile testing of steel tunes</td>
</tr>
<tr>
<td>1977-1975</td>
<td>Structural steel (ordinary quality)</td>
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<td>2062-1984</td>
<td>Structural steel (fusion welding quality)</td>
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<tr>
<td>4351-1976</td>
<td>Steel door frames</td>
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<tr>
<td>4736-1986</td>
<td>Hot-dip zinc coatings on steel tubes</td>
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<tr>
<td>6248-1979</td>
<td>Metal rolling shutters and rolling grills</td>
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<tr>
<td>7452-1990</td>
<td>Hot rolled steel sections for doors, windows &amp; ventilations</td>
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</table>

12 Flooring:
- 210-1978 Grey iron casting
- 653-1992 Sheet linoleum
- 777-1988 Glazed earthen-ware tiles
- 809-1992 Rubber flooring materials for general purpose
- 1122-1974 Methods for determination of specific Gravity and porosity of natural building stones
- 1124-1974 Method of test for water absorption of natural building stones
- 1130-1969 Marble (blocks, slabs and tiles)
- 1198-1982 Code of practice for laying and maintenance of linoleum floors
- 1200(pt.XI)-1977 Method of measurements of paving and floor finished
- 1237-1980 Cement concrete flooring tiles
- 1443-1972 Code of practice for laying and finishing of Cement concrete flooring tiles
- 1661-1972 Code of practice for application of cement and cement lime plaster finishes
- 2078-1979 Method of tensile testing of gray cast iron
- 2114-1984 Code of practice for laying in situ terrazzo floor finish
- 3400 Method of test of vulcanized rubbers
- 3400(pt.II)-1980 Hardness
- 3400(pt.X)-1977 Compression set at constant strain
- 3462-1986 Flexible PVC flooring
- 5389-1969 Code of practice for laying hardwood parquet and wood block floors

13 Roofing:
- 73-1992 Paving Bitumen
- 277-1992 Galvanized Steel sheets (plain and corrugated)
- 458-1988 Concrete pipes (with an without reinforcement)
- 459-1992 Un reinforced corrugated and semi corrugated
- 651-1992 Asbestos cement sheets
<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>702-1988</td>
<td>Salt glazed stone ware pipes and fittings</td>
</tr>
<tr>
<td>1199-1959</td>
<td>Industrial Bitumen</td>
</tr>
<tr>
<td>1200(pt.IX)-1973</td>
<td>Method of sampling &amp; analysis of concrete</td>
</tr>
<tr>
<td>1200(pt.X)-1973</td>
<td>Method of measurements of roof covering (including cladding)</td>
</tr>
<tr>
<td>1202-1978</td>
<td>Method of measurements of ceiling and lining</td>
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<tr>
<td>1203-1978</td>
<td>Determination of specific gravity for testing Tar and Bitumen</td>
</tr>
<tr>
<td>1205-1978</td>
<td>Determination of penetration for testing Tar and Bitumen</td>
</tr>
<tr>
<td>1208-1978</td>
<td>Determination of Ductility for testing Tar and Bitumen</td>
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<tr>
<td>1209-1978</td>
<td>Determination of flash point and fire point for Testing tar and bitumen</td>
</tr>
<tr>
<td>1211-1978</td>
<td>Determination of water content for testing Tar and bitumen</td>
</tr>
<tr>
<td>1212-1978</td>
<td>Determination of loss on heating for testing Tar and bitumen</td>
</tr>
<tr>
<td>1216-1978</td>
<td>Determination of solubility in carbon disulphide for testing Tar and bitumen</td>
</tr>
<tr>
<td>1322-1993</td>
<td>Bitumen felts for water proofing and damp proofing</td>
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<td>1346-1976</td>
<td>Code of practice for waterproofing of roof with Bitumen felts</td>
</tr>
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<td>1609-1991</td>
<td>Code of proactive for laying damp proof treatment using bitumen felts</td>
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<tr>
<td>1626-1994</td>
<td>Asbestos cement building pipes, gutters and fittings (spigot and socket types)</td>
</tr>
<tr>
<td>1834-1984</td>
<td>Specification for hot applied sealing compounds for joints in concrete</td>
</tr>
<tr>
<td>1838-(pt.I)-1983</td>
<td>Preformed filler for expansion joints in concrete non-extruding and resilient type (bitumen impregnated fiber)</td>
</tr>
<tr>
<td>2115-1980</td>
<td>Code of practice for flat roof finish mud phuska</td>
</tr>
<tr>
<td>2633-1986</td>
<td>Method of testing uniformity of coating on zinc coated articles</td>
</tr>
<tr>
<td>3348-1965</td>
<td>Fiber insulation boards</td>
</tr>
<tr>
<td>3607-1979</td>
<td>Magnetite for chemical industry</td>
</tr>
<tr>
<td>7193-1994</td>
<td>Specifications for glass fiber base coal tar pitch &amp; Bitumen felts</td>
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<tr>
<td>8183-1993</td>
<td>Bonded mineral wool</td>
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### 14 Finishing:

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
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<tbody>
<tr>
<td>75-1973</td>
<td>Linseed oil, raw and refinery</td>
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<td>Linseed oil, boiled, for paints</td>
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<td>102-1962</td>
<td>Ready mixed paint, brushing, red, lead for priming and general purposes</td>
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<td>103-1962</td>
<td>Ready mixed paint, brushing, white lead for priming an general purposes</td>
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<tr>
<td>104-1979</td>
<td>Specification for ready mixed paint, brushing, Zinc chrome priming</td>
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<tr>
<td>133-1993</td>
<td>Enamel, interior (a) under coating (b) finished colour as required</td>
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<td>137-1965</td>
<td>Ready mixed paint, brushing, matt or egg-shell flat, finishing, interior, to Indian Standard colour, as required</td>
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<td>158-1981</td>
<td>Ready mixed paint, brushing, bituminous, black lead free acid alkali, water an heat resting for general purposes</td>
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<td>Code</td>
<td>Description</td>
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<tr>
<td>168-1993</td>
<td>Read mixed paint, air drying for general purpose</td>
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<td>217-1988</td>
<td>Cut back bitumen</td>
</tr>
<tr>
<td>218-1983</td>
<td>Creosole and anthracene oil for use as wood preservatives</td>
</tr>
<tr>
<td>290-1961</td>
<td>Coal tar black paint</td>
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<tr>
<td>337-1975</td>
<td>Varnish, finishing interior</td>
</tr>
<tr>
<td>338-1952</td>
<td>Varnish, under coating exterior, natural resin</td>
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<td>339-1952</td>
<td>Varnish under coating, exterior, synthetic resin</td>
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<tr>
<td>340-1978</td>
<td>Varnish mixing</td>
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<tr>
<td>341-1973</td>
<td>Black Japan, type A, B and C.</td>
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<tr>
<td>345-1952</td>
<td>Wood filler, Transparent, liquid</td>
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<td>347-1975</td>
<td>Varnish shellac for general purpose</td>
</tr>
<tr>
<td>348-1968</td>
<td>French polish</td>
</tr>
<tr>
<td>419-1967</td>
<td>Putty for use of window frames</td>
</tr>
<tr>
<td>427-1965</td>
<td>Distemper, dry, colour as required</td>
</tr>
<tr>
<td>524-1983</td>
<td>Varnish, finishing exterior, synthetic</td>
</tr>
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<td>525-1968</td>
<td>Varnish, finishing exterior and general purposes</td>
</tr>
<tr>
<td>533-1973</td>
<td>Gum spirit of turpentine (oil of turpentine)</td>
</tr>
<tr>
<td>712-1984</td>
<td>Specification for building limes</td>
</tr>
<tr>
<td>1200(pt.XII)-1976</td>
<td>Method of measurements of plastering and pointing</td>
</tr>
<tr>
<td>1200(pt.XIII)-1987</td>
<td>Method of measurements of white washing</td>
</tr>
<tr>
<td>1200(pt.XV)-1987</td>
<td>Method of measurements of painting, polishing &amp; varnishing</td>
</tr>
<tr>
<td>2095-1982</td>
<td>Gypsum plaster boards</td>
</tr>
<tr>
<td>2096-1992</td>
<td>Asbestos cement flat sheets</td>
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<td>2339-1963</td>
<td>Aluminum paint for general purposes, in dual container</td>
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<tr>
<td>2547-1976</td>
<td>Gypsum building plaster</td>
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<td>2932-1994</td>
<td>Enamel synthetic, exterior (a) Under coating (b) Finishing</td>
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<td>Enamel, Exterior (a) Under coating (b) Finishing</td>
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<td>Cement paint, colour as required</td>
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<td>Plastic emulsion paint for interior use</td>
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<td>Code of practice for white washing &amp; colour washing</td>
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<td>Demolition and Dismantling:</td>
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<td>1200(pt.XVIII)-</td>
<td>Method of measurements of demolition and dismantling</td>
</tr>
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<td>16</td>
<td>Safety Codes:</td>
</tr>
<tr>
<td>818-1968</td>
<td>Safety and healthy requirements in Electric and gas welding and cutting operations</td>
</tr>
<tr>
<td>3698-(pt.I)-1987</td>
<td>Safety code for scaffolds</td>
</tr>
<tr>
<td>3696(pt.II)-1966</td>
<td>Safety code for ladders</td>
</tr>
<tr>
<td>3764-1966</td>
<td>Safety code for Excavation works</td>
</tr>
<tr>
<td>4081-1986</td>
<td>Safety code for blasting and related drilling operation</td>
</tr>
<tr>
<td>4130-1976</td>
<td>Safety code for demolition of building</td>
</tr>
<tr>
<td>5916-1970</td>
<td>Safety code for construction involving use of hot bituminous materials</td>
</tr>
<tr>
<td>6922-1973</td>
<td>Structure subject to underground blasts code of practice for safety and design for</td>
</tr>
<tr>
<td>7293-1974</td>
<td>Working with construction machinery safety code</td>
</tr>
</tbody>
</table>
# 3.0 LIST OF APPROVED MAKES: CIVIL WORKS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>MATERIALS</th>
<th>MANUFACTURERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Doors &amp; Windows fixtures/ Fittings:</td>
<td>Dorma/Dorset/Ebco</td>
</tr>
<tr>
<td>2.</td>
<td>Door Closer / Floor spring</td>
<td>Dorma/Ebco</td>
</tr>
<tr>
<td>3.</td>
<td>Aluminium Sections.</td>
<td>Bhoruka, Hindalco, Jindal</td>
</tr>
<tr>
<td>4.</td>
<td>Clear Glass/ Clear Float Glass / Toughened Glass</td>
<td>Modi(GG), AIS(Tata), Saint Gobain(SG)</td>
</tr>
<tr>
<td>5.</td>
<td>Laminates</td>
<td>Formica, Decolam, Century, Marino, National, Green Ply</td>
</tr>
<tr>
<td>6.</td>
<td>Synthetic Enamel Paints</td>
<td>Berger, Asian paints, Jotun, Kansai Nerolac</td>
</tr>
<tr>
<td>7.</td>
<td>Oil Bound Distemper</td>
<td>Asian paints, Lewis Berger, Kansai Nerolac, Jotun</td>
</tr>
<tr>
<td>8.</td>
<td>Cement Paint</td>
<td>Snowcem Plus, Berger (Durocem Extra), Nerolac(Nercocem with Titanium), Jotun</td>
</tr>
<tr>
<td>10.</td>
<td>Other Paints/Primers</td>
<td>Asian, Berger, Nerolac, Jotun</td>
</tr>
<tr>
<td>11.</td>
<td>Cement</td>
<td>(OPC 43 &amp; 53 grade conforming to BIS-8112) ACC, Grasim, JK, Ambuja (from lot not more than 1 month old)</td>
</tr>
<tr>
<td>12.</td>
<td>Silver Grey Cement</td>
<td>Sriram, ACC,</td>
</tr>
<tr>
<td>13.</td>
<td>Reinforcement Steel</td>
<td>TMT FE-500 steel conforming to BIS-1786 with appropriate Test certificates, TATA, Jindal</td>
</tr>
<tr>
<td>14.</td>
<td>Polysulphide sealant.</td>
<td>Pidilite, Fosroc,</td>
</tr>
<tr>
<td>15.</td>
<td>Polycarbonate Sheets</td>
<td>GE Plastics or approved equivalent</td>
</tr>
<tr>
<td>16.</td>
<td>Gypsum Board System</td>
<td>India Gypsum/Equivalent</td>
</tr>
<tr>
<td>17.</td>
<td>Wall putty</td>
<td>Birla, JK or equivalent</td>
</tr>
<tr>
<td>20.</td>
<td>Ceramic Tiles</td>
<td>Johnson, Somany, Kajaria, Spartek, Nitco</td>
</tr>
<tr>
<td>21.</td>
<td>Pre-Laminated Particle Board</td>
<td>Novopan, Greenlam, Kitlam, Bhutan Board.</td>
</tr>
<tr>
<td>22.</td>
<td>Flush Door Shutters.</td>
<td>Century, Kitply, Novapan, Green Ply</td>
</tr>
<tr>
<td>23.</td>
<td>Glazed Tiles</td>
<td>Bell, Somany, Johnson, Kajaria, Cera, Euro</td>
</tr>
<tr>
<td>24.</td>
<td>White Cement.</td>
<td>Birla White, J.K.</td>
</tr>
<tr>
<td>25.</td>
<td>Stainless Steel Screws For Fabrication and fixing of Windows</td>
<td>Kundan, Puja, Atul.</td>
</tr>
<tr>
<td>26.</td>
<td>Dash Fasteners/Anchor bolts</td>
<td>Hilti, Fischer, Bosch</td>
</tr>
<tr>
<td>28.</td>
<td>Floor Spring</td>
<td>Dorma/Equivalent</td>
</tr>
<tr>
<td></td>
<td>Aluminium Grill</td>
<td>Decogrill and approved equivalent</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>30</td>
<td>Vitrified Tiles</td>
<td>Naveen, Bell- Cremics, Kajaria, Somani, Euro, Orient</td>
</tr>
<tr>
<td>31</td>
<td>Door Locks</td>
<td>ACME, Godrej, Harrison, Dorset</td>
</tr>
<tr>
<td>32</td>
<td>Ply Board</td>
<td>Greenply, Kitply,</td>
</tr>
</tbody>
</table>
4.0 EXCAVATIONS, FILLING AND BACKFILLING

SCOPE OF WORK

The scope for work covered under this specifications pertain to excavation of foundations, trenches, pits and over areas, in all sorts of soil, soft and hard rock, correct to dimensions given in the drawing including shoring, protections of existing underground utilities of 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.

SITE CLEARANCE

Before the earth work is started the area coming under cutting and filling shall be cleared of all obstruction, loose stones, shrubs, rank vegetation, grass, bushes and rubbish removed up to a distance of 150 meters outside the periphery of the area under clearance. This work is deemed to be included in the earthwork item rate and no separate payment will be admissible.

ROOTS AND VEGETATION CLEARANCE

The roots of trees if any shall be removed to a minimum depth of 60 cm below ground level or a minimum of 30 cm below formation level whichever is lower and the hollows filled up with earth leveled and rammed. This work is deemed to be included in the earthwork items and no separate payment will be admissible for the work.

Any material obtained from the site will be the property of the Government of India and the useful materials as decided by the Engineer-in-charge will be conveyed and properly stacked as directed within the lead specified.

SETTING OUT AND MAKING PROFILES

Masonry or concrete pillars will be erected at suitable points in the area to serve as benchmarks for the execution of the work. These benchmarks shall be connected with G.T.S. or any other permanent benchmark 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 center 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.
EXCAVATION

The contractor shall notify the Engineer-in-charge before starting excavation and before the ground is disturbed, to enable him to take existing level 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 mounds, 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 earthwork 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, levels, grades and levels as directed by the Engineer-in-charge and per items in the schedule of quantities.

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 1.5m in width or 10sqm. on plan shall be described as excavation in foundation trenches.

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

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

CLASSIFICATION OF EARTHWORK

The earthwork shall be classified under the following main categories and measured separately for each category. All types of soil, murrum, boulders, Soft rock, Hard rock.

ALL TYPES OF SOIL, MURRUM AND BOULDERS

This includes earth, murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof ad 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.

EXCAVATION IN SOFT 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 an also the nature of foundation materials, levels and measurements shall also be recorded prior to taking up any further work.
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 shorting, 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 materials shall be removed and slope dressed to a modified stable slope. Removal of the slipped earth will not be measured for payment.

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 t keep it free from nuisance to other works in the neighborhood.

DISPOSAL OF EXCAVATED MATERIALS

ANTIQUITIES

Any finds of archeological 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.

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 3m 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. Material suitable and useful for backfilling or there use shall be stacked in convenient place but not in such a way as to obstruct free movement of materials, workers and vehicles or encroach on the area required for constructional purposes. It shall be used to the extent required to completely backfill the structure to original ground level or other elevation shown on the plan or as directed by the Engineer-in-charge. Materials not
useful in anyway shall be disposed off, leveled and compacted as directed by the Engineer-in-charge within a
specified lead. The site shall be left clan of all debris and leveled on completion.

**BACKFILLING IN SIDES OF FLOORS, 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
backfilling, 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 150mm, in thickness, watered and well consolidated by means of rammers
to at least 90% of the consolidation. 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
75mm. in any direction, salt, clods, organic or other foreign materials which might rot. The backfilling in plinth
and under floor 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 contractor’s bill.

**FILLING IN PLINTH AND UNDER FLOOR**

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 t
he item of schedule of quantities shall then be brought to site from approved locations and sources.

**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.

**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 12mm to 20mm. It shall be uniformly blind with approved type of soil and/or sand to obtain full compaction. Gravel shall be filled in specified thickness and shall be well watered and rammed entirely to the satisfaction of the Engineer-in-charge.

If sand is required to be filled under floors, it shall be clean, medium grained and free from impurities. The filled in sand shall be kept flooded with water for 24hrs. to ensure maximum consolidation 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.

**LEAD AND 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 center lines shall be taken as the leads 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 1.5m 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 1.5m 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 up to 250m. All excavation shall be measured in successive stages of 1.5m stating the commencing level. This shall not apply to cases where no lift is involved as in hill side cutting.

**MODE OF MEASUREMENTS**

All excavation in areas having depth more than 30cm. pits, trenches etc. shall be measured net. The dimensions for the purpose of payment shall be reckoned on the horizontal area of the excavations 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 meter basis, mentioning the average depth of excavation.

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.
Where direct measurements of rock excavation are not possible, volume of rock can 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 40% taking the voids into consideration as 40%. Similarly to arrive at net quantity to be paid in the case of soil, reduction at 20% of corresponding stack / truck measurements shall be made.

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

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

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

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 made, 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.

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 decided on measurement by levels, levels of site shall be jointly taken and recorded by the Engineer-in-charged 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 "Simpson's formula ' or any other approved method at the discretion of the Engineer-in-charge.
5.0 HARD CORE / SOLING UNDER FLOORS / FOUNDATIONS:

SCOPE
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 specification mentioned below and applicable drawings.

RUBBLE SOLE FLOORING
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.

PREPARATION OF SURFACE
The bed on which rubble soling is to be laid shall be cleared of all loose materials, leveled, watered ad 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.

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 230mm or 150mm 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 area.

The surfaces shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log-rammers as approved by the Engineer. After compaction, the Engineer-in-charge to give the required slope or level and dense sub-base and the surface shall present clean look. Adequate care shall be taken by the contractor while laying and compacting the rubble soling to see that concrete surfaces in contact with soling are not damaged.
MODE OF MEASUREMENT

The quoted rate shall be per square metre of the soling of specified thickness. The linear dimension 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 soling 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.
6.0 ANTI-TERMITE TREATMENT:

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

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

SCOPE
The scope of pre constructional anti-termite treatment covers the soil treatment with approved chemicals in water emulsion in foundation trenches for columns, plinth beams, 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 anti-termite treatment will be carried out as per IS 6313 (part II) 1981 and / or as per direction of the Engineer-in-charge.

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

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

b) Remove all concrete form work if left anywhere, leveling pegs, timber off-cuts and other building 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 75mm at least.

f) All sub-floor leveling 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.

**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 following chemicals in water emulsion, after approval from the Engineer-in-charge shall be used uniformly over the area to be treated.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>% of concentration of Chemical by weight in</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Heptachlor 20 EC emulsifiable concentrates (I.S.6439 – 19781-R)</td>
<td>0</td>
</tr>
<tr>
<td>II. Chlordance 20 EC emulsifiable concentrates (I.S.2682-1984 II-R)</td>
<td>1</td>
</tr>
<tr>
<td>III. THIODAN 35 EC emulsifiable concentrates (Endosulphan)</td>
<td>0</td>
</tr>
<tr>
<td>IV. Chloryprphos 20 EC emulsifiable concentrates (I.S. 8944-1974)</td>
<td>1</td>
</tr>
</tbody>
</table>

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.
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.

Treatment in Foundation Trenches:

In case of normal wall load bearing structures, columns pits, wall trenches and basement, the treatment shall be at 5 litres/sqm. or surface area of the bottom and sides to a height of at least 300mm. After the foundation work, the sides shall be treated at 7.5 litres/sqm. of vertical surface of substructure on each side. After the earth filling is done, treatment shall be done by rodding the earth at 150mm centers close to wall surface and spraying the chemical with the above dose i.e. 7.5 litres/sqm. In case of framed structure, the treatment shall start at a depth of 500mm below ground level. From this depth the backfill around the columns, beams and R.C.C. basement walls shall be treated at 7.5 litres / sqm. of the vertical and at 5 litres / sqm. for the horizontal surface at the bottom in the trenches / pits.

Treatment on Top Surfaces on 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 up to 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.

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) up to 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 up to the finished ground level at 150mm apart and the iron rod moved backward and forward to break the earth and chemical emulsion poured along the channel at 7.5 litres (or at recommended quantity per sqm. of the vertical wall / column surfaces so as to soak the soil right up to the bottom. The soil shall be tamped back into place after this operation.

Treatment for Expansion Joints:

The soil beneath the expansion joins 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.
Precautions during Treatment:

1. 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.

2. The treatment should not be carried out when it is raining or when the soil is wet with rain or sub-soil water.

3. 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.

Precautions for Health Hazards and Safety Measures:

All the chemicals mentioned above are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as 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 all the safety precautions particularly when handling these chemicals in the form of concentrates.

These chemicals are usually brought to the site in the form of emulsifiable concentrates. The containers should be clearly labeled and should be stored carefully out of the reach of children and pets animal. They should be kept securely locked.

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 especially before eating. 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 water and immediate medical attention should be sought.

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

Care should be taken in the application of chemicals / soil toxicants to see that they are not allowed to contaminate wells or springs and other sources of drinking water.

Guarantee:

The contractor has to furnish the guarantee for 10 (ten) years from the date of completion of work, starting 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.

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.
7.0 DAMP PROOF COURSE

Scope of work:

The work covered under this specifications consists supplying and laying plain cement concrete or cement plaster 1:3 as damp proof course with or without waterproofing admixture with this specification and applicable drawings.

Workmanship:

Surface to receive damp proof course shall be cleaned and carefully wiped 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 or cement plaster in the ratio CM 1:3. Approved water proofing compound @ 2% by weight of cement or as directed by the manufacturer shall be mixed in cement mortar for this concrete or plaster. The damp proof course shall be laid to the full width of the walls 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 by curing of damp proof course shall be continued along with the masonry work. Specification for cement, sand, aggregate and water shall be as described herein before for concrete works / cement plaster.

Mode of measurement:

The work shall be measured in sqm. area actually laid limited to sites as shown in drawing. The rate shall include cost of all the materials, labour etc. and scaffolding (if any).
8.0 REINFORCED CONCRETE AND ALLIED WORKS:

Scope:

After award of the work, if so desired by the contractor, he / they may be allowed by the Engineer-in-charge till the designed mix is obtained, to carry out the reinforce concrete work in foundation and plinth as per equivalent nominal mix against the specified design mix concrete as per IS 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 on this account whether the cement is supplied by the Department or procured by the contractor.

Cement Concrete (Plain and Reinforced):

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

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 equipment’s and the quality control system. Such an inspection shall be arranged by the contractor and the Engineer-in-charge's approval shall be obtained prior to starting the concrete work.

Materials for Standard Concrete:

The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement, clean sand, natural coarse aggregate, clean water, ice and admixtures if specially called for as per drawings or schedule of quantities.

Cement:

Unless otherwise specified or called for by the Engineer-in-charge, cement shall be ordinary Portland cement in 50 kg bags. The use of bulk cement will be permitted only with the approval of the Engineer-in-charge. Changing of brands or type of cement within the same structure will not be permitted. Ordinary Portland cement (OPC) 43 grades manufactured as per I.S. specifications of reputed brands like ACC / Ultratech / Zuari / Coramendel or any other brands as approved by the Engineer-in-charge from time to time shall be procured and used on the work. Joint account of cement consumed at site for every day for items of work carried shall be maintained by the Contractor for verification to ensure effective control on quality of cement used in the work.

A certified report attesting to the conformity of the cement to IS specifications by the cement
manufactures chemist shall be furnished to the Engineer-in-charge, if demanded. In case the cement is required to be arranged by the Contractor, the Contractor will have to make his own arrangement for the storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos which will provide complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangements shall be such that there is no dead storage. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be got approved by the Engineer-in-charge. Consignments in cement shall be stored as received and shall be consumed in the order of their delivery.

Contractor shall establish cement/concrete/soil testing laboratories at site of work with qualified person to handle the laboratory. Every consignment of cement procured shall accompany test certificate from the company indicating lot No etc. Sample shall be taken for each lot and sent to Standard Approved Material Testing Laboratory for physical and chemical analysis. The cost of testing shall be borne by the Contractor.

Cement held in store for a period of 90 (ninety) 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.

Aggregates:

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

"Fine Aggregate" is aggregate most of which passes through 4.75 mm I.S. sieve. "Coarse Aggregate" is aggregate most of which is retained on 4.75 mm I.S. sieve.

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, curable
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 and shall be based on the "mix design" and preliminary test on concrete specified hereinafter.

**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 placing of concrete. Record 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 or use, in determining suitability of the proposed aggregate.

**Storage of aggregates:**

All coarse and fine aggregates shall be stacked separately in stock pile 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 meters in height to prevent conning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected materials after remixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

**Specific Gravity:**

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

**Fine Aggregate:**

Fine aggregate except as noted above, and for other than light weight concrete shall consist of natural or crushed sand conforming to IS 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.

**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 same is washed and silt content is brought within 3% by weight.

**Foreign Material Limitations:**

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

<table>
<thead>
<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 IS 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 limit indicated hereunder:

<table>
<thead>
<tr>
<th>IS Sieve designation</th>
<th>Percentage passing for Zone-I</th>
<th>Percentage passing for Zone-II</th>
<th>Percentage passing for Zone-III</th>
<th>Percentage passing for Zone-IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mm</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4.75mm</td>
<td>90-100</td>
<td>90-100</td>
<td>90-100</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36mm</td>
<td>60-95</td>
<td>75-100</td>
<td>85-100</td>
<td>95-100</td>
</tr>
<tr>
<td>1.18mm</td>
<td>30-70</td>
<td>55-90</td>
<td>75-100</td>
<td>90-100</td>
</tr>
<tr>
<td>600 micron</td>
<td>15-34</td>
<td>35-59</td>
<td>60-79</td>
<td>80-100</td>
</tr>
<tr>
<td>300 micron</td>
<td>5-20</td>
<td>8-30</td>
<td>8-30</td>
<td>20-65</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-10</td>
<td>0-10</td>
<td>0-10</td>
<td>0-15</td>
</tr>
</tbody>
</table>

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron (IS) 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 (IS) 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 IS sieve sizes (4.75 mm, 2.36 mm, 1.18mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.
Coarse Aggregate:

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

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

Screening and Washing:

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

Grading:

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

<table>
<thead>
<tr>
<th>IS Sieve</th>
<th>Percentage passing for single sized aggregates</th>
<th>Percentage passing for graded aggregates of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63mm</td>
<td>40mm</td>
</tr>
<tr>
<td>75mm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>63mm</td>
<td>85-100</td>
<td>100</td>
</tr>
<tr>
<td>37.5mm</td>
<td>0-30</td>
<td>85-100</td>
</tr>
<tr>
<td>19mm</td>
<td>0.5</td>
<td>0.20</td>
</tr>
<tr>
<td>16mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11.2mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9.5mm</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>4.75mm</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>2.36mm</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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 160mm and up to any reasonable size can be used in plain mass concrete work of large dimensions up to 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 5mm, less than the minimum clear distance between the reinforcing main bars of 5mm less than 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 IS 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% or its over dry weight in air, as determined by IS 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>Percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Material finer than 75 micron IS Sieve</td>
<td>3.00 3.00</td>
</tr>
<tr>
<td>II</td>
<td>Coal and Lignite</td>
<td>1.00 1.00</td>
</tr>
<tr>
<td>III</td>
<td>Clay lumps</td>
<td>1.00 1.00</td>
</tr>
<tr>
<td>IV</td>
<td>Soft fragments</td>
<td>3.00 -</td>
</tr>
<tr>
<td>V</td>
<td>Total of all the above substances</td>
<td>5.00 5.00</td>
</tr>
</tbody>
</table>

**Water:**

Water used for both mixing and curing shall be free from injurious amount of deleterious materials; 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 IS 456. 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 150mm 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.

The initial setting time of test block made with the appropriate test cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than (+) 30 minutes form the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of IS 4031. 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.

**Limits of acidity:**

To neutralize 200ml sample of water, using phenolphthalein as an indicator, it should not require more than 2ml of 0.1 normal NaOH. The details of test shall be as given in IS 3025.
Limits of alkalinity:

To neutralize 200ml sample of water, using methyl orange as an indicator, it should not require more than 10ml of 0.1 normal HCL. The details of test shall be as given in IS 3025.

Percentage of solids shall not exceed the following:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>2.02% (200 mg/litre)</td>
<td></td>
</tr>
<tr>
<td>Inorganic</td>
<td>0.30% (3000mg/litre)</td>
<td></td>
</tr>
<tr>
<td>Sulphates (as SO4)</td>
<td>0.05% (500mg/litre)</td>
<td></td>
</tr>
<tr>
<td>Alkali chlorides (As cl)</td>
<td>0.20% (2000mg/litre) for plain concrete work &amp; 0.10% (1000mg/litre) for reinforced concrete work</td>
<td></td>
</tr>
<tr>
<td>Suspended matter</td>
<td>0.20% (2000mg/litre)</td>
<td></td>
</tr>
</tbody>
</table>

Design Mix Concrete:

All reinforced concrete in the works shall be "Design Mix Concrete" as defined in I.S. 456-2000. All "Design Mix Concrete" work to be carried out under these specifications shall be in grades designated as per table below:

Grades of Concrete:

<table>
<thead>
<tr>
<th>Grade Designation</th>
<th>Specified Characteristic compressive strength at 28 days(N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 10</td>
<td>10</td>
</tr>
<tr>
<td>M 15</td>
<td>15</td>
</tr>
<tr>
<td>M 20</td>
<td>20</td>
</tr>
<tr>
<td>M 25</td>
<td>25</td>
</tr>
<tr>
<td>M 30</td>
<td>30</td>
</tr>
<tr>
<td>M 35</td>
<td>35</td>
</tr>
<tr>
<td>M 40</td>
<td>40</td>
</tr>
</tbody>
</table>

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

Note 2: In the designation of a concrete mix, letter M refers to the mix and the number to the specified characteristic compressive strength of 15cm. cubes at 28 days.

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.
**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 proportion 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.*

**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 ration (by mass) corresponding to the target strength of 28 days may be selected from the relationship shown in Fig. 1 of IS. 10262- page 7.

Alternately, the preliminary free water ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig2-IS 10262-1982, Page 8 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 IS 10262 – 1982.

The calculated mix proportions shall be checked by means of trial batches. The contractor should refer to the item no.4 page 12, and the Appendix D (clause no.4.1) of IS 10262-1982 for neat illustration.

The contractor may refer Appendix C, clause 3.8 page no. 16 of IS 10262-1982 for an example illustrating the mix design of M-20.

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 of 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 IS 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 test is to determine the proportions of cement, aggregates and water necessary to produce the concrete of the required consistency to give such specified strength.

**Standard Deviation:**

Standard deviation of concrete of each grade shall be determined separately as stated below. When results of sufficient number of tests (at least 30) are not available, than depending on the degree of quality control expected to be exercised at the site, the value of standard deviation given in the following table may be adopted for guidance.

**Suggested Values of S.D:**

<table>
<thead>
<tr>
<th>Grade of concrete</th>
<th>S.D. for different degree of control in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>M 10</td>
<td>2.0</td>
</tr>
<tr>
<td>M 15</td>
<td>2.5</td>
</tr>
<tr>
<td>M 20</td>
<td>3.6</td>
</tr>
<tr>
<td>M 25</td>
<td>4.3</td>
</tr>
<tr>
<td>M 30</td>
<td>5.0</td>
</tr>
<tr>
<td>M 35</td>
<td>5.3</td>
</tr>
<tr>
<td>M 40</td>
<td>5.6</td>
</tr>
<tr>
<td>M 45</td>
<td>6.0</td>
</tr>
<tr>
<td>M 50</td>
<td>6.4</td>
</tr>
<tr>
<td>M 55</td>
<td>6.7</td>
</tr>
<tr>
<td>M 60</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Control expected for this work is "Very Good" and the contractor shall deploy weigh batcher if required to attain the required control Degree of Quality Control Expected under different site conditions:

<table>
<thead>
<tr>
<th>Degree of Control</th>
<th>Conditions of Productions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>Very Good</td>
<td>Fresh cement from single source and regular test, weigh batching of all materials, aggregates supplied in single size, control of water added, frequent supervision, regular workability an strength tests and field laboratory facilities.</td>
</tr>
<tr>
<td>Good</td>
<td>Carefully stored cement and periodic tests, weigh batching of all materials, controlled water, graded aggregate supplied, occasional grading and moisture test, periodic check of workability and strength, intermittent supervision an experienced workers.</td>
</tr>
<tr>
<td>Fair</td>
<td>Proper storage of cement volume, batching of all aggregate allowing for bulking of sand, weigh batching of cement, water content controlled by inspection of mix and occasional supervision and tests.</td>
</tr>
</tbody>
</table>

**Standard Deviation based on Test results:**

**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.

**Standard deviation to be brought up to date:**

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

**Determination of Standard Deviation:**

Concrete of each grade shall be analyzed separately to determine its standard deviation. The standard deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified for test strength of sample Estimated standard deviation

\[ S = \frac{2}{n-1} \text{and } n - \text{Number of sample test results} \]

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.

**Proportioning, Consistency, Batching and Mixing of Concrete:**

**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 weight batchers conforming to IS 2722, capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stacked in separate stock piles. The grading of coarse and fine aggregates shall be checked as frequently as possible, as determined by the Engineer-in-charge, to ensure maintaining of grading in accordance with samples used in preliminary mix design. The materials shall be stock piled well in advance of use.

**Cement**

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

**Specific Requirement of Cement for Concrete:**

The following minimum cement content, required to ensure durability under specified conditions of exposure as per IS 456-2000, shall be met with, in addition to those already stipulated in the specifications:

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Example</th>
<th>Plain concrete</th>
<th>Reinforced cement concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum cement content in</td>
<td>Maximum water cement</td>
</tr>
<tr>
<td>Mild</td>
<td>Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.</td>
<td>220</td>
<td>0.60</td>
</tr>
<tr>
<td>Moderate</td>
<td>Concrete surfaces sheltered from severe rain or freezing while wet. Concrete exposed to condensation and rain. Concrete continuously under water. Concrete in contact or buried under non-aggressive soil / ground water. Concrete surface sheltered from saturated salt air in coastal area.</td>
<td>240</td>
<td>0.60</td>
</tr>
</tbody>
</table>
Severe | 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. | 250 | 0.50 | 320 | 0.45 |

Very Severe | Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete in contact with or buried under aggressive sub soil / groundwater. | 260 | 0.45 | 340 | 0.45 |

Extreme | Surface of members in tidal zone. Members in direct contact with liquid /solid aggressive chemicals. | 280 | 0.40 | 360 | 0.40 |

Note: The minimum cement content is based on 20mm aggregate. For 40mm aggregate, it should be reduced by 30kg/cum and for 10mm aggregate, it should be increased by 40kg/cu.m.

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

**Consistency and slump:**

Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of mix shall be maintained throughout the progress of the corresponding parts of the work and approved tests e.g. slump test, compacting factor tests etc. in accordance with IS 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>Value of workability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Concreting of shallow sections with vibration.</td>
<td>Very low</td>
<td>• 20-10 seconds vee-bee time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 0.77-0.80 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly reinforced sections with vibration.</td>
<td>Low</td>
<td>• 10-15 seconds vee-bee time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 0.80-0.85 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly reinforced sections without vibration, heavily reinforced section with vibration.</td>
<td>Medium</td>
<td>• 5-2 seconds vee-bee time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 0.85-0.92 compacting factor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 25-75mm slump for 20mm</td>
</tr>
<tr>
<td>Concreting of heavily reinforced sections without vibration aggregate.</td>
<td>High</td>
<td>• Above 0.92-compacting factor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 75-125mm slump for 20mm</td>
</tr>
</tbody>
</table>

**Batching and mixing of concrete:**

The material and proportions of concrete materials as established by the preliminary tests for the mix design shall be rigidly followed for all concrete on the project and shall not be changed except when specifically permitted by Engineer-in-charge.

Concrete shall be produced only by weigh batching the ingredients. The mixer and weigh batcher shall be maintained in a clean serviceable condition. The accuracy of weigh batches shall be periodically checked. They shall be set up in level on a firm base and the hopper shall be loaded evenly. The needle shall be adjusted to zero when the hopper is empty. Fine and coarse aggregates shall be weighed separately unless otherwise stated. Volume batching will be permitted only at the discretion of the Engineer-in-charge. Concrete shall be of strength stipulated, all concrete shall be mixed in
mechanically operated batch mixers complying with IS1791 and of approved make with suitable provision for correctly controlling the water delivered to the drum. The quantity of water actually entering the drum shall be checked with the reading of the gauge or valve setting, when starting a job. The test should be made while the mixer is running. The volume of the mixed material shall not exceed the manufacturers rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum in advance of cement and aggregate. All water shall be in the drum by the end of the first 15 seconds of the specified mixing time. Each batch shall be mixed until the concrete is uniform in colour, for a minimum period of two minutes after all the materials and water are in the drum. The entire contents of the drum shall be discharged in one operation before the raw materials for the succeeding batches are fed into the drum.

**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>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cast iron cube moulds 15cm, size</td>
<td>24 nos.(min)</td>
</tr>
<tr>
<td>2</td>
<td>Slump cone complete with tamping rod</td>
<td>2 sets</td>
</tr>
<tr>
<td>3</td>
<td>Lab. Balance to weigh upto 5kg with sensitivity of 10gm</td>
<td>1 no.</td>
</tr>
<tr>
<td>4</td>
<td>Laboratory balance of 2kg. capacity and of sensitivity of 1gm</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 5ltrs. To 0.4 ltr.</td>
<td>Set</td>
</tr>
<tr>
<td>7</td>
<td>Electric over with thermostat upto 120°C</td>
<td>1 no.</td>
</tr>
<tr>
<td>8</td>
<td>Pycenometer</td>
<td>1 no.</td>
</tr>
<tr>
<td>9</td>
<td>Calibrated glass jar 1 litre capacity</td>
<td>2 nos.</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</td>
<td>1 no.</td>
</tr>
</tbody>
</table>

**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 Department. All incidental charges / cost shall be borne by the contractor.

**Sampling and Strength Test of Concrete:**

Samples from fresh concrete shall be taken as per IS 1199-1959 and cubes shall be made, cured and tested at 28 in accordance with IS 516-1959.

In order to get a relatively quicker idea of the quality of concrete, option tests on beams for modulus of rupture at (+) 2 hours or at 7 days or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength test. 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 of 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 rupture t 72 (+) 2 hours or 7 days may be accepted if the Engineer-in-charge may suitably relax the frequency of 28 days compressive strength, provided the expected strength values at the specified early stage are consistently met.

Optional Tests Requirement of Concrete:

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Compressive strength on 15cm cubes min,</th>
<th>Modulus of rupture by beam test minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At 72 (+) 2 hours N/mm²</td>
</tr>
<tr>
<td>M 10</td>
<td>7.0</td>
<td>1.2</td>
</tr>
<tr>
<td>M 15</td>
<td>10.0</td>
<td>1.5</td>
</tr>
<tr>
<td>M 20</td>
<td>13.5</td>
<td>1.7</td>
</tr>
<tr>
<td>M 25</td>
<td>17.0</td>
<td>1.9</td>
</tr>
<tr>
<td>M 30</td>
<td>20.0</td>
<td>2.1</td>
</tr>
<tr>
<td>M 35</td>
<td>23.5</td>
<td>2.3</td>
</tr>
<tr>
<td>M 40</td>
<td>27.0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Frequency of Sampling:

Sampling procedure:

A random sampling procedure shall be adopted to ensure that each concrete batch shall have reasonable chance of being tested i.e. the sampling should be spread over the entire period of concreting and cover all fixing units.

Frequency:

The minimum frequency of sampling of concrete of each grade shall be in accordance with 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 thereof</td>
</tr>
</tbody>
</table>

At least one sample shall be taken from each shift.

Test Specimen:

Three test specimens 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 7 days 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 IS 9013-1978.
The specimen shall be tested as described in IS 516-1959.

**Test Strength of Samples:**

The test strength of the samples shall be the average of the strength of three specimens. The individual variation should not be more than (+) 15 percent of the average.

**Consistency:**

Slump test shall be carried out 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.

**Standard Deviation:**

Vide clause 6 of this specification.

**Acceptance Criteria:**

(16.1) **Compressive Strength**

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

a) The mean strength determined from any group of four consecutive test results compiles with the appropriate limits in column 2 of Table 11.

b) Any individual test result complies with the appropriate limits in column 3 of Table 11.

(16.2) **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 atleast 0.3 N/mm².

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

(16.3) **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 Table (11) or in item (b) of (16.2), 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 quality of concrete that four consecutive test results represent shall be limited to 60m³.

(16.4) If the concrete is deemed not to comply pursuant to (16.3), the structural adequacy of the parts affected shall be investigated (see 17) and any consequential action as needed shall be taken.

(16.5) Concrete of each grade shall be assessed separately.

(16.6) 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.

(17) Inspection and Testing of Structures

(17.1) Inspection

To ensure that the construction complies with the design an inspection procedure should be set up covering materials, records, workmanship and construction.

(17.1.1) Tests should be made on reinforcement and the constituent materials of concrete in accordance with the relevant standards. Where applicable, use should be made of suitable quality assurance schemes.

(17.1.2) Care should be taken to see that:

a) design and detail are capable of being executed to a suitable standard, with due allowance for dimensional tolerances;

b) there are clear instructions on inspection standards;

c) there are clear instructions on permissible deviations;

d) elements critical to workmanship, structural performance, durability and appearance are identified; and

e) there is a system to verify that the quality is satisfactory in individual parts of the structure, especially the critical ones.
(17.2) Immediately after stripping the formwork, all concrete shall be carefully inspected and any defective work or small defects either removed or made good before concrete has thoroughly hardened.

(17.3) Testing

In case of doubt regarding the grade of concrete used, either due to poor workmanship or based on results of cube strength tests, compressive strength tests of concrete on the basis of (17.4) and / or load test (see 17.6) may be carried out.

(17.4) Core Test

17.4.1 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.

17.4.2. Cores shall be prepared and tested as described in IS: 516.

17.4.3. 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 atleast 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75 percent.

17.5 In case the core test results do not satisfy the requirements of (17.4.3) or where such tests have note been note, load test (17.6) may be resorted to.

17.6 Load Tests for Flexural Member

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

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

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

17.6.3 The deflection due to imposed load only shall be recorded. If within 24h of removal of the imposed load the structure does not recover atleast 75 percent of the deflection under superimposed load, the test may be repeated after a lapse of 72h. If the recover is less than 80 percent, the structure shall be deemed to be unacceptable.

17.6.3.1 If the maximum deflection in mm, shown during 24 h under load is less than $40l^2/D$, where $l$ is the effective span in m; and D, the overall depth of the section in mm, it is not necessary for the recovery to be measured and the recovery provisions of 17.6.3 shall not apply.
17.7 **Members Other Than Flexural Members**

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

17.8 **Non-destructive Test**

Non-destructive tests are used to obtain estimation of the properties of concrete in the structure. The methods adopted include ultrasonic pulse velocity [see IS:13311 (Part I)] and rebound hammer [see IS:13311 (Part 2)], probe penetration, pullout 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.

<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>M15</td>
<td>{\geq f_{ck} + 0.825 \times \text{established standard deviation}}/2 (rounded off to nearest 0.5 N/mm )</td>
<td></td>
</tr>
<tr>
<td>M20</td>
<td>{\geq f_{ck} + 0.825 \times \text{established standard deviation}} (rounded off to nearest 0.5 N/mm²) Or f_{ck} + 4 N/mm², whichever is greater</td>
<td>{\geq f_{ck}} N/mm²</td>
</tr>
</tbody>
</table>

Note – In the absence of established value of standard deviation, the values gives in Table 8 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.

**Admixtures:**

**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 manufacturer’s instructions and in the manner and with the control specified by Engineer-in-charge. rate quoted for concrete should include cost and labour for admixture. No extra payment will be made.

1) **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 IS 1199.

III) Retarding Admixtures:
Where specified an 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.

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 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.

Testing of Structures:

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

Tests on cement will be carried out by the 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 IS-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 bulk age 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 aggregate 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.

**Core test:**

The points from which cores are to be taken and the number of cores required, shall be at the discretion 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 IS 516-1959.

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 80% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has 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.

Load tests on parts of structure:

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

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

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

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

If the maximum deflection in mm shown during 24 hours under load is less than 40L2/D, where L is the effective span and D the overall depth of the section in mm, it is not necessary for recovery to be measured and the recovery provision above will not apply.

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

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 if found, the same shall be examined carefully and defects rectified / grouted if necessary. The drop in level exceeds 20mm 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 stepped into side compartment to the full height and checked for water leakages from the outer surfaces of the tank and inner surface of the middle compartment. The drop in level of surface of water shall also be checked as stated and defects rectified.

The external surface of the tank shall 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 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 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. Contractor shall make his own arrangement for filling the tank. The contractor shall make his own arrangement for water required for construction and labour etc. as per contract conditions at his own cost.

**Unsatisfactory Tests:**

Should the results of any test prove unsatisfactory, or the structure shown signs of weakness, undue deflection or construction, contractor shall remove and rebuild the member or members involved to 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 tests shall be borne by contractor if the tests show unsatisfactory results; otherwise such cost will be borne by the Department.

**Concrete in Alkali Soils and Alkaline Water:**

Where concrete is liable to attack from alkali salts or alkaline water, special cements containing low amount of tri-calcium shall be used, if so specified on the drawings. Such concrete shall have minimum cement content, for different exposes attached as given in table 19 and 20 in appendix A of IS 456-2000. If specified by Department, additional protection shall be obtained by the use of chemically resistant stone facing or a layer of plaster of Paris covered with suitable fabric, such as jute thoroughly impregnated with tar.

**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 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 suitable 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 embedment to be cast in the concrete as indicated on the drawing or as necessary for the proper execution of the work. All such embedment shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

Slots, openings, holes pockets etc. shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer-in-charge.
Reinforcement and other items to be cast in concrete shall have clear 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.

**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 no further concrete shall be placed thereon until such water is removed. To avoid sumps shall be provided.

**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.

**Transportation:**

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

**Re-tempered 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 ad which has not been placed within half an hour of mixing water with cement shall be rejected.

**Cleaning of Equipment:**

All equipments used for mixing, transporting ad 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.

**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 ad methods shall be submitted to Engineer-in-charge and no concrete shall be of such size ad design to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job ad placement location.

2) Time Interval between Mixing ad Placing:

Concrete shall be placed in final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes o leaving the mixer d once compacted it shall not be disturbed.

3) Avoiding Segregation:

Concrete shall in all the cases be deposited as nearly a practicable directly in its final position ad shall not be re-handled or caused to flow in a manner which will cause segregation, loss of materials displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, ad in narrow forms, contractor shall provide suitable prop ad Elephant Trunks to confine the movement of concrete. Special care shall be taken when concrete is dropped from 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 1.0m or handle in a manner which will cause segregation.

5) Placing by Mechanical Equipment:

The following specifications shall apply when placing of concrete by sue 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 d 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 1.0m. 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.

**Placement in restricted forms:**

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

**Chutting:**

Where it is necessary to use transfer chutes, specific approval of Engineer-in-charge must be obtained on type, length, slopes, baffles, vertical terming of operations. These shall be so arranged that almost continuous flow of concrete is obtained at the discharge end 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 lined 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.

**Placing by Pumping / Pneumatic Placers:**

Concrete may be conveyed and placed by mechanically operated equipments e.g. pumps or pneumatic placers, only with the written permission of Engineer-in-charge. The slums shall be held of 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 be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

When pneumatic placer is used, the manufacturer’s 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.

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

**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 15cm to 90cm. directed by Engineer-in-charge. These shall be placed as rapidly as practicable to prevent the formation of cold joints or places 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 a will facilitate spreading the layer to uniform depth and texture with a minimum of shoveling stone into mortar rater 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 ad bedding places shall be approximately horizontal unless other wise instructed.

**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 ad fits tightly against all form surfaces, reinforcement ad 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 ad caution is to be exercised not to over vibrate the concrete to the point of segregation.

**Type of Vibrators:**

Vibrator shall conform to IS 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 strong enough not to be damaged by it. Immersion vibrator shall have No load frequency amplitude and acceleration a as per IS 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.

**Use of Vibrators:**

The exact manner application d the most suitable machines for the purpose must be carefully considered ad operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450mm a part ad withdrawn when air bubbles ceases to cometo the surface.

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.

**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.
**Penetration of Vibrations:**

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

**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 of finished surfaces.

**Use of form attached Vibrators:**

Form attached vibrators shall be used only with specific authorization of Engineer-in-charge.

**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 vibrators shall be specifically designed may be permitted, upon approval of Engineer-in-charge.

**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.

**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.

**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 a 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.

**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 temporally move the top steel aside to get proper placement and restore reinforcing steel to design position.
**Bleeding:**

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

**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 drawing or as directed by Engineer-in-charge.

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 drawings. 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 to ensure a horizontal line ad if directed, shall also be used to form a grooved joint. For tank walls, similar work joints shall be formed as per IS 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 ad shall conform in detail to the requirements of the plans unless otherwise directed by Engineer-in-charge. Where not described, the joints shall be in accordance with the following:

**Column Joints:**

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

**Beam and Slab joints:**

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

**Joints in Liquid Retaining Structures:**

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

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

**Mass Foundations:**

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

**Treatment of construction joints on resuming Concreting:**

Drier shall be used for the top lift or horizontal pours to avoid a laitance. All laitance d loose stones shall be thoroughly and carefully removed by wire brushing / hacking ad 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 ad 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 ad to avoid segregation of the concrete along the joint plane.

**Curing, Protecting, Repairing ad Finishing:**

**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 ad hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

**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 lying 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.

**Continuous Spraying:**

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose sprinklers a spraying device. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by Engineer-in-charge.
Alternate curing Methods:

Whenever in the judgment of Engineer-in-charge, it may be necessary to omit the continuous spray method, covering of clear sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, during or after the curing period, will not be permitted.

Conversing 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 cutting 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 continuously filled with water during the curing period.

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.

Curing Equipment:

All equipments and materials required for curing shall be on hand ad ready for use before concrete is placed.

Protecting Fresh Concrete:

Fresh concrete shall be protected from the elements, from defacement sad 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 may be warned against and prevented form 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.

Repair and Replacement of unsatisfactory Concrete:

Immediately after the shuttering is removed, the surface of concrete shall be 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 2.36mm IS 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 ad 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 for 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 25mm), 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 newly concrete securely in place.

An area extending several centimeters beyond the edges ad the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

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.

Method of repair:

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

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

A 5mm 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 10mm thick layers. After an hour 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 ad the mix shall be kept as dry as possible.

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

**Approval by Engineer-in-charge:**

All materials, producers 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.

**Finishing:**

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

**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 surface 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, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of hole left by form ties and rods ad clean up of loose or adhering debris.

Surfaces which will be exposed to the weather ad which would normally be leveled shall be sloped for drainage. Unless the drawing specify a horizontal surface or shows the slope required, the tops of narrow surfaces such as staircase treads, walls, curbs ad parapets shall be sloped across the width approx. as 1 in 30. Broader surface such as walkways, roads, parking areas ad 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 ad similar surfaces shall be smooth, screened ad leveled to produce even surfaces. Surface irregularities shall not exceed 6mm. Surfaces which will not be covered by backfill, concrete or tile topping such a outside decks, floors of galleried ad sumps, parapets, gutters, side walks, floors and slabs shall be consolidated, screened ad floated.

Excess water and laitance shall be removed before final finishing. Floating may be done with hand with hand or power tools ad started a soon as the screeded surface has attained a stiffness to permit finishing operations ad these shall be the minimum required to produce a surface uniform in texture ad free from screed marks or other imperfections. Joints ad edges shall be tooled as called for on the drawings or as faceted by Engineer-in-charge.
**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 form having smoothed 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 blemished, projections etc. removed, leaving the surfaces reasonably smooth and unmarred.

**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 as per IS 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 at 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.

**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 there projections on the surfaces shall be carefully removed, off sets leveled and voids ad/ or damaged sections immediately saturated with water ad repaired by filling 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 a smooth appearance.

**Protection:**

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

**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 a 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 clan 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.

**Preparation Rock Strata of Foundations:**

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

Concrete shall not be deposited on large sloping 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 ad unshattered condition.

Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water ad 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 for 2 to 4 hours unless otherwise directed by the Engineer-in-charge.

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

**Preparation of Earth Strata of Foundations:**

All earth surfaces, upon which additional concrete is to be placed later, shall preferably be done by scarifying ad cleaning while the concrete is between its initial ad final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks ad 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 ad 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 ad roughen the surface.

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

**Bonding Treatment Mortar:**

After rock or concrete surfaces upon which new concrete is to be placed have been scarified, cleaned ad wetted 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 the concrete which shall be placed on it. The water cement ratio shall be determined by placing conditions ad approved by Engineer-in-charge.

Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 10mm thick for rock surface and about 5mm 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 ad shall be brushed out 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.

**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 in the specified bed-joint bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms, dipped in to the fresh converter. Where it is impracticable to apply such a mortar coating, special precautions will be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint by carefully paddling ad spading with aid of vibrators and suitable tools.

**Expansion and Contraction:**

Provision shall be made for expansion a 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 specification, shown in te drawings a directed by Engineer-in-charge.

**Weather Requirements:**

All concrete work performed in hot weather shall be in accordance with IS 56, 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 conveyors to direct sunlight ad the sue for reflective paint, on mixers etc. The temperature of the freshly placed concrete shall not be permitted to exceed 300°C.

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

In order to reduce loss of mixing water, the aggregates, wooden forms, sub grade, adjacent concrete and other moisture absorbing surfaces, shall be well wetted prior to concreting, placement ad 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 temperature 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.

**Placing concrete under Water:**

Under an ordinary conditions all foundations shall be completely dewatered ad concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS 456 and procedure shall be as follows:

**Method of placement:**

Concrete shall be deposited under water by means of tremise or drop bottom buckets of approved type.

**Direction, Inspection and Approval:**

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

**Pre cast Concrete and Pre cast Reinforced concrete:**

Pre cast concrete & pre cast reinforced concrete shall comply with IS 456 and with the following requirements:

**General requirements:**

Pre cast reinforced concrete units such as columns, fencing posts, door window frames, lintels, chajjas, copings, stills, 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 mould store accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes, Pre cast concrete shall be cast on suitable bed or platform with firm foundation ad free from wind. The contractor may pre cast 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 cat in one operation.
Contractor shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

Concrete used for pre casting the units should be well proportioned, mixed, placed ad thoroughly compacted by vibrations or tamping to give a dense concrete free from voids ad hone combing.

Pre cast 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 pre cast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The areas shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true tot eh lines. On being fractured, the interior of the units should present a clean homogenous appearance.

The longitudinal reinforcement shall have a minimum cover of 12mm 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 25mm.

**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 ad from harmful effects of frost, sun shine, drying windows d cold. The concrete shall be cured at least for 7 days from the date of casting.

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

**Marking:**

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

Pre cast 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 pre cast units shall be undertaken without causing shocks, vibration or under bending stress 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 overstress or otherwise affect seriously the strength of the pre cast unit. The reinforced side of the units shall be distinctly marked.

**Pre cast Cement Concrete Jali:**
The jail shall be of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 5mm nominal size) reinforced with suitable mild steel wire/rod unless otherwise specified.

**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 (1cement : 3 coarse sand ) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jail uniformly on all sides by connector pins no all sides.

**Measurements:**

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.

**Rate:**

The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills ad soffits, which will be paid for under relevant item of plastering.

**Curing:**

All pre cast work shall be protected from the direct rays of the sun for at least 7 days after casting ad 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 practice as given in clauses stated earlier shall be followed.

**Slots, Opening etc.**

Slots, opening 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.

**Grouting:**

*Standard Grout:*

Grout shall be provided as specified in the drawings:

The proportions of grout shall be such as to produce a flow able 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 (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></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:

<table>
<thead>
<tr>
<th>Passing I.S. sieve 2.36mm</th>
<th>95 to 100% Passing I.S. sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18mm</td>
<td>65 to 95% Passing I.S. sieve</td>
</tr>
<tr>
<td>300 micron above</td>
<td>10 to 30% Passing I.S. Sieve</td>
</tr>
<tr>
<td>150 micron above</td>
<td>3 to 10%</td>
</tr>
</tbody>
</table>

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 hole 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 in anchor bolts 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.

Special Grout:

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

**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 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.

**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 volume 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. 50kg/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>Quantity of material used per bag of cement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cement</td>
</tr>
<tr>
<td>1:5:10</td>
<td>1</td>
</tr>
<tr>
<td>1:4:8</td>
<td>1</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 be 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>50</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 authorized, it should be done on a water right 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 re-tempering 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 ad directed by the Engineer. In case of the thickness of concrete is more than 150mm, it may be vibrated as directed by the Engineer.

The concrete shall be cured for 10 days in ordinary weather ad 15 days in hot weather. Measurements for the work done shall be exact length, breadth ad depth shown in figures on the drawings or as directed by the Engineer ad after the concrete is consolidated. NO extra shall be paid for excess quantity resulting from faulty workmanship.

Specific Requirements for concrete ad allied works:

The following specific requirements shall be met within addition to those provided in the clause of specification for concrete ad allied works:

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".

**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/ sq.cm for the convenient and effective jetting of rock foundations and concrete surfaces, for cooling aggregate required for concrete, for curing concrete and other requirements.

**Fire protection System:**
The contractor shall provide and maintain at all times in adequate fire protection system to protect his equipment, material 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.

**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.

**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 plan shall be 7 days and 3 days respectively.

**Finishing of Concrete:**

**General:**
Unless otherwise specified, concrete finishes shall confirm to the following specification:

Finish F1, F2 and F3 shall describe formed surface. Finish U1, U2 and U3 shall describe un-formed surface.

Off sets or fins caused by disposed or misplaced form sheathing lining or form sections or by defective form lumber shall be referred to as abrupt irregularities. All other irregularities shall be referred to as gradual irregularities. Gradual irregularities shall be measured as deviation from a plane surface with a template 1.5 m long for formed surface and 3 m long for unformed surfaces.

**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 6mm, removal of ridges and abrupt irregularities by grinding.

**Finish F3:**

Shall apply to all formed surfaces exposed to view or where shown in the drawing or specified by the Engineer-in-charge. Finish F3 shall include all measures specified for finish F2 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 a half parts by volume of fine (minus 0.16 mesh) sand. Only sufficient mixing water to given the mortar’s 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 hole, irregularities etc.

Curing of the surface shall be continued for a period of 10 (ten) days.

**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 for the concrete to the required slope and grade. Unless the drawing specified a horizontal surface or shown the slope required, the tops of narrow surfaces such as stair, treads, walls, curbs, and parapets shall be sloped approximately 10mm per 300mm width. Surfaces to be covered by backfill or concert sub-floors to be covered with concrete topping, terrazzo ad similar surfaces shall be smooth screened and leveled to produce even surface, irregularities not exceeding.

**Finish U2:**

Shall apply to all unformed surfaces as shown in the drawing or specified by the Engineer-in-charge and shall include screeding ad 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 6mm.
**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 6mm, finishing joints and edges of concrete with edging tools.

**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 centimeters except for the thickness of slab which shall be measured to the nearest half centimeter.

b. Areas shall be worked out to the nearest 0.01 sqm.

c. Cubic contents shall be worked out 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 to 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 deduction shall be made for the following:

a. Ends of dissimilar materials e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc. up to 500 sq.cm in cross section.

b. Opening up to 0.1 sqm. (1000 sq.cm). c. Volume occupied by reinforcement.

d. Volume occupied by pipes, conduits, sheathing etc. not exceeding 25sq.cm. each in cross sectional area. Nothing extra shall be paid for leaving ad finishing such cavities and holes.

**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 Prismoidal Formula.

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

**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.

**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 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.

**I) Slab:**
The length and breadth of slab laid to correct thickness as shown in the detailed drawing for as ordered by the Engineer-in-charge shall be measured between beams, walls and columns.

**II) Chajjas, Facias, Fins and Mullions:**

a. Chajjas shall be measured net from supporting faces upto the edges of chajjas without any facia.

b. Facia shall be measured full excluding chajja hickness.

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.

**III 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 PCC / RCC 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 mention din the schedule for quantities. The rates also shall include the cost of testing material, mix design; cube test ad allied incidental expenses.

The reinforcement steel used in the works shall be measured and paid for separately under relevant item.

**Placing "Plums in Concrete"**
In mass concrete members, stone plums may be used, with a view to effect economy, in zones not subject to tensile stresses upto a maximum limit of 20 percent by volume of concrete when specifically permitted by the engineer-in-charge. While placing plums, care shall be taken that clear distance between any two plums is not less than either the width or thickness of either or the plums or 15 cms whichever is more. No stone shall be closer than 30 cm to an exposed surface. The stones shall not be dropped in place, but each stone shall be laid and carefully embedded so as to avoid any injury to forms or adjacent masonry and in such a manner that no planes of weakness or unnecessary seams occur in the structure.

During concreting, the first layer of concrete of the specified mix shall be laid to a thickness of at least two and a half times the thickness of the maximum size of plums to be used. The plums shall then be laid while the top portion of this concrete is still green but sufficiently stiff to prevent complete submergence of the plums under their own weight. These plums shall be about half embedded in the concrete and the remaining part exposed so as to form a key with the next layer of concrete. No plums shall be used for concrete laid under water.

If plums of stratified stone are used, they shall be laid on their natural bed. Stones with concave faces shall be laid with the concave face upwards.

The thickness of the next and successive layers of concrete shall be at least twice that of the largest plum..
**9. FORM WORK**

*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 and dismantling of form work.

*Design of Form Work*

The design and engineering of form work as well as its construction shall be the responsibility of Contractor. 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's approval shall not however, relieve Contractor of the full responsibility for the design and construction for 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 loadings.

*Tolerances:*

Tolerances are specified permissible variation from lines, grade or dimensions given in drawings. No tolerances specified for horizontal or vertical buildings lines or footings. Unless otherwise specified, the following tolerances will be permitted.

*Tolerances for R.C. Buildings:*

1) *Variation from the plumb:*

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

b) For exposed corner columns ad other conspicuous lines
   
   In any bay or 5 m, maximum : (+) 5 mm
   In 10 m or more: (+) 10mm

   ii) Variation from the level or from the grades indicated on the drawings. a) In slab soffits, ceilings, beam soffits and in arises.

   b) In 2.5m (+) 5mm
   
   In any bay or 5m maximum (+) 8 mm
   In 10 or more (+) 15mm

   c) For exposed lintels, sills, parapets, horizontal grooves and conspicuous lines

   iii) Variation of the linear building lines from established position in plan and related position of
columns, walls and partitions.
   In any bay or 5m maximum (+) 10 mm
   In 10 or more (+) 20 mm

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

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

vi) Footing:
   a) Variation in dimensions in plan (+) 50mm/(-) 5mm. V- Page 55 of 197 b) Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50mm.
   c) Reduction in thickness (-) 5% of specified thickness subject to maximum of 50mm.

vii) Variation in steps:
   a) In a flight of stairs
      Rise (+) 3.0 mm
      Tread (+) 5.0 mm b) Consecutive steps
      Rise (+) 1.5 mm
      Tread (+) 3.0 mm

**Tolerances in other concrete structure**

*a) Structures :*

Variation of the constructed liner outline from established position in plan

   In 5 m … … … (+) 10 mm
   In 10 m or more … (+) 15 mm

1) Variation of dimensions to individual structure features from established position in plan

   In 20m or more … (+) 25 mm
   In buried constructions … (+) 150 mm

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

   In 2.5m … … … (+) 10 mm In 5.0m … …
   … (+) 15 mm In 10.0m or more … (+) 25 mm
   In buried constructions (+) Twice the above limits

3) Variation from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves.

   In 2.5m … … … (+) 5 mm
   In 7.5m … … … (+) 10 mm
In buried constructions (+) Twice the above limits

4) Variation in cross-sectional dimensions of columns, beams, buttresses, piers of similar members (+) 10mm / (-) 5mm

5) Variation in the thickness of slabs, walls, arch sections of similar members (+) 10mm / (-) 5mm

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

I) Variation of dimensions in plant (+) 50mm/(-) 10 mm

II) Misplacement of 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 maximum of 50mm.

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

Type of Form work:

Form work may be of timber, plywood, Acrow spans, Acrow pipe (or) Doka type formwork. 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.

Form work 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 for 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 from 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 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 ad if rejected by Engineer-in-charge shall be removed from the site.
Shores supporting successive stores shall be placed directly over those below or be so designed and placed that the load will be transmitted directly by them. Trussed supports shall be provided for stores 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 contour indicated on the drawings, shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be entirely removed and 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 shall be so designed and constructed that they can be striped in the order required and their removal do not damage the concrete. Face formwork shall provide true vertical and horizontal joints shall 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 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.

Re-propping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported 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.

Inspection of Formwork:

Following points shall be borne in mind while checking during erection of form work and formwork got approved by the Engineer-in-charge before placing of reinforcement bars:
a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.

b) Material used should be checked to ensure that, wrong items/ rejects are not used.

c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

d) (i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
(ii) Sole plates shall be properly seated on their bearing pads or sleepers. (iii) The bearing plates of steel props shall not be distorted.
(iv) The steel parts on the bearing members shall have adequate bearing areas.

e) Safety measures to prevent impact of traffic, scour due to water etc should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall at adequately restrained against tilting, overturning 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 centralizing beams placed in the fork heads.

i) Screw adjustment of adjustable props shall not be over extended.

j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened / clamped down after adjustment to prevent other shifting.

k) No member shall be eccentric upon vertical member

l) The number of nuts and bolts shall be adequate

m) All provisional 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 another 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.

**Form Oil:**

Use of form oil shall not be permitted on the surface which require painting. If the contractor desire to use form oil on the inside of formwork of the other concrete structures, a non staining mineral oil or other approved oil CEMOL-35 of Ms. Hindustan Petroleum Co. Ltd may be used, provided it is applied before placing reinforcing steel and embedded parts. All excess oil on the form surfaces and any oil on metal or other parts to be bedded 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, wooden shavings and other unwanted materials.

**Chamfers and Fillers:**

All corners and angles exposed in the finished structure shall be formed with moldings to form chamfers or fillers on the finished concrete. The standard dimensions of chamfers ad fillers, unless otherwise specified, shall be 20 X 20 mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the mounding shall be planed or surfaced to the same texture as the form s to which it is attached.

**Vertical Construction Joint Chamfers:**

Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above accept where not permitted by Engineer-in-charge.

**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.

**Reuse of forms:**

Before reuse, all forms shall be thoroughly scrapped, 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.

**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 ht 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 form work.

In normal circumstances (generally where temperature are above 20°C ) forms may be struck after expiry of the following periods :

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of formwork</th>
<th>Minimum Period Before striking Formwork (For OPC Cement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Vertical formwork to columns, walls, beams</td>
<td>16 – 24h</td>
</tr>
<tr>
<td>b)</td>
<td>Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)</td>
<td>3 days</td>
</tr>
<tr>
<td>c)</td>
<td>Soffit formwork 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:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I) Spanning upto 4.5 m</td>
<td>7 days</td>
</tr>
<tr>
<td></td>
<td>II) Spanning over 4.5 m</td>
<td>14 days</td>
</tr>
<tr>
<td>e)</td>
<td>Props to beams and arches: I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spanning upto 6 m II)</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Spanning over 6 m</td>
<td>21 days</td>
</tr>
</tbody>
</table>

Striking shall be done slowly with utmost care to avoid damage to arise ad projection a 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 ad made good as specified earlier.

Reinforced temporary opening shall be provided, as directed by Engineer-in-charge, to facilitate removal of formwork which otherwise may be inaccessible.

Tie rods, clamps, form bolts etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours no 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 reconstructed at contractors cost.

**Mode of measurement :**

The form work measured shall be the area of concrete in contact with concrete only.
In case the item of concreting are inclusive of cost of form work, it shall not be measured separately.

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

No deduction shall be made for opening / obstructions up to an area 0.1 sqm. and nothing extra shall be paid for forming such openings.

The rate shall include the cost of erecting, centering, shuttering materials, transport, de shuttering and removal of materials from site and labour required for all such operations etc.
10.0. STEEL REINFORCEMENT

Steel reinforcement bars, if supplied or arranged by contractor, shall be either plain round mild steel bars grade as per IS 432 (part-I) or medium tensile steel bars as per IS 452 (part-I) or hot rolled mild steel ad medium tensile steel deformed bars as per IS 1139 or cold twisted steel bars and hot weld strength deformed bars as per IS 1786, as shown and specified on the drawings. Wire mesh or fabric shall be in accordance with IS 1566. Substitution of reinforcement will not be permitted except upon written approval from Engineer-in-charge.

Storage:

The reinforcement steel shall not be kept in direct contact with ground but stacked on top of an arrangement of timber sleepers or the like. Reinforcement steel shall be with cement wash before stacking to prevent scale and rust. Fabricated reinforcement shall be carefully stock to prevent damage, distortion, corrosion ad deteriorations.

Quality:

All steel shall be grade I quality unless specifically permitted by the Engineer-in-charge. No rolled material will be accepted. If demanded by the Engineer-in-charge. Contractor shall submit the manufacturers test certificate for steel. Random tests on steel supplied by contractor may be performed by Department as per relevant Indian Standards. All costs incidental to such tests shall be at contractors expense. Steel not conforming to specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt loose mill, scale dust, bituminous materials 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 2751, according to best modern practices ad 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. Special specifications, as specified by the Engineer-in-charge, shall be adhered to in the welding of cold worked reinforcing bars and bars other than mild steel.

Laps:

Laps ad splices for reinforcement shall be shown in the drawings. Splices, in adjacent bars shall be staggered ad the locations of all splices, except those pecified on the drawing shall be approved by the Engineer-in-charge. The bars shall not be lapped unless the length required exceeds the maximum available length of bars at site.

Bending:

All bars shall be accurately bent according to the sizes ad shapes shown on the detailed working drawings/
Reinforcing bars shall not be straightened and rebent 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 25mm in diameter which may be bent hot if specifically approved by the Engineer-in-charge. Bars bent hot shall not be heated beyond cherry red colour (not exceeding 645ºC) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if means used for straightening and rebinding be such as shall not, in the opinion of the Engineer-in-charge injure the material. NO reinforcement bar shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having links or bends other than those required by design shall not be used.

*Bending at Construction Joints:*

Where reinforcement bars are bent aide at construction joints and afterwards bent back into their original position, care should be taken to ensure that 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.

*Fixing / Placing ad Tolerance on Placing:*

Reinforcement shall be accurately fixed by ay approved means maintain din the correct position as shown in the drawings by the use of blocks, spacer and chairs as per IS 2502 to prevent displacement during placing ad compaction of concrete. Bar 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 mild steel 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 by the Engineer-in-charge, reinforcement shall be placed within the following tolerances:

Tolerance in spacing

a) For effective depth, 200 mm or less ± 10 mm  
b) For effective depth, more than 200 mm ± 15 mm

*Cover to Reinforcement:*

The cover shall in no case be reduced by more than one third of specified cover or 5mm 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 200mm or under, whose reinforcing bars do not exceed 12mm, a
cover of 25mm may be used.

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

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

e) For any other reinforcement not less than 15mm, 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, railways) etc. and such increase of cover may be between 15mm 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 40mm, 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 M25 and above, the additional thickness of cover specified in (f), (g) and (h) above a my be
   reduced to half. In all such cases the cover should not exceed 75mm.

j) Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by
   providing a 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 ad slabs on sub grade shall be supported on precise concrete blocks as approved by the
   Engineer-in-charge. The use of pebbles or stones shall be permitted.

l) The minimum clear distance between reinforcing bars shall be in accordance with IS 456 or as shown in drawings.

The Bars shall be kept in correction position by the following methods:

a) In case of beam ad slab construction precast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand)
   about 4X4 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 ad 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 theme 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 RCC 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.

**Inspection:**

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

**Mode of Measurement for reinforcement for R.C.C Works:**

Reinforcement detailed in schedule of quantities shall be measured for payment lineally as per ht cutting length nearest to a centimeter 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.S. per meter length. No allowance shall be measured. The cost of steel used by the contractor in the 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 authorized 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 as per direction of Engineer-in-charge and shall be measured for payment.

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

Scope of Work:

The work covered by this specification consists of furnishing and erecting of structural steel complete in strict accordance with this specification and the applicable drawings.

Materials:

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.

All structural steel and electrodes shall comply in all respects with relevant I.S.S. for structural steel.

Workmanship:

All workmanship shall be of first class quality in every respect to get greatest accuracy 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 fit tightly at both ends.

All holes in plates and section between 12mm and 20mm thick shall be punched to such diameter that 3mm 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.

Erection and Marking:

Erection and fabrication shall be according to IS 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 dispatched until it has been inspected and passed. The contractor shall supply free of charge all labour and tools required for testing of work.
**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 otherwise damaged before actual delivery on work.

**Shop Drawing:**

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 leader.

**Painting:**

Painting should be strictly according to IS. 1477-1971 (Part-I-Pretreatment) and IS 1477-1971 (part-II painting).

Painting should be carried out on dry surfaces free from dust, scale etc. The paint shall be approved by the Engineer-in-charge. Once 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.

**Welding:**


**Welding Consumables:**

Covered electrodes shall conform to IS 814 (part-I) – 1974 and IS814 (part-II)- 1974 or IS 1395-1982 as appropriate.

Filler rods and wires for gas welding shall conform to IS 1278-1972.

The bar wire electrodes for submerged arc welding shall conform to IS 7280-1974. The combination of age and flash shall satisfy the requirements of IS 3613-1974.

The filler rods ad bare electrodes for gas shielded metal, are welding shall conform to IS 6419-1971 and IS 6560-1972 as appropriate.
**Type of Welding:**

Are welding (direct or alternating current) or Oxyacetylene welding may used. Field welding may be used. Field welding shall be by D.C.

**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 electrode</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>5/16&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.

**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 type 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.

**Welding Procedure:**

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 are length, rate of travel, current and polarity for the type of electrode and nature of work. Welding plant capacity 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.

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.
Workmanship:

Preparation of Fusion Faces:

Fusion faces shall be cut by starring 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 relative movement due to distortion, wind or any other cause.

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>60° – 90°</th>
<th>91° – 100°</th>
<th>101° – 106°</th>
<th>107° – 113°</th>
<th>114° – 120°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throat thickness in cms.</td>
<td>0.70</td>
<td>0.65</td>
<td>0.60</td>
<td>0.55</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 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 ad regular appearance.

In welds containing crack, porosity or cavities in which the weld metal tends to overlap on the parent metal without proper fusion, the defective portions of the welds shall be out cut and re-welded.

Where serious under cutting occurs, additional weld metal shall be deposited to make good reduction.

Mode of Measurement:

All structural steel shall be measured on weight basis in metric tones 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 as 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 at of all labour, materials, scaffolding, transport and also cost of welding, riveting ad bolting, field connections if any all to complete the job as per specifications.
12.0 MS GRILLS & RAILINGS

General
The contractor shall submit 6 copies of shop drawings shall show all dimension, details of construction, installation relating to the adjoining work.

Materials:
All structural steel shall conform to IS 226-1963 sections for grills and shall be free from loose mill scales, rusts, pitting or any other defects affecting its strength and durability.

Fabrication:
The grills 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 rill / railing so fixed shall be firm and there shall not be any lateral movements.

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.

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.

Painting:
Painting shall be done as per the specification specified under painting.

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.

**Finishing / Painting/Polishing for railing:**

Teak wood hand rail shall be polished with wax polish / French polish / melamine 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.

**Mode of measurements (hand rails):**

Hand railing shall be measured for payment in running metre. The lengths shall be measured along the top center line of the hand rail and shall be measured between ends of balusters, newels, posts as the case may be upto two places of decimals of a metre. Rates shall include fabrication, leaving suitable pockets, grouting the same, providing an fixing suitable teak wood plugs, fixing, all labour, materials, transport, painting/polishing, finishing and scaffolding if necessary.
13.0 BRICK WORK

Scope of work:

The work covered under this specification pertains to procurement of best quality locally available bricks and workmanship of building walls of various thickness. In strict compliance with the specifications and applicable drawings.

Materials:

Brick shall be best quality locally available bricks and shall be got approved by the Engineer-in-charge before incorporation in the work.

The nominal size of bricks (F.P.S) shall be 22.9 X 11.4 X 7cm (9" X 4 1/2 X 2 3/4" ). Permissible tolerance on dimensions shall be + 3mm. in length and + 1.5 mm in width / thickness. 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.

In case the size of bricks used in the work found lesser than the specified one for the whole lot:

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 to contractor's account.

If the plastering to be done is more than the specified thickness to bring the plaster surface to perfect line, level and plumb with adjoining columns, beams walls etc., the contractor shall be responsible to provide and fix chicken wire mesh to receive 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, found more than the permissible, the contractor shall chip out the exposed edges of bricks upto the required level of wall to receive specified thickness of plaster at no extra cost.

Bricks shall generally conform to IS 1077-1970. In any case minimum crushing strength shall not be less than 35 kg/sq.cm 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 have an appreciable quantity of sulphates and chlorides. The specifications for cement, sand and water shall be same as described herein before under cement concrete. Bricks shall be thoroughly soaked in water before using till the bubbles ceases. No half or quarter brick shall be used except as closer. The closers 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.

Workmanship:

Four courses of brick work with four joints should not exceed by more than 40mm 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 10mm as the work proceeds. The surface of brick work shall be cleaned down and wiped 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 backed / chipped / keyed, cleaned and cement slurry is applied so that a proper bond is achieved between the two dissimilar materials. It is responsibility of the contractors to ensure that there will not be any cracks / fissure 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 thought out 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 ad then it 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 marinating them in level. Similarly all other courses are built. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances:

Deviation from vertical within a storey shall not exceed 6mm per 3 m height. Deviation in verticality in total height of any wall for building more than one storey in height shall not exceed 12.5 mm.

Deviation from position shown on plan of any brick work shall not exceed 12.5 mm. Relative displacement between load bearing wall in adjacent storeys in the ended to be vertical alignment shall not exceed 6mm.

A set of tools comprising of wooden straight edge, masonry spirit level, 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 brick work 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.

Materials and workmanship for a half brick or brick on edge partition wall shall be as specified above.

The wall shall be stiffened by providing with 2 nos. 6mm diameter M.S. or as specified in the schedule as bottom reinforcement (only the M.S. reinforcement will be paid separately under relevant item).

The rates for brick work shall include the cost of the following:

Providing and fixing necessary single or double scaffolding and removing the same after the work is completed.

Watering, curing, lifting of material to any eight. Raking out of joints to receive plaster.

Forming slab sittings, cutting or leaving holes for lugs of windows, doors, sills, switch and plug boxes etc.

Making good all holes, chases etc. to any depth due to conduit pipes, holdfasts, bolts, switch and plug boxes etc.

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.

Mode of measurement:

For Brick work measured in Cubic Meters:

The contract rate shall be for a unit of one cubic metre of brick masonry as actually

For measurement purpose, thickness of single brick wall shall be taken as 215 mm. irrespective of thickness used. Brick walls of more than one brick thickness shall be measured as per actual thickness constructed.
All opening in brick work for doors, windows and ventilators shall be deducted to get the net quantity of actual brick work done.

Opening or chases required for P.H. or electrical inserts less than 0.1 sqm. and bearing of precast concrete members shall not be deducted.

No extra payment shall be made for any extra work involved in making the above openings or placements.

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 windows ad ventilators shall be deducted to get the net quantity of actual work done.

Openings of 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.

PRECAST CEMENT CONCRETE SOLID BLOCK MASONRY:

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 sin strict compliance with the specifications and applicable drawings.

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 IS as stipulated in specification for cement concrete works herein before.

Minimum crushing strength of the solid blocks shall be 40 to 60kg/sq.cm 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 390X190 X 100mm or as approved by Engineer-in-charge 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 atleast for 14 days before incorporation into the work. The cement mortar for concrete blocks masonry shall be 1:4 and joints shall not be more than 10mm thick.
Workmanship and Mode of measurement:

The workmanship and mode of measurement shall be as stipulated in the specification for thick work as applicable stated earlier ad concrete block masonry with 140mm thick block shall be measured in sqm. nearest to two place of decimals of a metre.

The rate quoted shall include cost of all materials, labour including frame work in casting the blocks, curing, transporting, handling, hoisting the blocks to proper level, curing masonry etc. complete.
14. CEMENT PLASTERING FOR WALLS AND CEILINGS & SAND FACE PLASTERS

Scope of work:

The work covered under these specification consists of supplying all material for rendering all types of plaster / pointing finishes strictly in accordance with these specifications, applicable drawings etc.

General:

Cement, sand and water required for the work shall conform to specifications laid down herein before under section cement concrete (plain and reinforced), except that sand for finishing coat shall generally conform to IS 1542-1960. the plastering works shall generally conform to IS 1661-1987(pt.III) Code of practice for cement plaster finish on walls and ceilings). All general precautions as specified in I.S. 1661-1987 (pt.III) clause 8, shall be taken and preparation of the background shall be done as laid down in IS 1661 clause 12 and IS 2402-2963 shall be generally followed for 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 for fixing switch boxes at specified 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.

Preparation of Surface:

The surface to be plastered shall first be thoroughly cleaned of all muck and cleaned down. All joints shall be racked to in case of brick work / stone masonry and closely hacked in case of concrete as the work proceeds. The surface to be plastered shall be well wetted for a minimum period of 6 hours before commencing to work. The mortar for all plaster work shall be 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 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 conduit boxes, EDB’s, 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 plaster buttons 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 corrosion 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 on contractor at his own cost and the plaster should be done to required line and level with no extra cost whatsoever.

The finished plastered surface shall be free from cracks, fissures, crevices, hair cracks, blistering, local swellings and flaking. The finished surface shall be true to line, level, plumb and 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 work the surface should be got approved by the Engineer-in-charge.

In order to avoid the formation of deep and side cracks an for dispersion for cracks at the junctions between concrete surfaces 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.

**Groves:**

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 shall be included in the rates wherever mentioned in the schedule of quantities.

**Mix Proportion:**

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

**Mixing:**

Cement and fine aggregates shall be mixed dry in the required proportions to obtain a uniform colour. Water shall then be added to get the required consistency for the plaster.

Mixing shall be done mechanically. However, manual mixing will be allowed only in exceptional circumstances at the discretion of the Engineer-in-charge. Manual mixing, where adopted, shall be carried out on a clean water tight platform. After water is added during mixing, the mix shall be held back and forth for 10 to 15 minutes.

In machine mixing, the mixer shall run atleast 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 and shall be removed for the with from the site.

**10mm Plaster:**

The plaster shall be laid with somewhat more than 10mm, thickness and pressed and leveled with wooden ruler to a finished thicken of 10mm. 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.

**15mm Plaster:**

The proportions of sand and cement shall be as specified an shall cover all irregularities, undulations, depressions due to chasing etc. in the surface o be plastered. The mortar shall be applied slightly more than 15mm thick and pressed and leveled with wooden ruler or straight edge to finished
thickness of 15mm.

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, place and plumb. All exposed angles and junction 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:
1) Preparation of surface to receive the plaster, providing cement plaster of he specified average thickness and proportions with specified number of coats.
2) All labour, materials, scaffolding, use of tools and equipment to complete the plastering work as per specifications.
3) Curing for 10 days.
4) Cleaning the surface of doors, windows, floors or any other surfaces where plastering might have splashed.
5) Finishing the portion of plaster left above the terrazzo, 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.

Sand Faced Cement Plaster :

General :
Materials and preparation of surfaces and scaffolding etc. for sand faced plaster wherever applicable shall conform to specification laid down herein before under section cement plastering and the following specifications are also to be complied with.

Preparation of Surface :

The surface to be plastered shall first be thoroughly cleaned down. All joints shall have been raked out in case of brick work/stone masonry as the work proceeds. Concrete surface shall also be clearly hacked and wire brushed if not already done before plastering is taken up. 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 construction at his own expenses wherever directed by the Engineer-in-charge, Scaffolding shall be erected with pipes or bellies 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.

**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 12mm 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 12mm (1/2") apart and about 3mm (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 3mm. 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 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 the same is taken up. Vatas shall be done simultaneously with chajja plaster.

**Mode of Measurement:**

Area of plastering will be measured net and shall be paid for. The measurement of length of wall plastering shall be taken between walls or partitions (dimensions before plastering shall be taken) for 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, so fits, 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 hall include the cost of finished all the edges, corners, cost of all materials, labour, scaffolding, transport, curing etc.

The rate shall include the cost of finishing all the edges, corners, cost of all materials, labour, transport, scaffolding, curing etc. and grooves if so specified in the item of schedule of quantities.
The rate for plastering should include the cost of work towards the following items for coordination with electrical item:

- Neatly plastering around DB's junction boxes, M.S. boxes etc. should be done and made matching with the wall finish after installation of electrical equipments.

- All BD's service boxes, covers etc. should be covered by a plastic cloth of other suitable covering material 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.

- For fixing M.S. boxes, DB's etc. Thiya should be given such that the required face of the M.S. box, DB covers etc. in line with final finished plastered surface.

- 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 prepare dint eh same thickness of plaster shall not be measured separately and shall be covered by respective plaster items.
15. FLOORING

Scope:

The work covered under this specification consists of providing and laying at levels and floors, flooring of different types, strictly in accordance with these specifications and relevant drawings.

Cement Concrete Flooring (Indian Patent Stone):

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 10mm. 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.

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 atleast 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 before laying the topping. Before laying the concrete, cement slurry at 2.75 kg. / sqm. of surface shall be applied for better bond, / flush as per drawings. 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 a skirting/ dado. The border shall have mitred joints at the corners of the room.

Where aluminium dividing strips are proposed to be provided, the same shall be fixed in cement mortar 1:2 @ 1200 mm. centers 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 joints, alternate panels only may be cast on same day. Atleast 48 hours shall elapse before the concreting of adjacent bay is commenced.

**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 10mm 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

**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 and leveled carefully. The concrete shall be compacted 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 correction needed shall be made up by adding or removing the concrete and whole surface is again leveled. When the layer is made even, the surface shall be completed by ramming or beating ad then screed to a uniform line and level. Before the initial set commences, the surface 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.

**Finishing the surface:**

After the concrete has been fully compacted, it shall be finished by toweling or floating. Finishing operations shall start shortly after the compaction of concrete an shall be spread over a period of one to six hours depending upon the temperature ad 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 retrowelled many times at intervals to close any pores in the surface shall be retrowelled many times at intervals to close any pres 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. Bromming 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 timed 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 a 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 ad the joint shall be finished in perfectly straight line.

**Steel Trowel Finish :**

Areas where marblax tiles are proposed to be used are required to have base concrete finished smooth by steel trowel.

**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
The surface shall be covered and cured continuously from the next day after finishing, at least for a period for 7 days.

Bunding with murrum for curing is prohibited as it will leave permanent stain on the finished floor.

Cure 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 its 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.

**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 not 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 areas where flooring is not done shall be deducted and net areas only shall be measured a 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 places of decimals of a metre and area worked out up to two places of decimal of a square meter.

**POLISHED GRANITE STONE FLOORING DADO / LINING AND SKIRTING FLOORING**

i) **Granite Slabs:**

The granite slabs shall be hard, sound, durable, and resistant to wear as per IS3376-1974 and IS14223 (part 1): 1995. The granite slabs shall be without any soft veins, cracks or flaws and shall have a uniform colour. A tolerance of 3mm in thickness at any point shall be permitted. The exposed surface of stone slabs shall be machine polished to a smooth even and true plan and the edges to be chiseled to half its depth, true and square to ensure uniform width of joint. The edges of stone slabs shall be machine cut square the required shape if necessary. The stone slab shall be of approved colours and shades. A few approved samples of stone slabs to be used shall be deposited by the contractor in the office of the Site Engineer.

ii) **Mortar Bedding:**
Lime mortar shall be prepared in a mortar mill or pan. 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 stone slabs. Before spreading the mortar the sub floor or base cleaned of all dirt, scum, loose materials and laitance if any by scrubbing with coir or steel wire brush or by hacking if necessary, and then well wetted without forming any pools of water on the surface. Before laying the mortar, the sub grade shall be got approved by the Site Engineer. In case of R.C.C. floors, the top shall be left little rough. All points of level of the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens, only over so much area, as will be covered with slabs within half an hour. The thickness of the mortar bedding shall not be less than ‘1/1/2” and not more than 1”. The required slope shall be given to the bed. Unless otherwise specified, the proportion of mortar bedding shall be 1:1:1 (1 lime putty: 1 surkhi: 1 sand). Sand for mortar bedding shall be from approved source, and shall conform to I.S. NO.2116-1965 as applicable to unreinforced masonry work.

iii) Laying, Curing, Polishing, Finishing and Cleaning:

The stone slabs 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. The stone slabs shall be laid in the approved pattern in single or two-tone colour. Each stone slab shall be gently tapped with a wooden mallet till it is firmly and properly bedded. There shall be no hollows left. If there is a hollow sound on gentle tapping of the stone slabs, such stone slabs shall be removed and reset properly. The mason shall make the joint of uniform thickness and straight lines. The thickness of joints shall not exceed 1.5mm. The joints shall be grouted with neat cement slurry. No border stone slabs shall be less than 4" in width, unless otherwise approved by the Architect. When the bedding and joints of the flooring have been completely set, the surface shall be machine polished to give a smooth, even and true plane to the floor and thoroughly cleaned.

iv) Rates to include:

Apart from other factors mentioned elsewhere in this contract the contractor’s rate quoted shall include for the following:

Cleaning the base and providing and laying bedding mortar and levelling.
Providing and fixing the stone slabs in neat cement float on the bedding mortar.
Filling joints of stone slabs with neat cement slurry of required colour to match the colour of the stone slabs.
Chiselling, polishing, finishing and cleaning.
All labour, materials and use of tools for carrying out the item as specified above.

CERAMIC TILE FLOORING AND DADO/SKIRTING:
General:

This item relates to the furnishing of materials and installations of ceramic tiles in flooring dado, etc. Tiles shall conform to IS : 15622 and workmanship shall be per IS : 1443.

Materials:

The ceramic tiles shall be of first quality of approved manufacturers. The size of tiles shall be as specified or as directed in the drawing and shall be of appropriate minimum thickness as mentioned in the item of ceramic tile flooring & dado in BOQ. No chipped, cracked, crazed or warped tiles shall be used. Glazed rounded corners and cups (convex or concave) shall be provided at corner of walls, edge, junctions of floor and dado etc., if so specified. The mortar shall be in the proportion 1:4. (Cement : Sand)

Laying:

The fixing shall generally conform to IS : 1443.

Workmanship:

The surface to be covered shall be plastered rough to a thickness of 12 mm. Fix 12 mm size stone chips (5 no. one in each corner and one in the middle of each tile with Adhesive viz., Areldite of equivalent for keying action) and the tiles shall be soaked in water for at least 2 (two) hours prior to fixing at site. A thin layer of cement paste shall be buttered on the back of the tile and on the side after which the tile shall be pressed and tapped home taking care that the corner tiles are perfectly matching. After the backing coat has set the tile joints shall be grouted with neat, white cement slurry with necessary pigment. All surplus slurry that remains on the surface shall be carefully wiped off before it sets. Care shall be taken to ensure that the finished surface is absolutely plumb and to proper levels without any profusions, waviness or zig-zag. Joints between tiles shall be uniform in straight level lines. After completion of the entire work or part of it, the surface shall be cleared of all stains, cement etc., by washing with oxalic acid (1:10) or any other approved compound.

Fixing tiles for Dado and Skirting / Facia:

The dado work, shall be done only after fixing the tiles / slabs on the floor. The approved glazed tiles before laying shall be soaked in water for at least 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 1:3 using fine sand (table III, zone IV, IS383-1963), 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 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 tiles 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.

Cleaning: -
After the tiles have been laid in a room or the day 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 sawdust. It shall be removed only after
completion of the construction work and just before the floor is used.

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.

Testing of the tiles:-
The tiles used for dado including border tiles are to be tested as per IS 13630 from
Part I to Part 13 whichever is applicable In the periodicity of the testing shall be one set of
tiles for every 300 Sqm of dado area and part thereof. The tiles used for the flooring are to be
tested as per IS 13630 from Part I to Part 13 whichever is applicable and in case of its
periodicity of testing may be done as one set of tiles for every 100 sqm and part thereof.

NITOFLO FLOORING AND DADO/SKIRTING:

Description
Nitocote PUW100 is a two component prepacked, water dispersed polyurethane resin
system supplied ready for onsite mixing and use. The cured film forms a hard, flexible, matt
seal to concrete and other substrates. The total dry film thickness shall be of 90 microns in two
coats.

Technical support
Fosroc offers technical support service to specifiers, end users and contractors, as well
as onsite technical assistance in locations all over the country.

Note: After the usable life has expired, any excess material although not hardened &
increased in viscosity should not be used for application.

Chemical resistance
Samples of Nitocote PUW100 have been subjected to constant immersion at 300C for 3
months in the following chemicals and have been found to be unaffected.

Dilute Sulphuric acid 20%
Dilute Citric acid
Dilute Sodium Hydroxide 20%
Ammonia 10% solution
Oil and grease
Petrol
Tap water
Sodium chloride

Good housekeeping is essential in areas where chemical spillage is likely to occur. It is especially important that such spillage should not be allowed to dry as higher concentrations of chemicals are involved.

Where chemicals at higher temperatures are involved, Fosroc shall be contacted.

Properties

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<td>Pencil hardness</td>
<td>&gt; 2H</td>
</tr>
<tr>
<td>ASTM D3363</td>
<td></td>
</tr>
<tr>
<td>Impact resistance</td>
<td>&gt; 50</td>
</tr>
<tr>
<td>(ASTM 2794) (cm.kg)</td>
<td></td>
</tr>
<tr>
<td>Abrasion resistant</td>
<td>&lt; 50mg</td>
</tr>
<tr>
<td>(ASTM D 4060)</td>
<td></td>
</tr>
<tr>
<td>(1000g, 1000 cycles)(CS10 wheel)</td>
<td></td>
</tr>
<tr>
<td>Alcohol(100%) double rub,</td>
<td>&gt; 150</td>
</tr>
<tr>
<td>(ASTM D5402)</td>
<td></td>
</tr>
<tr>
<td>MEK double rub,</td>
<td>&gt;150</td>
</tr>
<tr>
<td>(ASTM D5402)</td>
<td></td>
</tr>
<tr>
<td>Pull of Adhesion Strength</td>
<td>&gt;3N/mm²</td>
</tr>
<tr>
<td>(ASTM D4541) (concrete failure)</td>
<td></td>
</tr>
</tbody>
</table>

Application instructions

Instructions for use
Surface preparation

The long term durability of any coating is determined by the adhesive bond achieved between the coating material and the substrate. It is most important therefore that substrates are correctly prepared prior to application.
**New concrete substrate**

These should normally have been placed for at least 28 days and have a moisture content of less than 5%. Substrate should be sound and free from contamination such as oil and grease, mortar and paint splashes or curing compound residues. Excessive laitence can be removed by the use of mechanical methods. Dust and other debris should then be removed by vacuum cleaning.

**Old concrete substrate**

A sound, clean substrate is essential to achieve maximum adhesion. As for new concrete substrate dry removal of laitance by use of mechanical methods is preferable. Oil and grease penetration should be removed by the use of a proprietary chemical degreaser or by hot compressed air treatment. Any damaged areas or surface irregularities should be repaired using Nitocote Putty.

**Priming**

Priming is not normally required provided the substrate is sound, untreated and good quality nonporous concrete. If any doubts exist of the quality of the concrete, or if it is porous it should be primed with Nitoprime XG. Contact the local Fosroc office for advice.

Nitoprime XG should be mixed in the proportions supplied. Add the entire contents of the hardener can to the base can. When thoroughly mixed, preferably using a slow speed drill and paddle, the primer should be applied in a thin continuous film, using rollers or stiff brushes. Work the primer well into the surface of the concrete taking care to avoid ponding or over application. The primer should be left to achieve a tack-free condition before applying the top coat. A second coat of primer may be required if the substrate is excessively porous.

**Mixing the coating**

The base component of Nitocote PUW 100 should be thoroughly stirred before it is mixed with hardener. The entire contents of the hardener container should be poured into the base container and mix thoroughly, for atleast 3 minutes using power mixing tools. Mix these components in the quantities supplied taking care to ensure all containers are scraped clean. Do not add solvent thinners at any time.

**Standard application**

The mixed Nitocote PUW100 should be applied to the prepared surface by spray, brush or roller. Ensure the loose hair on the roller are removed before use. A minimum wet film thickness of 100 microns should be applied in 1 coat.

When the base coat has reached initial cure (8 hours @ 27°C), the second coat can be applied at minimum wet film thickness of 100 microns. Care should be taken to ensure that a continuous film is achieved.
Estimating
Nitocote PUW100 is supplied in 4 litre packs. The coverage of Nitocote PUW100 coating depends to a large extent on the substrate & site conditions. For calculation purpose 10m²/litre/coat @ 100 microns WFT (45 microns DFT) can be taken as coverage.

Storage
Nitocote PUW100 should be stored under normal warehouse conditions, and must be protected from frost.

Shelf life
6 months in unopened containers.

Precautions

Health & Safety instructions
Since some people are sensitive to isocyanate resins, gloves, goggles and barrier creams should be used when handling these products. If contact with skin occurs, it must be removed, before it hardens, with resin removing creams followed by washing with soap and water. Solvent should not be used. The use of goggles is recommended. Direct contact with eyes will cause irritation and may cause serious damage, if left untreated. Any eye contamination should be washed with plenty of water and seeking immediate medical treatment is suggested.

Fire
Nitocote PUW100 coating is non-flammable.

Additional information
Fosroc manufactures a wide range of products specifically designed for the repair and refurbishment of damaged reinforced concrete. This includes repair mortars, fluid micro concretes, chemical resistant epoxy mortars in addition to comprehensive package of protective coatings. In addition, a wide range of complementary products are available. This includes admixtures, joint sealants, waterproofing membranes, grouts and anchors specialised flooring materials and bonding agents.
Separate data sheets are available on these products.
16. PAINTING

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 hereinafter with the item of schedule of quantities.

Materials:

Paints, oils varnishes etc. of approved brand and manufacture shall be used. Ready mixed paints as recovered 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 for 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.

Commencing Work:

Scaffolding:

Wherever scaffolding is necessary, it shall be erected on double supports ties together by horizontal pieces, over which scaffolding planks shall be fixed. No bellies, bamboos or planks shall rest on or touch the surface which is being painted.

Were ladders are used, pieces of old gunny bags shall be ties 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 entire building cleaned up at least one day in advance of the paint work being started.

**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 and 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.

**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 he R.C.C. Jalli, fins and the panels above 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 and 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 cut 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 tightly 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. Prospect 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.

**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 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 and can be used again.

**Measurement:**

Painting, unless otherwise stated shall be measured by area in square metre. Length and breadth shall be measured correct upto two places of decimal of a metre.

No deduction shall be made for opening not exceeding 0.05 sqm. and no addition shall be made for painting to the beading, moulding edges, jambs, soffits, sils, architraves etc. of such openings.

In measuring painting, varnishing, oiling etc. of joinery and steel work etc. the co-efficient as in the following table shall be used to obtain the areas payable. The co-efficient shall be applied to the areas measured flat and not girthed in all cases.

In case of painting of door shutter with push plates in plastic laminate, deduction will be made for area of such laminations.

**Precautions:**

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

**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.

**Painting, Priming coat on Wood, Iron of Plastered Surfaces**

**Primer**

The primer for wood work, iron work or plastered surface shall be as specified in the description of the item.

Primer for wood work / Iron & Steel / Plastered / Aluminium surfaces shall be as specified below:
<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Surfaces</th>
<th>Primer to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Wood work (hard and soft wood)</td>
<td>Pink conforming to IS 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 galvanized steel Work</td>
<td>Zinc chromate primer conforming to IS 104-1962</td>
</tr>
<tr>
<td>d)</td>
<td>Plastered surfaces, cement brick work, Asbestos surfaces for oil bound</td>
<td>Cement primer</td>
</tr>
</tbody>
</table>

The primer shall be ready mixed primer of approved band and manufacture.

**Preparation of Surface**

**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 herein 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.

**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.

**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 / putty and rubbed smooth.

*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 herein before.

*Other details*:

The specifications for Painting (General) shall hold good so far it is applicable.

**Painting with superior quality and Flat Oil ready mixed paints on new Surface**

**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 IS specifications.

**Preparation of Surface**

**Wood work**:

The surface shall be cleaned and all unevenness removed as in para 32.10.2 (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.

**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.

**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.
Application:

The specifications mentioned herein 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.

Other Details:

The specifications for painting (general) specified herein before shall hold good in so far as they are applicable.

Painting with synthetic enamel / Semi glossy Paint on new work

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.

Preparation of Surface:

This shall be as per painting with superior quality ready mixed paint as mentioned herein before.

Application:

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

Under Coat:

The 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.
Top coat:
Finishing coats of specified paint of the desired colour and 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.

Other Details:
The specifications for "Painting (General)" mentioned herein before shall hold good as far as they are applicable.

Painting with Acrylic Emulsion/Plastic Emulsion Paint

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

Primer:
The primer to be sued 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.

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.

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, frills, ventilation, outlets, electrical boxes and such obstructions not painted, if they are individually more than 0.05 sqm.
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 during progress of work.

All wood surfaces are to be pointed with semi glossy synthetic enamel paint with an approved primer.

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

White Washing with lime

Preparation of surface:

Before new work is white washed, the surface shall be thoroughly brushed free from mortar dropping and foreign matter.

In the case of old work, all loose pieces and scales shall be scrape off and holes in plaster as well as patches of less than 0.5 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.

Preparation of lime wash:

The wash shall be prepared from fresh lime stone white lime. 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 or Fevicol DDL Binder which shall be added to each 10 cubic decimeter 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 (Robin Blue) upto 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 litres 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.
**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 strike, 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 reach 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 hereinbefore, 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.

**Protective measures:**

Doors, windows, floors, articles of furniture etc. and such other parts of the building act to be white washed shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surfaces cleaned. Damages, if any to painted surfaces, furniture or fittings and fixtures etc. shall be recoverable from the contractor.

**Measurements:**

All measurements for payment shall be taken on net surface areas actually white washed, unless otherwise specified. Deductions will be made from the areas for fixtures, grills, ventilation, outlets, electrical boxes and such obstruction not painted if they are individually more than 0.05 sqm. Length and breadth shall be taken correct upto two places of decimal of a metre and areas so worked out shall be correct upto two places of decimals of a square metre.
Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the percentages to allow for the girthed area:

- Corrugated asbestos cement sheets: 20%
- Semi-corrugated asbestos cement sheets: 10%

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.05 sqm. each with materials similar in composition to the surface to be prepared.

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

**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 finish 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.

**Distempering**

*a) Distemper*:

Dry distemper (IS 427 - 1965) of approved brand and manufacture, colour and required shade shall be used. The 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 herein before in so far as it is applicable.

**c) Application:**

In case of new work, the treatment shall consist of priming coat followed by the application of two or more coats of distemper till the surface shows an even colour.

**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 used. No white washing coat shall be used as a priming coat for distempering.

- The application of each coat as mentioned in the specifications for painting (General) herein before, shall hold good, as far as it is applicable.

**Oil Emulsion (oil bound) Distempering / Acrylic Distemper**

**a). Oil bound distemper :**

(IS 428-1969) 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 manufacture. Only s quality of distemper required for days work shall be prepared.

**b) Preparation of surfaces :**

The surface shall be prepared as described herein 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 oil bound distemper primer. The surfaces shall be finished as uniformly as possible leaving no brush marks, priming coat shall be allowed to dry for atleast 48 hours before oil bound is temper 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 atleast 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.

Other details:

The specifications for "Painting (General)" mentioned herein before shall hold good as far as it is applicable.

Water Proofing Cement based paint

a) Material:

Cement based paint (IS 5410-1969) 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 surfaces shall be got approved before painting is commenced.

The water proof cement paint shall be mixed in such quantities as can be used up within 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 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 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 surfaces already treated with white wash, dry or oil distemper, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

d) Other details:

The specifications for painting (general) mentioned herein 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 to areas. Deduction will be made from areas for opening / obstructions not painted, if they are individually more than 0.05 sq.m. Length and breadth shall be taken correct up to two places of decimal of a meter and areas shall be worked out correct up to 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) Corrugate 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 labor involved in all the operation described above.

Bees Waxing of Polishing with Readymade Wax Polish (New Work): Materials:

The polishing shall be done with bees waxing prepared locally or with readymade wax polish of approved brand and manufacture, as stipulated in the description of item.
Where bees waxing is to be prepared locally, the following specifications for the same shall apply:

Pure bees wax free from paraffin or stearing adulterants shall be sued. Its specific gravity shall be 0.965 to 0.969 and melting point shall be 63°C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2:1.5:1:05 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.

**Preparation of Surface:**

Preparation of surface will be as mentioned herein under para 32.20.2 with the exception that knotting, holes and cracks shall be stepped with a mixture of fine saw dust formed of hardwood being treated, beaten, beaten up with sufficient bees wax to enhance cohesion.

**Application:**

The polish shall be applied evenly with a clean soft pad of cotton cloth in such 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.

**Other details:**

The specifications for painting (general) as mentioned herein before shall hold good as far as they are applicable.

French Spirit Polishing (On new work with a coat of wood filler):
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.

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 to red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glaziers putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

Application:

The number of coats of polish to be applied shall be as described in the item. A pad of wooden cloth covered by fine cloth shall be used to apply the polish. The and 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.

Measurement, Rate and other details:

These shall be as for painting (general) mentioned herein before as far as they are applicable.

Resin based Thermo Plastic Paint (Decorative and Protective Finish):

Materials:

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

Preparation of Surface and General:

The specifications for painting (General) described herein before shall hold good as far as they are applicable.
**Protective Coatings:**

On surfaces such as ferrous metals, brass, copper and phosper bronze, a protective coating of suitable bituminous compound or chromated redoxide should be given. New wood should be treated with a leafing grade aluminium primer or a water based acrylic emulsion primer.

The surfaces with algae growth thoroughly cleaned down to remove as much growth as possible and effective solution of stabilized household bleach (calcium hypochloride) of approved quality with approximate 35% chlorine content @ 2 kgs. per 50 litres (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 materials such as snowsol stabilizing solution or other approved equivalent with white spirit.

**Application:**

The ready mix Sandtex Matt or other equivalent approved resin based there 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, one undercoat of cement based paint such as snocem 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 litres of water to 20 litres of paint or as directed.

Painting with resin based thermo plastic shall be carried out generally as per manufacturers specifications.

**Other details:**

The specification for painting (general) mentioned herein 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 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.
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.

Rate:
The rate shall include the cost of all materials and labour involved in all the operations described above.
Consumption of paint for different Painting items:

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Brief description of painting work</th>
<th>Consumption per 10 sqm. of net area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Oil Bound Distemper on plastered surfaces:</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Cement primer (one coat)</td>
<td>0.91 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Two finishing coats</td>
<td>1.60 Kgs.</td>
</tr>
<tr>
<td>3.</td>
<td>Three finishing coats</td>
<td>2.4 Kgs.</td>
</tr>
<tr>
<td>2.</td>
<td><strong>Flat oil paint to plastered surfaces:</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Cement primer (one coat)</td>
<td>0.91 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Cement primer (two coats)</td>
<td>1.82 Litres</td>
</tr>
<tr>
<td>3.</td>
<td>Two finish coats</td>
<td>1.72 Litres</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Acrylic Emulsion paint</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Cement primer (one coat)</td>
<td>0.91 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Cement primer (two coats)</td>
<td>0.87 Litre</td>
</tr>
<tr>
<td>3.</td>
<td>Two finish coats</td>
<td>1.30 Litres</td>
</tr>
<tr>
<td>4.</td>
<td><strong>Cement Paint (old surface)</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Two coats on sand faced plastered surface</td>
<td>4.10 Kgs.</td>
</tr>
<tr>
<td>2.</td>
<td>Two coats on rough cast plastered</td>
<td>7.70 Kgs.</td>
</tr>
<tr>
<td>5.</td>
<td><strong>Cement paint (old surface)</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Two coats on sand faced plastered surface</td>
<td>4.50 Kgs.</td>
</tr>
<tr>
<td>2.</td>
<td>Two coats on rough cast plastered</td>
<td>8.50 Kgs.</td>
</tr>
<tr>
<td>6.</td>
<td><strong>Enamel paint to wood / steel</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Wood primer (one coat)</td>
<td>0.90 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Steel primer (one coat)</td>
<td>0.75 Litre</td>
</tr>
<tr>
<td>3.</td>
<td>Two finishing coats on wood</td>
<td>1.40 Litres</td>
</tr>
<tr>
<td>4.</td>
<td>Two finishing coats on steel</td>
<td>1.35 Litres</td>
</tr>
<tr>
<td>7.</td>
<td><strong>Flat oil paint to wood / steel work</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Wood primer (one coat)</td>
<td>0.90 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Steel primer (one coat)</td>
<td>0.75 Litre</td>
</tr>
<tr>
<td>3.</td>
<td>Two finishing coats on wood</td>
<td>1.70 Litres</td>
</tr>
<tr>
<td>4.</td>
<td>Two finishing coats on steel</td>
<td>1.75 Litres</td>
</tr>
<tr>
<td>8.</td>
<td><strong>External painting with flat oil paint</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Cement primer (one coat)</td>
<td>1.00 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Two finishing coats</td>
<td>1.74 Litres</td>
</tr>
<tr>
<td>9.</td>
<td><strong>Repainting old painted surface</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Two coats of emulsion paint</td>
<td>0.86 Litre</td>
</tr>
<tr>
<td>2.</td>
<td>Two coats of flat oil paint</td>
<td>1.59 Litres</td>
</tr>
<tr>
<td>3.</td>
<td>Two coats of enamel paint</td>
<td>1.35 Litres</td>
</tr>
</tbody>
</table>
17. WATERPROOFING

Water proofing plaster in toilet area

General:

The guarantee for water proofing treatment in prescribed proforma must be given by the specialized agency which shall be given by the specialized agency which shall be countersigned by the contractor in token of his overall responsibility. The guarantee for waterproofing treatment in the prescribed proforma shall also cover horizontal expansion joint and vertical expansion joint.

Water proofing plaster in Toilet area:

The following specification shall be followed unless otherwise stated in schedule of quantities. This shall be 20mm thick cement plaster 1:3 including an under coat not exceeding 13mm thick, for walls upto slab level and further above finish floor level upto 600 mm high and for floor the thickness of cement plaster shall be 25mm. Approved water proofing compound like CICO No.1 or other approved equivalent shall be added @ 3% by weight of cement in cement mortar or as per manufacturers specifications in both the coats. The workmanship and material shall be same as described in plaster work in general. All exposed surfaces shall be finished smooth with a coat of neat cement as directed.

Brick bat Coba Water Proofing on Terrace: Materials:

The aggregate for brick bat coba shall be broken from good and thoroughly well burnt bricks. These shall be approved by the Engineer-in-charge before use.

Brick bat coba shall be in Cement Mortar 1:2

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 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 and rapidly with wooden beaters to get the required compaction and to obtain complete integration of brick bats and lime.

b) White beating, fresh fracture may take place which may cause absorption of water from the mortar. Additional
water may be sprinkled with beating in such causes 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 (vatas) as shown in the drawing and as directed by the Engineer-in-charge.

**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. Vatas shall not be measured separately. Rated shall include cost of preparation of surface, cost of materials, labour, making vatas etc.

**China Mosaic Water Proofing**

**General:**

This type of water proofing shall consist of setting in thick cement slurry selected colour / white glazed tile broken pieces of approved make and size over cement mortar (1:3) 20mm. thick bedding 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 IS. Specifications and shall be got approved before incorporating in the work.

The surface of brick bat coba shall be thoroughly cleaned of dust, dirt and loose particles removed and adequately watered. Thick coat of cement slurry of the honey like consistency shall be sprayed on the base before cement mortar screening of specified thinness is laid.

**Laying:**

Over the prepared surface of brick bat coba, a layer of cement mortar 1:3, 20 mm thick screed mixed with approved water proofing compound by weight of cement 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 6mm thick selected white / colour glazed tiles not less than 25mm and not more than 50mm 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 an cotton waste. Finally the surface shall be cleaned with weak acid solution to remove cement marks over the white glazed tile pieces. The finished work shall be cured for atleast 7 days. Care shall be taken to see that cements in joints does not get dissolved due to acid washing. At corners and junctions with parapet, the water proofing coarse shall be rounded off in the form of vata with cement mortar bedding as per drawing and shall be included in the quoted rate.

**Mode of measurement:**

The length and breadth shall be measured to two places of decimal of a meter, alongside the surface including vata curves etc. and area worked out in square metre. Vatas shall not be measured separately. The rain water 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.

**Cement based Water Proofing of W.C. and Baths Areas**

**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 treatment etc.

**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 contactor. If any honey combs are observed in beams and slab 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.

**Sequence of Treatment:**

All cutting an 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 compound according to the plaster treatment mixed with the water proofing compound according to the recommended specifications of the water proofing agency. Waterproof cement plaster 1:3 of 225mm thick for floor and sides of walls upto slab level and about 20mm thick for walls, above finished floor level upto 600mm high.
The plumping agency shall then lay and fix the pipes, W.D. 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 water proofing 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.

**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.

**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 underside 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 for the waterproofing treatment for maintaining the underside 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 for cost, starting his work of checking up and rectification within a week’s time from the date of receipt of information about such leakages etc. by him.

The contractor shall submit the guarantee bond appropriate stamp paper and as per the enclosed proforma.

**Mode of measurement:**

1. Waterproof plaster shall be computed by taking the length and breadth of the area actually plastered corrected upto two decimal places of a metre. NO deduction shall be made for W.C. pans, pipes etc. in the measurement.

2. 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, upto two decimal places of a metre and also no deductions shall be made for W.C. pans, pipes etc.
Waterproofing for Terrace

Uses

Brushbond RFX is an high performance elastomeric cementitious coating used for waterproofing and to protect atmospherically exposed reinforced concrete structures from attack by acid gases, chloride ions, oxygen & water. Brushbond RFX is suitable for all types of structures including those in coastal environments. The product can be used on concrete, brick and blockwork substrates and is equally suitable for new and existing structures. The product is designed to reface and even out variations in concrete and masonry surfaces and bridge shrinkage cracks. It provides a seamless, flexible waterproof coating suitable for water tanks, reservoirs, drainage culverts basements and roofs. The product provides a tough durable water resistant coating which can withstand light pedestrian traffic and also has excellent weather resistance for exterior applications.

Advantages


Standards compliance

Tested to ASTM D4060, ASTM D4541, ASTM D638, ASTM C836.

Description

Brushbond RFX is a two component acrylic polymer modified cementitious coating which consists of Brushbond RFX powder and Nitobond BBX acrylic emulsion. It requires only the addition of clean water at site to produce an easily brushable coating. Brushbond RFX can simply be applied by stiff brush, roller or trowel to obtain the desired thickness.

Technical Support

Fosroc offers technical support service to specifiers, endusers and contractors, as well as on-site technical assistance in locations all over the country.

Application Instructions

Surface Preparation

All surfaces which are to receive the coating must be free from oil, laitance, grease, wax, dirt or any other form of foreign matter which might affect adhesion. Typically concrete surfaces can be cleaned using high pressure water jet or grit blasting or by proper wire brushing. Spalled surfaces or those containing large blow holes, cracks and other such defects
should be repaired using Renderoc concrete repair mortars. For further advice on suitable repair mortars, contact the local Fosroc Office.

**Mixing**

Nitobond BBX concentrate should be poured into a plastic container or metal drum. Clean fresh water is added in the proportions shown below and mixing commenced with a propeller agitator attached to a slow speed drill (500pm). The powder component should be added gradually to the liquid to avoid lump formation and mixed for 2-4 minutes. Brushbond RFX should be immediately used after mixing. Do not mix more material than can be used within the pot life. Keep stirring Brushbond RFX during the application.

**Mixing ratio**

**Brushbond RFX Brush Application**

**Components Indl Pack Small**

- Powder 15kg 5kg
- Nitobond BBX 4.8L 1.63L
- Water 3L 1L

**Application**

For best results, surfaces should be damp. In order to obtain the protective properties of Brushbond RFX, it is important that the correct rates of application are observed. Use a short stiff brush preferably 120-150mm width and apply the mixed material like paint. The application of Brushbond RFX should not be done if the temperature of the substrate is below 10 C. When applying Brushbond RFX on hot substrates i.e., over 30 C surface temperature, saturate the surface with water. Apply Brushbond RFX in 2 coats to achieve 1mm thickness. The second coat of Brushbond RFX shall be applied as soon as the first coat has reached touch dry state. It is recommended that for general surfacing Brushbond RFX should be applied at a minimum thickness of 1mm. Areas subjected to moderate and heavy loads/hydrostatic pressure, minimum 2mm thickness coating is recommended with screed above. Allow the Brushbond RFX coating to dry before covering with screed. Sprinkle coarse sand on wet surface of final coating for better adhesion of screed. Average drying time is 4 to 6 hours at normal temperatures.

**Cleaning**

Brushbond RFX should be removed from tools and equipment with clean water immediately after use. Hardened material can only be removed mechanically.

**Estimating**

**Packing**

Powder component : 15kg & 5kg packs
Liquid polymer component : 4.8 & 1.63 L containers

Coverage

This depends on the required consistency. The approximate coverage per pack at even consistency (1mm thickness) is as follows

- Consistency Brush application
  - Coverage (15kg + 4.8 lit pack) 12 - 14m
  - Coverage (5 + 1.63 lit pack) 4 - 4.5m

Storage

Shelf life

6 months in unopened packs if kept in a dry store.

Precautions

Health and Safety instruction

Brushbond RFX is non-toxic but alkaline in nature. Gloves and goggles should be worn. Any splashes to the skin or eyes should be washed off with clean water. In the event of prolonged irritation, seek medical advice. Use a dust mask while handling the powder.

Fire

Brushbond RFX components are non inflammable.

Internal Waterproofing for Overhead Water/Lift Pit/Underground Sump or Tanks

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 water tightness of the water proofing treatment and furnishing guarantee as specified.

Preparation of surfaces

The surface to receive the waterproofing treatment shall be thoroughly cleaned of scales, laitance, set mortar etc. The surface shall be roughened with close hacking to provide adequate key for the waterproofing treatment. All honey combs in concrete surface shall be carefully hacked and loose materials removed and all pockets plugged suitably well before commencing waterproofing treatment.

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 waterproofing compound of appropriate consistency to fill up all cracks and crevices if any. A layer of waterproofing mix recommended by the specialization agency 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 50mm. and that on walls not less than 20mm. The entire surface shall be finished smooth with steel trowel in cement colour. The plastered surfaces shall be kept continuously wt immediately after 24 hours so as to cure it properly for atleast seven days.

Testing:

The tank will thereafter be got filled into the full height immediately by the Department 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 if 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 month 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 contactor.

Mode of measurement:
Measurement for payment of waterproofing treatment shall be as per actual area covered by waterproofing treatment including offset, overlapping, vata, haunch etc. as provided at site. The length and breadth of the surface actually treated with waterproofing treatment shall be measured upto two places of decimal or a metre. No deduction shall be made for inlet, outlet, scour connection, by out 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.
18. RUBBER / PVC WATER STOPS

General:

The corrugated Rubber / PVC water stops with center bulb of specified width, shall be of approved manufacture and shall satisfy all the normal tests such as tensile strength, elongation etc.

Sample:

A sample of Rubber / PVC water stops shall be got approved from the Engineer-in-charge before procurement of bulk quantity.

Placing in Position:

The eater stops shall be provided in available maximum length and as far as possible, jointing shall be avoided. All the joints when unavoidable, shall be field jointed for water tightness as per manufacturers specifications.

The eater 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 damaged caused to water stops shall be made good by the contractor at his own cost.

Mode of measurement:

The mode of measurements shall be in running meter, of water stop actually laid without any allowance for taps, wastage etc. measured correct to one centimeter.

Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc. all as described above.
19. ROAD AND PAVEMENTS

Scope of work:
The work contemplated under these specification refers to Earth Work in excavation. Forming Embankments, soling W.B.M. Bituminous Macadam. Wearing course / sealing coat etc. for road an pavement works.

Approximate quantities of materials to be used in the work are listed below for reference:

i) Soling stone:
   a) For 230 mm thick consolidated thickness 2.65 cum / 10 sqm.
   b) For 150 mm thick consolidated thickness 1.725 cum / 10 sqm.

ii) Stone aggregate 50mm nominal size for 75mm thick consolidated WBM: 0.975 cum / 10 sqm.

iii) Murrum for 75mm thick consolidated WBM: 0.305 cum / 10 sqm.

iv) Bituminous macadam for premix carpets for 38mm consolidated thickness: 11 sqm / mt.

v) Seal coat (Bituminous concrete for wearing course) for 12mm consolidated thickness: 33 sqm / mt.

Earth work in excavation:
The specifications for "Excavation, Fill and Back fill" under chapter-I, specified herein before shall hold good as far as they are applicable.

Forming embankment:
The work shall include preliminaries of clearing site, setting out and preparing the ground and thereafter forming embankment for the rods, paths etc. with approved materials available from excavations under this contract (excavation paid separately under respective items) or elsewhere, spreading in layers, watering and compacting to the required density and lines, curves, grades, camber and cross section and dimensions shown in the plan or as directed by the Engineer-in-charge. When the embankment is to be laid on hill sides or slopes, the existing slopes are to be ploughed deeply. If the cross slopes are steeper than 1 on 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 tope 15cm. 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 200mm. 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 slope 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, leveled and compacted as specified hereinafter, 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 100mm 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 moistures, it shall be allowed to dry until the moisture is reduced to require to the appropriate amount by exposure, embankment work shall be suspended till suitable conditions prevail at no extra claim / compensation.

When loose layer is leveled manually or mechanically and moistened or dried to a uniform moisture content suitable for maximum compaction, it shall be compacted by 8 to 10 tone power roller or sheep foot rollers or heavy hauling or dozing equipment to give the specified 90% of the proctor density. It 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 150mm to 200mm 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 in to 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 mentions 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 to cubic metre on lines similar to those specified for earth work hereinbefore.

**Sub Grade:**

**Preparation of sub-grade:**

The surface of the formation for a width of sub-base, which shall be as per drawing shall first be cut to and 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 subgrade 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 re-rolled.

**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 or Surface Regularity:**

<table>
<thead>
<tr>
<th>Longitudinal Profile</th>
<th>Cross Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Permissible undulation when measured with a 3 metre straight edge.</td>
<td>Maximum permissible variation from specified profile when measured with a camber templates</td>
</tr>
<tr>
<td>24 mm</td>
<td>15 mm</td>
</tr>
</tbody>
</table>
Where the surface irregularity of the subgrade 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 and 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 labor required for all the operations mentioned above, unless specified otherwise.

**Sub-bases:**

*Water Bound Macadam sub-base with stone aggregate:*

Stone aggregate of size 90mm to 45mm shall be used. This consists of clean crushed coarse aggregate mechanically interlocked by rolling using power road roller of 8 to 10 tones and voids thereof file width screening and blinding materials with the assistance of water, laid on a prepared sub-grade / sub-base.

**Specifications for laying:**

**Quantities of materials:**

Quantities of coarse aggregate, screening and blinding material required to be stacked for 100 mm approximate 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>Net Qty.</th>
<th>Grading / Classification and size</th>
<th>Net Qty.</th>
<th>Blinding Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading –1</td>
<td>90mm to 1.2 cum to 1.28 cum</td>
<td>Type A 13.2 mm</td>
<td>0.27 cum to 0.08 cum to 0.10 cum.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Net Quantity = Loose Quantity measure din stack minus 7.5%.

**Preparation of Foundation:**

In the case of an existing un surfaced 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 depression and pot holes made good with suitable materials, before spreading the aggregate for WBM.
**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 not shall be spread uniformly to proper profile by using templates placed across the used to spread the aggregate uniformly. The level along the longitudinal direction upon which the metal shall be laid shall be first obtained at site to the satisfaction of Engineer-in-charge and these shall be adhered to.

The surface of the aggregate spread shall be carefully trued up and all high or low remedied by removing or adding aggregate as may be required.

The WBM 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 to 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 edges to the center parallel to the center line of the road and overlapping uniformly each preceding rear wheel track by one half width and 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-grade. When rolling develops irregularities that exceed 12mm when tested with a three metre straight edge the irregular surface shall be loosened and the 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 an 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 screening to make up depressions be permitted.
Application of screenings:

After the coarse aggregate has been lightly rolled to the required true surface, screenings. 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 fitting of voids difficult, or to prevent the 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 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 weep 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 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 materials, 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 materials 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 spits 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 direction shall be as specified in the table given below:

<table>
<thead>
<tr>
<th>Size of coarse aggregate</th>
<th>Longitudinal profile</th>
<th>Cross profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-90 mm</td>
<td>when permissible undulation when measured with a 3 M straight edge</td>
<td>Max. permissible undulation when measured with a camber template</td>
</tr>
<tr>
<td></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 center line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10m.

**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 scarificed over the affected area, reshaped with added material or removed and replaced with fresh material as applicable, and recompacted. The area treated in the aforesaid manner shall not be less than 10 sqm. In no cases shall depressions be filled up with screenings and blinding material.

**Measurements and Rate :**

The length and breadth shall be taken to the nearest centimeter and thickness to the nearest half centimeter. 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.

**Rubble Soling :**

Rubble soling for road work including foot paths, culverts side drains etc. shall be carried out as specified hereinbefore under chapter, 3, para 3.3 for Rubble stone soling, as 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 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 to mm to 50mm 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.

a) Damages to the Department's Property :

Any damage to theDept's property due to negligence of the contractor while executing the work shall be made good to the original condition at his own cost.

b) 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 50mm 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 ht Engineer-in-charge shall not be paid.
20. 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.

**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 hereinbefore under relevant sections. All the posts an struts shall be of sizes and lengths as specified in the tender schedule. The exposed surfaces of the posts and struts shall be painted with two coats of approved primer.

**R.C.C Posts and Struts :**

All the posts and struts shall be of standard size as specified in schedule. These shall be coated 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 hereinbefore. The reinforcement shall be provided as hereinbefore under relevant sections. To 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 leveled 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.

**Spacing of the Posts and Struts :**

The spacing of posts shall be 3 m. center to center 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 dies or as directed by the Engineer-in-charges. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

**Fixing of M.S. / R.C.C. Posts and Struts :**

Pits of size 45 X 45 X 45 cm. deep or 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 15cm. 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 15cm. thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix, shall then be filled in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for atleast 7 days to ensure proper curing.
**Barbed Wire:**

The barbed wire shall be of M.S. or G.I. as specified and it shall generally conform to I.S.278-1978.

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 galvanized 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 line 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 (14 G)</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 13mm and not more than 18mm. The points shall be sharp and well pointed. Barbed spacing shall be as given in the above table. Wherever required for every 50 reels or part thereof, samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

*Tensile Properties:*

<table>
<thead>
<tr>
<th>Size of lien wire Nominal dia (in mm)</th>
<th>Breaking load of line wire</th>
<th>Min. breaking load of complete barbed wire (in Kg.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min. (in Kg.)</td>
<td>Max. (in Kg.)</td>
</tr>
</tbody>
</table>
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.

**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 140mm 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 posts 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 10mm dia hole in the RCC post to hold barbed wire shall be turned up and down to get an overlap of 25mm on the face of RCC post. Turn buckles and straining bolts shall be used at the end posts if specified.

**Mode of Measurement:**

The work shall be measured in running metre length of fencing correct to a centimeter for the finished work, from center to center of the posts.

The rate shall include the cost of labor and material 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.

**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 together defects and shall be uniformly galvanized if specified.

**Fixing of the Chain Link Fencing to MS or RCC 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 20mm clearance in the case of

<table>
<thead>
<tr>
<th>2.50 (12G)</th>
<th>216</th>
<th>302</th>
<th>444</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.24 (13G)</td>
<td>128</td>
<td>179</td>
<td>263</td>
</tr>
</tbody>
</table>
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 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.

Measurement:

The work shall be measured in running metre length of fencing correct to a centimeter for the finished work from centre to center of the posts.

The rate shall include the cost of labor and material involved in all the operation described above including the cost of barbed wire, turn buckle, straining bolts and bolts and the nuts / U clamps, 6mm dia M.S. / GI anchor bar etc. including excavation and foundation concrete or as specified in item description for the work.
21. ALUMINIUM WINDOWS, VENTILATORS, COMPOSITE UNIT ETC

Scope of work:

The scope of work in the tender item includes fabrication supply and installation of anodized matt finished aluminium windows, ventilators, composite units, glazing etc. strictly in accordance with these specifications and relevant detailed approved shop drawings.

General:

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 work. No fabrication work shall be undertaken prior to the approval of the shop drawings 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.

Materials:

The aluminium alloy used in the manufacture for extruded window section shall correspond to IS 733-1966 (or any further revision thereof). Extruded sections shall conform to IS designation HE9-WP and Hollow sections shall conform to IS Designation HV9-WP. The frame work, stiles, mullions, beadings, transoms, hinges, pegstays, handles etc. 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.

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, argon are welding or flash butt welding shall be employed (Gas welding or brazing not to be done). Sub-dividing bars of units shall be tenonned an riveted into the frames. Water bar in aluminium section shall be provided. The dimensions shown in the drawings 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, windows fasteners etc. shall be of aluminium. The handle shall be mounted on a handle plate riveted to the opening frame. The pegstays shall be 300mm. long or as required complete with peg and locking bracket and shall have holes for keeping the shutters open in three different positions. No field fabrication of frames is permitted. The complete fabricated assembly shall be anodized 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 for the aluminium windows etc. by the supplier to protect
the surface 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 the Engineer-in-charge and all sections of the windows shall be protected by P.V.C. film
covering.

Hardware :

All cut outs, recesses, mortising or milling and operation 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 anodized 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.

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 walls with holdfasts. All aluminium windows shall be fixed in position as per IS 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 and mastic or polysulphide
compound in order to ensure water tight joints. Joints shall be neatly painted with matching cement an excess
materials shall be removed. Hardware shall be fixed in workman like manner all as directed by the Engineer-in-
charge.

Samples :

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

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 shall be of M/s Triveni / Saint Gobain / I.A.G./ Modi make
The specifications specified herein before shall hold good as far as applicable Glazing will be paid on square
metre basis.

Mode of measurement :

Payment will be made on the basis of weight of fabricated anodized aluminium frames/member/fixtures along with all fittings actually installed in position without any extra allowance for wastage.
Guarantee:

All materials and workmanship in above work shall be guaranteed for a period of one year (unless otherwise specified) from the date of handling over. Unqualified performance guarantee for smooth operations 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.

Testing:

All windows shall be tested for water tightness. Any leakage found during testing shall be rectified by the contractor without extra charge.
THEORETICAL, STANDARD REQUIREMENT OF CEMENT FOR VARIOUS ITEMS OF WORK FOR GUIDANCE OF CONTRACTOR.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Brief description of item</th>
<th>Unit</th>
<th>Qty. of cement in kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cement Concrete 1:5:10</td>
<td>Cum</td>
<td>2.60</td>
</tr>
<tr>
<td>2</td>
<td>Cement Concrete 1:4:8</td>
<td>Cum</td>
<td>3.40</td>
</tr>
<tr>
<td>3</td>
<td>Cement Concrete 1:3:6</td>
<td>Cum</td>
<td>4.40 *</td>
</tr>
<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 1/2 :3</td>
<td>Cum</td>
<td>8.00 *</td>
</tr>
<tr>
<td>7</td>
<td>Reinforced Cement Concrete 1:1:2</td>
<td>Cum</td>
<td>12.20 *</td>
</tr>
</tbody>
</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 Engineer-in-charge on the basis of design mixes approved for individual work.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Brief description of item</th>
<th>Unit</th>
<th>Qty. of cement in kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Brick Masonry in C.M. 1:4</td>
<td>Cum</td>
<td>1.90</td>
</tr>
<tr>
<td>9</td>
<td>Brick Masonry in C.M. 1:6</td>
<td>Cum</td>
<td>1.25</td>
</tr>
<tr>
<td>10</td>
<td>Half brick masonry in C.M. 1:4 with RCC 1:2:4 stiffeners</td>
<td>Sqm</td>
<td>0.27</td>
</tr>
<tr>
<td>11</td>
<td>Half brick masonry in 1:4</td>
<td>Sqm</td>
<td>1.21</td>
</tr>
<tr>
<td>12 a.</td>
<td>R.R. Masonry in C.M. 1:6</td>
<td>Cum</td>
<td>1.65</td>
</tr>
<tr>
<td>12 b.</td>
<td>C.R. Masonry in C.M. 1:6</td>
<td>Cum</td>
<td>1.56</td>
</tr>
<tr>
<td>13</td>
<td>IPS Flooring (C.C. 1:2:4, Finished smooth)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>30 mm thick</td>
<td>Sqm</td>
<td>0.23</td>
</tr>
<tr>
<td>b.</td>
<td>40 mm thick (smooth / broom finish)</td>
<td>Sqm</td>
<td>0.30</td>
</tr>
<tr>
<td>c.</td>
<td>50 mm thick</td>
<td>Sqm</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>(+) 20 mm thick skirtin /dado in cm. 1:3</td>
<td>Sqm</td>
<td>0.30</td>
</tr>
<tr>
<td>14</td>
<td>Hardunate flooring – 50 mm thick (C.C. 1:2:4, finished smooth)</td>
<td>Sqm</td>
<td>0.41</td>
</tr>
<tr>
<td>15 a.</td>
<td>Flooring (with lime mortar bedding pointed with matching</td>
<td>Sqm</td>
<td>0.13</td>
</tr>
<tr>
<td>15 b.</td>
<td>Skirting with 20mm thick C.M. 1:3 backing</td>
<td>Sqm</td>
<td>0.27</td>
</tr>
<tr>
<td>15 c.</td>
<td>Coping</td>
<td>Sqm</td>
<td>0.13</td>
</tr>
<tr>
<td>16 a.</td>
<td>Flooring (with lime mortar bedding and pointed with cement</td>
<td>Sqm</td>
<td>0.18</td>
</tr>
<tr>
<td>16 b.</td>
<td>Skirting with 20 mm thick C.M. 1:3</td>
<td>Sqm</td>
<td>0.28</td>
</tr>
<tr>
<td>16 c.</td>
<td>Treads, hydraulically pressed with C.M. 1:3 bedding</td>
<td>Sqm</td>
<td>0.37</td>
</tr>
<tr>
<td>16 d.</td>
<td>Treads in one piece</td>
<td>Sqm</td>
<td>0.28</td>
</tr>
<tr>
<td>16 e.</td>
<td>Risers, hydraulically pressed with C.M. 1:3 backing</td>
<td>Sqm</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>f.</td>
<td>Risers in one piece</td>
<td>Sqm.</td>
<td>0.23</td>
</tr>
<tr>
<td>17</td>
<td>Cast in situ terrazzo:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Flooring 40 mm thick (28 mm C.C. 1:2:4 + 12mm with marble chips &amp; powder)</td>
<td>Sqm.</td>
<td>0.26</td>
</tr>
<tr>
<td>b.</td>
<td>Skirting, 20mm thick (12mm C.M. 1:3 + 8 mm 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>
<tr>
<td>19</td>
<td>Cement tile:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Flooring (Lime mortar bedding)</td>
<td>Sqm.</td>
<td>0.18</td>
</tr>
<tr>
<td>b.</td>
<td>Skirting with 20 mm thick C.M. 1:3</td>
<td>Sqm.</td>
<td>0.28</td>
</tr>
<tr>
<td>20</td>
<td>Plaster skirting, 20 mm thick in C.M. 1:3</td>
<td>Sqm.</td>
<td>0.30</td>
</tr>
<tr>
<td>21</td>
<td>Cuddapah stone kitchen platform over 20mm thick C.M. 1:4</td>
<td>Sqm</td>
<td>0.30</td>
</tr>
<tr>
<td>22</td>
<td>Cuddapah stone window sill over 20mm thick C.M. 1:4</td>
<td>Sqm</td>
<td>0.27</td>
</tr>
<tr>
<td>23</td>
<td>Fixing hold fasts in cement concrete 1:3:6 of size 300 X 100 X 150mm for door &amp; windows</td>
<td>100 nos.</td>
<td>2.20</td>
</tr>
<tr>
<td>24</td>
<td>Cement plaster in C.M. 1:4 / 1:5 with neeru finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A.</td>
<td>Cement mortar 1:4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>12 mm thick</td>
<td>Sqm.</td>
<td>0.11</td>
</tr>
<tr>
<td>b.</td>
<td>15 mm thick</td>
<td>Sqm.</td>
<td>0.13</td>
</tr>
<tr>
<td>c.</td>
<td>20 mm thick</td>
<td>Sqm.</td>
<td>0.17</td>
</tr>
<tr>
<td>B.</td>
<td>Cement mortar 1:5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>12 mm thick</td>
<td>Sqm.</td>
<td>0.09</td>
</tr>
<tr>
<td>b.</td>
<td>15 mm thick</td>
<td>Sqm.</td>
<td>0.11</td>
</tr>
<tr>
<td>c.</td>
<td>20 mm thick</td>
<td>Sqm.</td>
<td>0.14</td>
</tr>
<tr>
<td>25</td>
<td>Cement plaster in C.M. 1:4 in two coats with neat cement punning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>12 mm thick 10 mm + 5 mm ( for ceiling)</td>
<td>Sqm.</td>
<td>0.18</td>
</tr>
<tr>
<td>b.</td>
<td>15 mm thick 15 mm + 5 mm (for internal walls)</td>
<td>Sqm.</td>
<td>0.22</td>
</tr>
<tr>
<td>26</td>
<td>Cement plaster in C.M. 1:4, 20 mm thick rough finish (for external brick / concrete surfaces)</td>
<td>Sqm.</td>
<td>0.17</td>
</tr>
<tr>
<td>27</td>
<td>Sand faced plaster, 20 mm thick ( 12 mm C.M. 1:4 + 8mm C.M. 1:3)</td>
<td>Sqm.</td>
<td>0.21</td>
</tr>
<tr>
<td>28</td>
<td>Rough cast plaster, 25mm thick ( 12 mm C.M. 1:4 + 13mm C.M. 1:3)</td>
<td>Sqm.</td>
<td>0.27</td>
</tr>
<tr>
<td>(+) (+) 10 mm wide &amp; 18 mm thick plain or moulded cement mortar band in CM 1:4</td>
<td>100 RM</td>
<td>0.152</td>
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<tr>
<td>29</td>
<td>Cement plaster in C.M. 1:3 with water proofing compound finished smooth with neat cement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>12 mm thick</td>
<td>Sqm.</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Unit</td>
<td>Quantity</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------</td>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>30</td>
<td>Cement pointing in C.M. 1:3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Ruled pointing (groove pointing)</td>
<td>Sqm.</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>b. Raised &amp; cut pointing</td>
<td>Sqm.</td>
<td>0.04</td>
</tr>
<tr>
<td>31</td>
<td>Cement based waterproofing works (M/s India water-proofing or equivalent</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>a. Terrace type average 115mm thick</td>
<td>Sqm.</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>b. Basement type (Box type)</td>
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<td>0.70</td>
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<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>RM</td>
<td>0.50</td>
</tr>
<tr>
<td>32</td>
<td>Damp proof course in CC 1:2:4</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>a. 25 mm thick</td>
<td>Sqm.</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>b. 38 mm 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>10 m</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>B. 150 mm dia</td>
<td>10 m</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>C. 250 mm dia</td>
<td>10 m</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>D. 300 mm dia</td>
<td>10 m</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>E. 450 mm dia</td>
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<td>0.48</td>
</tr>
<tr>
<td></td>
<td>F. 600 mm dia</td>
<td>10 m</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. 20 mm thick</td>
<td>Sqm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. 50 mm dia</td>
<td>Sqm.</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Chain link fencing / barbed wire fencing C.C. 1:3:4 pockets of 45 X 450 X 600 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 125 X 375 mm</td>
<td>m</td>
<td>0.21</td>
</tr>
<tr>
<td>37</td>
<td>Shahabad stone paving, pointed in C.M. 1:3 15 X 10 mm groove</td>
<td>Sqm.</td>
<td>0.02</td>
</tr>
<tr>
<td>38</td>
<td>Pointing &amp; grouting stone pitching in CM 1:3</td>
<td>Sqm.</td>
<td>0.14</td>
</tr>
</tbody>
</table>
B. Technical Specifications for Plumbing

1. **GENERAL**

SCOPE

This specification covers the requirements of supply, installation, testing and Commissioning of Water Supply and Sewerage system for the proposed Commercial Building for TENDER FOR NCSCM CHENNAI.

Scope of work generally includes Supply, fixing, testing and commissioning of the following,

- Internal Sanitary Fixtures.
- Internal and External Water Supply system.
- Internal and External Drainage system.
- Irrigation piping system.

The General character and the scope of work to be carried out under this section is illustrated in the drawings and specifications attached herewith. The contractor shall carry out and complete the said work under this contract in every respect in conformity with the rules and regulations of the local authority. The Contractor shall furnish all labour, materials, appliances, tools and equipment necessary for the work for plumbing services installation including testing and commissioning as specified herein, and as per the relevant Bureau of Indian Standards (BIS), British Standards (BS) codes and as shown on the drawings. This also includes any material, appliances and equipment not specifically mentioned herein or noted on the drawings as being furnished or installed which are necessary and customary to make a complete installation properly connected and in working order.

Wherever brand names and makes are specified in these Technical Specifications below, all or any EQUIVALENT brand or make will also be acceptable. The selected bidder will provide documentary evidence in support of the equivalence of brand(s) and make(s), and will use such equivalent brand(s) and make(s) as and if approved by the Engineer.

Carryout all incidental works connected with plumbing services installation, such as excavation in trenches and backfilling. Cutting and chasing in concrete or brick and making good, cutting / drilling holes through walls, floors, and grouting for embedding of fixing of fixtures / equipment and so forth.

Furnish and install complete workable, plumbing services installation as shown on the drawings and described in this specification and as per the latest Bureau of Indian Standards (BIS), British Standards (BS) specifications including all that which is reasonably inferred to all the buildings, internally and externally.

Complete installation of the sewerage and sewerage appurtenances internally as well as around the building.

Complete installation of all sanitary and plumbing fixtures in all the floors of the building including basement floor.

Co-operation with other trades in putting the installation in place. Any work done without regard or consultation with other trades, shall be removed by the contractor without additional cost to the Employer, to permit proper installation of all other work, as desired by the Engineer.
Repair all damage done to the premises as a result of this installation and remove all debris left by those engaged for this installation to the satisfaction of Engineer.

Cleaning of all plumbing and sanitary fixtures, testing and proving the satisfactory performance of all fixtures at the time the buildings are handed over to the Employer.

It is the responsibility of the contractor to take care of all the fixtures fitted until the time of handing over to the Employer.

Painting of all concealed and exposed pipes as specified.

Wrapping and coating of all underground GI pipes.

Assume full responsibility for getting the entire installation duly approved by the authorities concerned and for all expenses in connection with the same. Assume responsibility for obtaining and delivering to the Employer certificate of final inspection and approval by the concerned authorities.

SITE CONDITIONS

Temperature : Maximum 32.8 °C
Altitude : 29 feet

LICENSED PLUMBER

All work performed by the contractor shall be through licensed plumbing supervisor possessing a valid plumbing contractors license employing Engineers, Technicians, Foremen, Plumbers, Masons, Helpers, etc., as required.

REGULATIONS AND STANDARDS

The installation shall conform in all respects to the following standards in general:

IS 651 – 1992 : Specification for Salt Glazed stoneware pipes and fittings (Fifth revision)
IS 7558 – 1974 : Code of practice for domestic hot water installation
Is 2064 – 1973 : Code of practice for selection, installation and maintenance of sanitary appliances
IS 1200 (Part 1) : Method of measurement of building earthwork
IS 1200 (Part 16) : Method of measurement of laying of water and sewer lines including appurtenant
IS 1200 (Part 19) : Method of measurement of Water supply, plumbing and drains.
IS 783 – 1959 : Code of practice for laying of concrete pipes
IS 13592 – 1992 : Specification for unplasticized PVC pipes for soil and waste discharge system inside building including ventilation and
rainwater.


IS 6784 – 1984 : Method of performance testing of water meters (Domestic type).

IS 458 – 1988 : Specification for pre cast concrete pipes (with or without reinforcement)

IS 2692 – 1989 : Specification of ferrules for water services


IS 771 – (Part 3 to 6) : Specific requirements for urinals.

IS 2548 (Part 1&2) : Specification for plastic seats and covers for water closets.


IS 1711 – 1984 : Specification for self closing taps for water supply

IS 1703 – 1977 : Specification for ball valves (Horizontal plunger type) including floats for water supply purposes.


IS 1172 – 1983 : Code of basic requirements for water supply, drainage & sanitation (revised).

IS 1239 – 1990 : Specifications for mild steel tube, tubular and other steel pipe fittings.

IS 1239 – 1992 : Specifications for mild steel tube, tubular and other steel pipe fittings.

IS 1726 – 1991 : Code for cast iron manhole frame and cover (third revision).

IS 1742 – 1983 : Code of practice for building drainage. (Second revision)


IS 4111 – 1986 : Code of practice for Ancillary structures in sewerage system


BS 4515 : Specification for unplasticized PVC pipe fittings.

IS 4985 – 1988 : Specification for unplasticized PVC pipes for portable water supplies (second revision)


The installation shall also be in conformity with the bye laws and requirements of the local authority in so far as these become applicable to the installation. Wherever this specification calls for, a higher standard of materials and / or workmanship than those required by any of the above regulations and standards, then this specification shall take precedence over the said regulations and standards.

Wherever drawings and specifications require something that may conflict with the regulations, the regulations shall govern. This shall be referred to the Engineer for arbitration.

EXECUTION OF WORK

The work shall be carried out in conformity with the water supply and sanitary drawings and within the requirements of architectural, HVAC, Electrical, and other specialized services drawings.

The contractor shall co-operate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up or progress of the construction programme. Any work done without regard (or) consultation with other trades, shall be removed and rectified by the contractor without additional cost to the Employer.

On award of the work, contractor shall submit a construction programme in the form of a PERT chart or Bar chart for approval of the Engineer. All dates and time schedule agreed upon shall be strictly adhered to, within the stipulated time of completion/commissioning.

The contractor shall furnish and install a complete working, plumbing services installation as per approved drawings and as per the latest BIS codes of practice.

Execution of work by the contractor includes complete installation of internal & external water supply
system, sewerage and sewerage appurtenances internally as well as around the building, controllers, valves and power control wiring for controller etc. complete installation of all sanitary and plumbing fixtures.

It is the responsibility of the contractor to protect all the installed fixtures and fittings until the time of handing over to the EMPLOYER.

The Contractor shall set out the drainage, soil, waste and water pipe lines and other fittings and fixtures in accordance with the Drawings and instructions of the Engineer. The contractor shall be responsible for the correctness of the above and any incorrectness shall be rectified at his own cost. He will be responsible for taking levels at site before setting out and putting them on record without extra charge.

The contractor shall provide at all times during the progress of the works and during maintenance period proper facilities and necessary attendance for inspection or measurement of the works by the Engineer or their representatives.

FEES, PERMITS AND NOTICES

Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for the payment of all fees and other charges and giving and receiving of all necessary notices. Contractor shall keep the Engineer timely informed about regulations and requirements of statutory authorities and shall obtain the final certificates of inspection and approval from the authorities.

DRAWINGS AND SPECIFICATIONS

The drawings and specifications shall be considered as part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice versa shall be executed as if specifically called for in both. Contractor shall be responsible for getting authorities approval on both design and shop drawings.

The tender drawings indicate the extent and general arrangement of the fixtures, drainage system etc., and are essentially diagrammatic. The tender drawings indicate the points of supply and termination of work and broadly suggest the routes to be followed. The works shall be executed as indicated on the drawings. However, any changes found essential to co-ordinate with this work and other trades shall be made without any additional cost. The drawings and specifications are meant for the assistance and guidance of the contractor, and exact location, distance and levels will be governed by the building and site conditions. Therefore, approval of the Engineer shall be obtained before commencement of work.

SHOP DRAWINGS

1.1.1. The contractor shall submit to the EMPLOYER four copies of the shop drawings.

1.1.2. Shop drawings shall be submitted as follows.

1.1.3. Drawings showing any change in layout in the contract drawings.
1.1.4. Floor plans, Enlarged toilet details, schematic showing water supply and sanitary installation works.

1.1.5. Manufacturer’s or Contractor’s fabrication drawings for any materials or equipment.

1.1.6. The contractor shall submit four copies of catalogues, manufacturer’s drawings, equipment characteristic data or performance charts as required by the EMPLOYER.

**AS BUILT DRAWINGS**

1.1.7. On completion of works, the Contractor shall submit one complete set of original tracings and two prints of “As built” drawings to the EMPLOYER. He shall also submit all drawings / information in AutoCAD latest version. These drawings shall have the following information:

1.1.8. Exact run and sizes of all piping on all floors and vertical stacks.

1.1.9. Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

1.1.10. Run of all water supply lines with diameters, location of control valves, access panels.

1.1.11. Location of all mechanical equipment with layout and piping connections.

1.1.12. Contractor shall provide four sets of product catalogues, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.1.13. All “Warranty Cards” given by the manufacturers shall be handed over to the Engineer.

1.1.14. Four sets of Operation and maintenance manuals in the desired format shall be handed over to the Employer.

**MANUFACTURERS’ INSTRUCTIONS**

Where manufacturers have furnished specific instructions relating to the materials used in this job and methods of construction that are not specifically mentioned in these documents, such instructions shall be followed in all cases. The contractor shall also furnish detailed instruction and operation manuals in triplicate including detailed completion drawings on a tracing paper to an approved scale. Further it is the responsibility of the contractor to train the EMPLOYER's personnel in the operation and maintenance of the system.

**MATERIALS**

Materials shall be of approved make and quality specified. They shall conform to the respective Bureau of Indian Standards, British Standards Specifications and supported by Manufacturing Certificate / test certificate.

Samples of all materials shall be as per the first choice of the list of approved brand manufacture, the sample of which shall be approved by the Engineer before placing the order.

In any case of non-availability of materials in metric sizes, the nearest size of FPS units shall be provided with prior approval of the Engineer at no extra cost to the Employer.
Colour code shall be used to identify pipe material. The CONTRACTOR shall be able to identify on request all random piping prior to any field installation.

As far as possible materials bearing I.S. certification marks shall be used with the approval of the Engineer.

Unless otherwise specified and expressly approved in writing by the Engineer, materials of makes and specifications mentioned in this document/BOQ shall be used.

The CONTRACTOR shall furnish two (2) copies of certificates for piping for –

Dimensions and Hydrostatic test

Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Engineer.

If directed, materials shall be tested in an approved testing laboratory and the contractor shall produce the test certificate in original to the Engineer and the entire charges for original as well as repeated tests shall be borne by the Contractor. If required by the Engineer, the Contractor shall arrange to test portions of the work at his own cost in order to prove their soundness and efficiency. If after any such test the work or portions of work is found in the opinion of the Engineer, to be defective or unsound, the Contractor shall pull down and re-do the same at his own cost. Defective materials shall be removed from site.

It shall be obligatory for the Contractor to furnish certificates if demanded by the Engineer from manufactures or materials suppliers, that the work has been carried out by using their material and installed/fixed as per their recommendations

Cement: Cement required, for the plumbing work shall be supplied to the Contractor through the Civil Contractors. However, the contractor will have to make his own arrangement to lift the cement from the go-down to the site. Cost of cement issued will be recovered from contractor.
Cement shall be stored in weather proof shed with raised wooden plank flooring to prevent deterioration by dampness or intrusion by foreign matter.

Sand: Sand shall be clean, shells, free from silt, clay, loam, shells, and vegetable matter and be as approved by the Engineer.

Coarse Aggregate: Shall be angular, tough, and sharp and well graded stone metal, Basalt from approved source.
**Bricks:** Bricks shall be local best quality obtainable and shall be table moulded. Well burnt, but not over burnt and shall be free from cracks, chips, flaws, and stones. It shall not absorb water more than 20% of its own weight when dry. The crushing strength of bricks shall not be less than 35 kg./sq.cm.

**Cement Concrete:** P.C.C shall be of the proportion specified in the particular item in the schedule of quantities. Sand and Metal shall be measured in suitable measuring boxes and correct quantity of cement shall be added. The materials shall be mixed dry on a clean platform. Clean water is then added, and mixed thoroughly. It shall be prepared in such quantity as can be readily used up. P.C.C which has partially set shall under no circumstances be used and shall be removed away from the site.

**Reinforced Steel:** Reinforced steel shall be ribbed torsteel. Steel required for plumbing work shall be supplied to the Contractor Free of Cost' through Civil Contractor. However the Contractor shall make his own arrangements to lift the steel from the go-down to the site.

**Water proof:** Both sides of the chamber / manholes / gully traps have to be water proofed with FOSROC water proofing material.

### 5.4 CONTRACTOR RATES

The rates quoted by the contractor shall be inclusive of cost of materials, accessories, labour, supervision, erection, tools, tackles, plant, scaffolding, pipe hangers, supports, clamps, brackets, service connection, transport to site, storing at site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required for complete installation of all the items of work as described in the specifications, drawings and to the satisfaction of the Engineer.

The rates quoted are for all heights and depths as required for the work.

All rates quoted shall be for complete items inclusive of all the required accessories, fixtures and fixing arrangements, nuts, bolts, hangers, supports etc. are part of the particular item except where specifically mentioned otherwise.

All rates quoted are inclusive of making holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by the Engineer.

Contractor shall provide necessary holes, sleeves and puddle flanges, recesses parallel in the concrete and masonry work as the work proceeds.

The quoted rates shall be inclusive of cost incurred in testing, erection and commissioning of works and materials.

The contractor shall have full responsibility for all required liaison work including getting the sanction.
letter from the concerned authority for getting the service connections. The statutory charges will be paid by the Employer.

The contractor shall furnish the Engineer with voucher on request to prove that the materials are as specified and to indicate the rates at which the materials are purchased in order to work out the rate analysis for the non-tendered items, which he may be called upon to carry out.

6.0 PIPE HANGERS, SUPPORTS, CLAMPS, BRACKETS ETC.

6.1 GENERAL:

Provided proper solid angle iron/channel section, supports for all pipes complete with clamps. Wherever comes, provided wooden guide to support pipe on the angle iron hangers/supports. For attachment in concrete, use Hi-Tech fasteners or anchor plug type inserts of equipment. Provide hangers with in 900 mm of all changes in direction of pipes. A minimum of three hangers per expansion band wherever shown in drawing.

Provided all additional structural steel angles, channels of the members whether specifically shown or not but are required for proper support.

Where necessary additional hangers to be provided to arrest water hammers or hydraulic resonance with proper rubber padding.

Space hangers as noted below, except on all soil pipes which shall have a hanger of multiple fittings.

Sufficient hangers shall be provided to maintain proper slope without sagging. In case of angle suspended line, the following is suggested.

Standard sizes of Hanger rods

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Pipe Sizes</th>
<th>Hanger Rod Dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 through 50 mm</td>
<td>6 mm</td>
</tr>
<tr>
<td>2</td>
<td>65 through 125 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>3</td>
<td>150 and above</td>
<td>15 mm</td>
</tr>
</tbody>
</table>

Standard spacing of supports for pipes.
<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Pipe size</th>
<th>Spacing of supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12 to 40 mm</td>
<td>1.0 m apart</td>
</tr>
<tr>
<td>2</td>
<td>50 and above</td>
<td>1.5 m apart or as per IS</td>
</tr>
</tbody>
</table>

Provide floor stands, wall brackets of masonry pillars etc. for all lines running near the floor or near walls for those lines which cannot be properly supported or suspended from the walls or floors. Pipe lines near concrete or masonry walls may be hung also by hangers carried from wall brackets at a higher level than pipes. Hanging of any pipe from another pipe is prohibited.

Band type hangers shall be provided. Hot water piping is to be provided with suspended supports as far as possible. Note that straphangers are not permitted and clamps should be of removable type.

All vertical pipes shall be fixed by M.S. galvanised Clamps truly vertical.

Inclined pipes running along ceiling shall be fixed on M.S adjustable hangers of special design as directed. Pipes shall be laid to uniform slope and the hangers adjusted to the proper levels so that the pipes fully rest on them.

Structural clamps shall be fabricated from M.S. structural members e.g. rods, angles, channels, flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding and paint the clamps with two coats of zinc chromate primer and two coats of approved enamel paint. Wooden saddles shall be provided free of cost.

Slotted angle/channel supports on walls shall be provided wherever shown on drawings or as required. Angles/channels shall be fixed to brick walls and bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. Holes required in RCC walls shall be neatly drilled by electric drills and no manual chiselling will be allowed. The spacing of supports horizontally shall not exceed 1.8 M.

Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and for making good with cement concrete 1:2:4 as directed by the Engineer.

6.2 CORE CUTTING
Wherever required to run the water supply pipes and sanitary pipes in RCC slabs/ beams/retaining walls/masonry walls, the core cutting shall be done by the contractor at his own cost using core-cutting machine. Manual breaking of holes in the RCC structure shall be not allowed. Contractor to mark the positions of core cutting at site and get the approval from the Engineer before cutting the holes.

6.3 INSERTS AND SLEEVES

Layout work in advance of placing of concrete slabs or construction of walls, furnish and set inserts and sleeves necessary to complete the work. Cost of cutting or patching made necessary as a result of this operation shall be at no expense to the Employer Opening shall be as per structural Engineers approval.

7.0 CLEANOUT PLUGS

Cleanout plugs at the head of horizontal pipes under the floor, ceiling level, on floor and vertical pipes on wall/pipe shaft, cleanout on paved area including CI frame and cover shall be provided as per the standard drawings and as per the instructions of the Engineer. The cost of supply and installation of cleanout plug, CI frame, cover etc., shall not be paid separately and the same shall be measured as part of the piping item.

Internal toilet floor and wall cleanouts shall be fitted with brass cleanout cover and screwed cap. The cost of supply and installation of brass items for floor and wall cleanout shall be paid as per the bill of quantities.

8.0 SITE FACILITIES

An open area shall be made on the plot to enable the contractor to put up the site office and store at his won cost.

Water supply will be provided by EMPLOYER at one point during the construction period and the necessary piping shall be done by the contractor to the required point at his won cost.

Electric power supply will be provided at by the EMPLOYER at one point. The contractor can use the electricity on chargeable basis by providing a energy meter at his own cost.

8.1 SITE CLEARANCE AND CLEANUP

The contractor shall, from time to time clear away all the debris and excess materials accumulated at site.s
After the equipment and appliances have been installed and commissioned, contractor shall clear-up the same and remove all plaster, paint stains, stickers and other foreign matter of discolouration leaving the same in a ready to use condition.

On completion of all the works, contractor shall demolish all the temporary structures, remove all surplus material on written permission of the Engineer, and leave the site in a room clean condition.

9.0 CUTTING AND MAKING GOOD

Structural member shall not be chased or cut without the written permission of the Engineer.

Any tiles or finished surfaces or floors damaged by the contractor while doing his work shall be made good with new tiles or other finishing material as approved by the Engineer at his own cost.

In case the plumbing contractor fails to get the work done to the satisfaction of the Engineer, the same shall be repaired by other agencies and debit the cost of such repair to the plumbing contractor.

10.0 RECOVERY OF COST OF MATERIALS DAMAGED BY THE CONTRACTOR, ISSUED FREE OF COST TO THEM

If any materials issued to the contractor at free of cost by the EMPLOYER, is damaged or pilfered. The cost of the same shall be recovered from the contractor on the basis of actual cost to the Employer, which shall include basic cost of material and all freight and transportation, excise duty, sales tax, octroi, import duty etc. The derivation of the actual cost given by the Employer shall be final and binding on the contractor.

11.0 ANNUAL MAINTENANCE CONTRACT

Annual maintenance contract requirement after the defect liability period (DLP) is detailed elsewhere in the specification. This requirement shall be included.

The entire scope of plumbing and sanitary work as described in this specification should preferably be executed by one of the firms well established and proven in the field of design and installation of plumbing and sanitary systems to be approved by the Consultant.

12.0 TAKING OVER CERTIFICATE

As soon as the Works have been completed in accordance with the Contract and have passed the tests on completion, the Consulting ENGINEER will issue a provisional certificate (hereinafter called the
provisional Taking over Certificate) in which he shall certify the date on which the Works have been successfully commissioned.

13.0 BRAND NAME / MAKE OF MATERIAL

For the entire plumbing and sanitary system TENDERERs are required to offer only the ‘Brand’ Make / as indicated in the specification of to ensure fair evaluation of proposal. It is to be noted by the contractor that materials / equipment, for which brand / make has not been specified, the contractor shall use only reputed makes. The contractor shall submit a list of such brands / makes to the engineer along with his offer for approval.

14.0 GUARANTEE

The contractor shall guarantee for the materials, equipments and accessories supplied by him against the manufacturing defects, malfunctioning or under capacity, functioning and workmanship of first class quality corresponding to standard engineering practice. Any defective materials / workmanship shall be rejected, the contractor has to rectify / replace at his own cost. Guarantee certificate of the materials supplied shall be handed over to the Employer. The warranty period shall be valid for a period of one year from the date of commissioning and handing over.
**2.0 INTERNAL SANITARY FIXTURES**

**01 SCOPE**

The Client / employer shall supply all sanitary fixtures like sanitary ware, CP fittings, bath room accessories, wall flanges, valves and all related to bath room, kitchen utility fittings (CP and sanitary fittings).

The Client / employer shall also supply small accessory piping and any specialties furnished for fixtures such as waste connector, WC connector, PVC connection pipe, connecting nipple, screws, clamps, white cement wall flanges, washers, sealant and other accessories of this type as required.

The client engineer will issue the CP fittings or sanitary fittings when required by the contractor. It is the contractor responsibility to install the fittings received from the client engineer in a good condition otherwise contractor shall pay for the entire fittings cost. (Including transportation charges, all taxes, and other accessories)

Scope of installation to be performed by the contractor is outlined below:

The contractor shall hydrostatically test all the sanitary appliances and CP fittings installation including accessories and specialties.

Contractor shall supply all Jointing material as required for all joints. Like screws, washers, sealants, Installation tools, tackles, drilling machine as required to complete the work.

Tile Sanitary fixtures and fittings shall be installed at the correct aligned position as shown on the drawings and as directed by the engineer, and shall fully meet with the aesthetic and symmetrical requirements as required by the employer.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Project Engineer requirements. Wherever necessary the fittings shall be centered to dimensions pattern as called for.

Fixture shall be installed by skilled plumber with appropriate tools according to the best trade practice. Manufacturer’s instruction shall be followed for the installation of fixtures. Fixtures in all toilets shall be standard height, mounting as called for on the drawings. Fixtures shall be mounted rigid, plumb and true to alignment.

All fixtures shall be fixed firmly to the floor / wall with accessories supplied by the manufacturer. Use chrome plated brass cap nuts for fixation screws.

All ferrous accessories used for the installation of sanitary fixtures shall have anti-rust treatment given at the factory.
Provide chrome plated brass escutcheon plates on chrome fittings fixed on the wall.

Refer to schedules on drawings for roughing in details.

Mount fixtures at the following heights above FFL, unless otherwise dictated by selection.

- Water closet............ 390 mm to top of bowl rim.
- Bidet.................... 390 mm to top of bowl rim.
- Urinal.................... 600 mm to top of bowl rim.
- Washbasin/Sinks....... 750-800 mm to top of bowl rim.

Refer to interior architectural documents for details of toilet and bathroom accessories. These are part of the finishing works.

Care shall be taken in fixing all approved chromium plated (CP) fixtures and accessories so as not to leave any tool marks or damages on the finish. All such fixtures shall be tightened with fixed spanners. Use of 'Stiltsn' type pipe wrenches with toothed jaws shall not be allowed.

All fixtures shall be thoroughly tested after connecting the drainage and water supply system. All fixtures shall be thoroughly finished and any leakage in piping valves and waste fittings corrected to the complete satisfaction of the Engineer.

Upon completion of the work, all labels, stickers, plaster, etc. shall be removed from the fixtures and all fixtures shall be cleaned with soap and water so as to present a neat and clean toilet.

2.0 CODES AND STANDARDS

Unless specifically mentioned otherwise, all the applicable codes and standards published by the Bureau of Indian Standards and their subsequent revision shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

Nothing in this specification shall construe to relieve the CONTRACTOR of his responsibility. The material supplied shall comply with the latest applicable Indian and / or British Standards. Other National Standards are acceptable, if they are established to be equal or superior.

Following standards and codes are made part of this specification.

- IS 10446 – 1983  Glossary of terms relating to water supply and sanitation.
- IS 11208 –1985  Guidelines for registration of Plumbers
IS 2082-1993  Water Heaters.
IS 3004 – 1979 Specification for plug cocks for water supply purposes.
IS775 – 1970 Specifications for CI brackets and supports for wash basins and sinks.
IS 9758 – 1981 Specification for flush valves and fittings for water closets and urinals.
IS 9763 – 2000 Plastic Bib Taps, pillar taps, angle valves and stop valves for hot and cold water services.
IS 13983 – 1994 Stainless steel sinks for domestic purposes – Specification
SP –35 Hand books of water supply and drainage (with special emphasis on plumbing)
IS 1700 – 1973 Specification for drinking fountains
SP 7 – 1983 National building code of India (Part IX – Plumbing services)
IS 2064 – 1993 Code of Practice for selection, installation and maintenance of Sanitary appliances (First Revision)
IS 774 – 1984 Specification for – flushing cistern for water closets and urinals (Other than plastic cistern)
IS 2326 – 1987 Specification for automatic flushing cisterns for urinals
IS 2548 – part 1 Specification for plastic seats and covers for water closets (Part 1 Thermo-set seats and covers)
IS 2548 – part 1 Specification for plastic seats and covers for water closets (Part 2 Thermoplastic seats and covers)
IS 3489 – 1985 Specification for enameled steel bath tub
IS 6411 – 1985 Specification for gel coated glass fiber reinforced polyester resin bath tub
IS 9110- 1979 Hand Operated Angers For Cleaning Water Closet & Pipes
IS 1795 – 1982 Specifications for Pillar taps for water supply purposes
IS 2556 – 1994 Specifications for the Vitreous Sanitary Appliances
Part 1 –part 14 (Vitreous china) (Part 1 general requirements)
3.0 EUROPEAN TYPE WATER CLOSET

The closet shall be white or colored as per BOQ and made of vitreous China and shall be of the best quality manufactured by an approved firm, and fixed by approved means. It shall have 100 mm dia ‘P’ or ‘S’ trap depending on the location of water closets and soil stacks with effective seal. Each closet shall be provided with the following accessories:

- a) Double flapped heavy urea formaldehyde seat cover of approved make quality and color with rubber buffers and C.P. brass bar and screws fixed to the pan.
- b) 2/4 liters cistern as specified in the BOQ
- c) Cast-iron chair or cantilever bracket for wall hung type with C.P bolt & nut.

The quoted rate is inclusive of, receiving of items, installation and testing as per the specifications and instructions of the Engineer.

3.1 MODE OF MEASUREMENT

European Water Closets shall be measured per number and the quoted rate shall include: fixing of,

- a) W.C pan, trap with brackets/bolts, ceramic cistern, hose pipe and angular stop cock
- b) Plastic seat cover.
- c) Jointing and fixing material.
- d) C.I chair / cantilever bracket.
- e) Fixing the WC as per the drawing.
- f) Testing as specified, if any.

4.0 MODE OF MEASUREMENT

Indian Water Closets shall be measured per number and the quoted rate shall include: fixing of

- a) W.C. pan with ‘P’ or ‘S’ trap, cistern, PVC inlet pipe, CP brass stopcock and fixing materials.
- b) Setting the closets in Plain cement concrete including the cost of cement concrete.

5.0 WASH BASINS

They shall be white or colored as per BOQ and of vitreous China with best quality manufactured by an approved firm and size as specified. Oval / rectangular wash basin shall be supported on a RC counter with necessary steel reinforcement and rectangular wash basins with or without pedestals shall be supported by a pair of CI brackets of approved design. The wash basin shall be circular or oval shape below or above counter or rectangular with or without pedestal type as specified in Schedule of Quantities.

Each washbasin shall be fitted with 1 No. CP brass sensor faucet, 15mm CP brass angular stop cock, 20 mm CPVC inlet pipe, 32mm CP waste half threaded coupling, 40mm dia PVC waste pipe.
The quoted rate is inclusive of complete fixing of supporting brackets, installation and testing as per the specifications and instructions of the Engineer.

5.1 MODE OF MEASUREMENT

Washbasins shall be measured per number and the quoted rate shall include:

a) Above said items.
b) Necessary fixtures.
c) Fixing in position and
d) Testing where necessary / specified.

6.0 SHOWER UNIT

The shower unit shall be brass chromium plated wall mounted exposed type 4-way diverter, and CP spout. The shower unit shall be fitted with an overhead shower set comprising of shower arm, rose, wall flange etc., for complete installation of shower unit as per manufacture/Engineer instructions.

6.1 MODE OF MEASUREMENT

All the items above shall be measured in numbers only and the quoted rate shall be per number, which shall include: fixing of

a) Above said items.
b) Necessary fixtures.
c) Fixing in position and
d) Testing where necessary/specifed.

7.0 SINKS

They shall be Stainless steel of best quality and shall be supported on necessary brackets. Each sink shall be provided with 40 mm CP waste coupling, 40mm waste pipe, wall flanges, connection pipe, angle valve, long nose bibcock etc. including all the fixing materials.

Each sink shall be provided with 40mm CP waste coupling & 40mm PVC waste pipe.

The quoted rate is inclusive of complete fixing of supporting brackets, installation and testing as per the specifications and instructions of the Engineer.

7.1 MODE OF MEASUREMENT

Sinks shall be measured in numbers including all items stated above and shall include fixing in position.
8.0 URINAL

Urinal shall be white or colored as per Schedule of Quantities. The urinal shall be water less or as per the specification in the BOQ. This includes fixing of partition in position and fixing of the followings,

- Eco trap
- Blue seal liquid

The quoted rate is inclusive of complete fixing of supporting brackets, installation and testing as per the specifications and instructions of the Engineer.

8.1 MODE OF MEASUREMENT

Urinal shall be measured in numbers and the quoted rate shall include. Fixing of
a) Waterless urinals
b) Accessories for ceramic water less urinal
c) Jointing and fixing material
d) Supply & Fixing of the blue seal liquid and eco trap

9.0 TOILET ACCESSORIES

9.1 TOWEL RAIL

Towel rail shall be of C.P. with reinforced bends and circular flanges. The size of the rail shall be as specified. The bracket shall be fixed by means of stainless steel screws to wooden / plastic cleats firmly embedded in the wall.

9.2 TOILET PAPER HOLDER

Toilet paper holder shall be of chromium plated as specified in the B.O.Q.

9.3 TOWEL RING, SOAP TRAY, CLOTH STAND ETC.

These shall be of CP specified in the Schedule of quantities. These shall be fixed by means of stainless steel screws to wooden / plastic cleats firmly embedded in the wall.

9.4 ELECTRIC HAND DRIER

The electric hand drier shall be twin blower type interpreted with timer range 0 to 3 minutes. The drier
shall be fully automatic. The power requirement shall be 230V, 1PH, 50Hz 1700 watts. The drier shall be wall-mounted type.

9.5 SOAP DISPENSER

The Soap dispenser shall be wall mounted type tough ABS plastic with soap pouch and pump system as per list of recommended makes. The capacity of dispenser shall be 500 ml

9.6 BOTTLE TRAPS

Bottle trap (for wash basins, sinks, urinals etc.,) shall be deep seal (minimum 60mm water seal) cast brass bottle, heavy chromium plated. All bottle traps shall be provided with suitable cleaning eye, extension piece, flare nuts all chromium plated. Bottle traps shall be of approved make and design. Traps for washbasins, urinal and sinks shall be 32mm

9.7 MODE OF MEASUREMENT

All the items above shall be measured in numbers only and the quoted rate shall be per number, which shall include:

a) Fixing of respective materials.
b) Necessary fixtures.
c) Fixing in position, wiring, conducting and
d) Testing where necessary / specified.

9.8 WATER COOLERS

Water coolers specified shall be exterior stainless steel construction. They should have PUF insulation to reduce the effective electrical power consumption. The water cooler should be capable of supplying water to the drinking standards as enumerated in Indian Standard 10500 – 1980. The cooler to be installed in plumbing with the floor level and should consist of rubber mounted adjustable jack bolts to suit parallelism of the floor. The compressor is to rugged and dependable and hermetically sealed for any leakage. Surge drums in the refrigerant circuit should be well enough to prevent leakage in the compressor unit. The cooling and loading capacities should be sufficient as per the bill of quantities. The nominal cooling capacities through a drop of temperature should conform to IS 11475.

9.8.1 MODE OF MEASUREMENT

Electric water coolers shall be measured in numbers and should include all the items as mentioned above.

9.9 WATER HEATER:
These shall be of best approved make and type and capacity as per Bill of materials. They shall be mounted on the wall/left with necessary bolts of approved make. They shall have an internal tank made of 99% pure copper, 15 mm PVC inlet pipe, 12 mm lead/copper pipe outlet, 15 mm non-return valve. These shall be measured per number and the rate quoted shall include. Fixing of

a) Water heater with all built-in electrical accessories like pilot lamp, thermostat, standard length of cable and 3 pin 15A plug.

b) PVC inlet leads outlet pipe and non-return valve.

c) Fixing accessories like bolts and nuts etc.,

9.10.1 MODE OF MEASUREMENT

Water heater shall be measured in numbers only and the quoted rate shall be per number, which shall include: fixing of

a) Above said item

b) Necessary fixtures.

c) Fixing in position.

d) Testing where necessary / specified.

10.0 MOCK UP AND TRIAL ASSEMBLY

The installation of the sanitary fixtures and shall be as per the shop drawings approved by the Employer.

The Contractor shall assemble on trial basis at least one set of each type of sanitary fixture and fittings in order to determine precisely the required supply and disposal "connections. Relevant instructions from manufacturer shall be followed as applicable. This trial, assembly shall be developed to facilitate determining the location of punctures, holes, holding devices etc., which will be required for final installation In position of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Employer.

The fixtures in the trial assembly can be reused for final installation without any additional payments for fixing or dismantling of the fixtures.
3.0 INTERNAL WATER SUPPLY SYSTEM

1.0 SCOPE

Work under this section consists of furnishing all labor, materials, equipment and appliances necessary and required to completely install internal and external water supply pipes, pipes, fittings, valves and specialties, construction of valve chambers with Both sides of the chamber / manholes / gully traps have to be water proofed with FOSROC water proofing material as indicated on the drawings and specifications.

1.2 Without restricting to the generality of the foregoing works, the scope of the work shall include Supply, Installation and testing of all Piping works like cold Water, hot water, piping and related valves, specialties and accessories for internal and external water supply.

1.3 The Contractor shall carryout and completes the said work under this contract in every respect in conformity with the rules and regulations of the local Authority. The Contractor shall furnish all labour, supply and install all new materials, appliances, equipment necessary for the complete installation and testing of the internal and external water supply system, as per the relevant BIS codes. This also includes any material, appliance, equipment not specifically mentioned herein or noted in the drawings but which are necessary and customary to make a complete installation as shown on the drawings or described herein, properly connected and in working condition. However, this specification does not relieve the contractor for the correctness of the system.

1.4 The contractor shall include all implied/allied items in their offer. Nothing extra will be paid whatsoever for incidental or contingental work.

1.5 The contractor must get acquainted with the proposed site for the works and study specifications and conditions carefully before tendering. The work shall be executed as per programme approved by the Project Engineer. If part of site is not available for any reason or there is some unavoidable delay in supply of materials stipulated by the employer, the programme of construction shall be modified accordingly and the contractor shall have no claim for any extras or compensation on this account.

1.6 Three sets of all manuals for the water supply system shall be submitted to the EMPLOYER. This shall include instruction and maintenance manuals.

1.7 It is the responsibility of the Contractor to train the Employer’s personnel in the operation and maintenance of the system.

1.8 Supply, Installation, testing and commissioning of the complete water supply system shall be as per the specifications and drawings and as per the instructions of the Engineer.

2.0 CODES AND STANDARDS
2.1 Unless specifically mentioned otherwise, all the applicable codes and standards published by the Bureau of Indian Standards and their subsequent revision shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

Nothing in this specification shall ensure to relieve the CONTRACTOR of his responsibility. The material supplied shall comply with the latest applicable Indian and / or British Standards. Other National Standards are acceptable, if they are established to be equal or superior.

Following codes and standards are made part of these specifications.

IS 10446 – 1983  Glossary of terms relating to water supply and sanitation.
IS 11208 –1985  Guidelines for registration of Plumbers
IS 7558-1974  Code of practice for domestic hot water installations
SP 7 -1983 National Building Code of India (Part IX- Plumbing services)
IS 1239  Mild steel tubular and other wrought steel pipes and fittings.
(Part-I)-1990
IS 1239  Mild steel tubular and other wrought steel pipes and fittings
(Part-II) –1990
IS 779 -1978 Specifications for Water Meters Domestic Type
IS 2104 – 1981  Specification for water meter boxes (Domestic type)
IS 7413-1981  Insulation Material
IS 778- 1984 Specifications for copper alloy Gate, Globe and Check Valves for water supply purposes
IS 1703 – 1977 Specification for ball valves (horizontal plunger type) including floats for water supply purposes.
IS 3004 – 1979 Specification for plug cocks for water supply purposes.
IS 3950 – 1979 Specifications for surface boxes for sluice valves.
IS 9338 – 1984 Specification for cast iron screw -down stop valves and stop and check valves for water works.
IS 4346 – 1982 Specification for washers for use with fittings for water services.
IS 5219 – Part 1 Specification for cast copper alloy traps – Part1 1982
IS 5312 – part 1 Specification for swing check type reflux (Non-return) 1969
valve for water works purposes part 1 single door pattern
IS 13049 – 1919  Diaphragm type (plastic body) float operated valve for cold water services – specification.

IS 13114 – 1991  Forged brass gate, globe and check valves for water works purposes – specification.

IS 14399 – part 1  Hot press moulded thermosetting glass fiber reinforced polyester (GRP) resin sectional water storage tanks.
&Part 1 – 1996

IS 310 –1965  Code Of Practice for Water Supply

SP –35  Hand book of water supply and drainage (with special emphasis on plumbing)

IS 1172-1983  Code of Basic Requirement For Water Supply, Drainage & Sanitation (Third Revision)

IS 12183  Code of practice for Plumbing in Multi-Storey buildings

Part I) – 1987 (Part 1 water supply)


(Part 1 earth work)


SP 7 – 1983  National building code of India (Part IX – Plumbing services)


IS 780-1984  Specification for Sluice valves for water works purposes (50 to 300mm size)

(Sixth Revision)

3.0 WATER SUPPLY

Main source of water is from Rain water / Bore well / Municipal / Tanker water supply

4.0 CPVC PIPES AND FITTINGS FOR WATER CONNECTIONS

CPVC pipes and fittings shall be used for cold and hot water services above and below ground applications. All internal and external piping shall be of CPVC SDR 13.5 up to 50 mm and above 50 mm shall be CPVC SCH 40.

All exposed pipes, accessories; fitting, mounting clamps in the kitchen shall be of Chrome plated or stainless steel.

4.1 LAYING AND FIXING

Visually inspect pipe ends before making the joint. Use of chamfering tool will help identity any cracks, as it will catch on to any crack.
Pipe may be cut quickly and efficiently by several methods. Wheel type plastic tubing cutters are preferred. Ratchet type cutters or fine tooth saws are another option. However, when using the ratchet cutter, be certain to score the exterior wall by rotating the cutter blade in a circular motion around the pipe. Do this before applying significant downward pressure to finalize the cut. This step leads to a square cut. In addition, make sure ratchet blades are sharp. Cutting tubing as squarely as possible provides optimal bonding area within a joint.

Burrs and fittings can prevent proper contact between the tube and fittings during assembly, and should be removed from the outside and inside of the tube. A chamfering tool is preferred, but a pocketknife or files are also suitable for this purpose.

A primer is required with two-step solvent cement; it is important to use the proper applicator. A dauber or natural bristle paint brush approximately half the size of the tubing end and the fitting socket. Solvent cement must be applied when the pipe surface is tacky from primer. Do not allow primer to puddle inside the fitting or finished assembly.

Use CPVC cement or all-purpose cement conforming to ASTM F-493 otherwise joint failure may result.

When using solvents be certain of proper ventilation.

When making a joint, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged water ways. Do not allow excess cement to puddle in the fitting and pipe assembly. This could result in a weakening of the pipe wall and possible pipe failure when the system is pressurised.

Rotate pipe one quarter to one half turn while inserting in into the fitting socket. Once the pipe end is sealed, hold it in place for five to ten seconds to allow the joint set.

When making a transition connection to metal threads, use a special transition fitting or CPVC male threaded adapter whenever possible. Do not over torque plastic threaded connections. Hand tight plus one half turn should be adequate.

When female threaded transitions are required, use only the type manufactured with brass-threaded inserts.

Use care when selecting threaded sealants.
Teflon tape is always compatible with CPVC. If you prefer paste, use only those sealants specially approved for use with CPVC. Paste based on horse hair, widely used with galvanized iron is not recommended with CPVC. Included in the installation section is a list of known incompatible sealants.

Hang or strap CPVC systems loosely to allow for thermal expansion. Do not use metal straps with sharp edges that might damage the tubing.

When connecting gas water heater, CPVC tubing should not be located within 50 cm of the flue. For water heaters lacking reliable temperature control, this distance may be increased up to 1m. A metal nipple or flexible appliance connector should be utilized. These measure climates the potential for damage to plastic piping that might result from excessive radiant heat from the flue.

Use of a brass / CPVC transition adapter when connecting CPVC to a water heater will help facilitate water heater replacement in the future.

Pressure test CPVC systems in accordance with local code requirements

An alternative method is the use of ratchet cutter. Although this option is quick and easy, this method should be used only if you are willing to be diligent in regularly sharpening your cutting blades. If poorly sharpened blades are used, it is possible that the downward pressure from cutting will cause cracking of the pipe end. When using the ratchet cutter be certain to score the exterior wall by rotating the cutter blade in a circular motion around the pipe. Do this before applying significant downward pressure on the pipe. As a precaution in cold weather, we recommended you use your hands to grip the area of the pipe to be cut for 5 to 10 seconds. Lastly, when cutting pipe in extremely cold weather we recommend to choose alternative methods of cutting.

Safe handling of solvents:

When using solvent cements, primers, and cleaners there are some basic safety measures all users should keep in mind.

Avoid prolonged breathing of solvent vapors. When pipe and fittings are being joined in enclosed areas, the use of ventilating devices are advised.

Keep cements, primers and cleaners away from all sources of ignition, heat, sparks and open flame.

Keep containers of cements, primers and cleaners tightly closed except when product is being used.

Dispose of all rags used with solvents in a proper outdoor waste receptacle.
Avoid eye and skin contact. In case of eye contact, flush with plenty of water for 15 minutes and call a physician.

All exposed CPVC pipes and fittings shall be supported on MS pipe supports, hangers, ‘U’ clamps, and bolts etc., as shown on the detailed drawings and as per the Engineers’ instructions. All the pipe supports shall be hot dip galvanised as per the Indian standard specifications. All the pipe supports shall be painted with two coats of enamel paint over a coat of zinc chromate primer. The colour of the paint shall be approved by the Engineer.

For internal work all pipes and fittings shall be fixed truly vertical and horizontal, either by means of standard pattern holder bat clamps keeping the pipes 1/2” (12mm) clear of the wall everywhere or concealed as directed.

For external work pipes and fittings shall be laid in trenches. The width of the trench shall be the minimum width required for working. The pipes laid underground, the cover on top of pipe shall be not less than 600mm for metal pipes and shall not be less than 900mm for plastic pipes from the finished ground level and a minimum horizontal distance of 600mm shall be maintained between other services lines. Backfilling of trenches shall be as explained elsewhere in the specifications.

### 4.2 COLOUR CODE FOR WATER SUPPLY PIPES

Colour code for water supply pipes shall be as per standard requirement. Details as mentioned below.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description</th>
<th>Ground Colour</th>
<th>First Colour Band</th>
<th>Second Colour Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>WATER</td>
<td>Sea green</td>
<td>French blue</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Cooling</td>
<td>Sea green</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>2.0</td>
<td>Boiler feed</td>
<td>Sea green</td>
<td>Light brown</td>
<td>------</td>
</tr>
<tr>
<td>3.0</td>
<td>Condensate</td>
<td>Sea green</td>
<td>French blue</td>
<td>Signal red</td>
</tr>
<tr>
<td>4.0</td>
<td>Drinking</td>
<td>Sea green</td>
<td>Light orange</td>
<td>------</td>
</tr>
<tr>
<td>5.0</td>
<td>Treated</td>
<td>Sea green</td>
<td>French blue</td>
<td>Canary yellow</td>
</tr>
<tr>
<td>6.0</td>
<td>Cold water from storage tank.</td>
<td>Sea green</td>
<td>French blue</td>
<td></td>
</tr>
</tbody>
</table>
4.3 TESTING

Before any pipes are painted or covered / buried, they shall be tested to a hydrostatic pressure of one and half times the working pressure. Pressure shall be maintained for at least eight hours without an appreciable drop in pressure. In addition to the sectional testing of water supply pipes, the contractor shall test the whole installation to the entire satisfaction of the Engineer. He shall rectify any leakages, failure of fittings or valves.

4.4 RECTIFICATION

Any leakage noticed shall be promptly attended by the contractor. If required the pipes and fittings shall be replaced to achieve an absolutely watertight system at his own cost.

4.5 DISINFECTION OF THE PIPE NETWORK

The contractor to disinfect the entire water distribution network including the storage tanks at his own cost. The disinfection shall be done by using residual chlorine of 0.2 ppm for a period of 2 (two) hours. The entire chlorinated pipe network is to be flushed out with fresh water before the water supply system is put into operation for domestic usage.

4.6 MODE OF MEASUREMENT

CPVC pipes above ground shall be measured along the centre line of the pipes and fittings. The quoted rate for respective item shall be per Rmt and shall include the following:

a) Cost of respective pipes and specials.
b) Laying, fixing and jointing with standard pipe clamps available for different sizes inside the wall chase and fixed on MS angle iron brackets and GI U clamps for pipes in ducts as shown on the drawing.
c) Cutting holes and chases in walls, floors, etc. and making good the same.
d) All supporting arrangements, brackets, etc.

Testing and making good the defects, if any. Pipes below ground shall be measured as stated elsewhere in the specifications.

5.0 Insulation for Hot Water Pipes:

All hot water piping shall be of CPVC insulated with Nitrile Rubber Tubular Insulation with CPVC pipes. Before applying insulation, all pipe work and fittings shall be brushed and cleaned. Dust, dirt, mortar and oil shall be removed.
Hot water pipes exposed in kitchen area must be provided with SS Jacket or Zinc aluminum jacket as per local code over the pipe insulation specified above.

The thickness of insulation to be applied shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation Thickness (VEDO FLEX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 mm, 20 mm</td>
<td>6 mm</td>
</tr>
<tr>
<td>25 mm, 32 mm</td>
<td>6 mm</td>
</tr>
<tr>
<td>40 mm &amp; above</td>
<td>9 mm</td>
</tr>
</tbody>
</table>

The thickness of insulation mentioned in the table above is exclusive of the thickness of plaster / protective coat to be applied over the insulation material.

6.0 VALVES AND CONTROLS

6.1 GENERAL

This section deals with different type of valves like butterfly valves, gate valves, ball valves, check valves, and Strainers and pressure gauges. The contractor shall refer to the approved make of materials specified in the document & relevant drawings.

Valves shall be provided on branch pipe connections to mains and at connection to equipment where indicated. All valves are to be located for easy access. All valves shall be supported wherever necessary with MS brackets. Valves shall comply with IS 780 (Class I) for C.I sluice valves and IS 778 for G.M valves and tested.

Pressure gauges shall have outer diameter not less than 115mm with 10mm BSP full thread, brass body siphon and gauge cock of size 10mm. Dial gauges shall have adequate response for the pressures encountered within the specified (Range 0-15Kg/sq.cm).

All exposed pipe accessories; fitting, mounting clamps in the kitchen shall be of Chrome plated or stainless steel.
6.2 GATE VALVE

The primary function of a gate valve is for starting and stopping of flow. It has a disc actuated by a stem screw and hand wheel, moves up and down at right angles to the path of flow of fluid and seats against two faces to shut off flow. As the disc of the gate valve presents a flat surface to the direction of flow, this valve is only for starting and shutting the flow in the pipe.

Supplying, fixing and testing shall correspond to IS 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

All globe and check valves shall have working parts suitable for hot and cold water, as required. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

All valves should have manufacturer’s test certificate indicating the date of shop test and other quality control tests with the material used for the same. Gate valves shall be of the size as specified in the BOQ.

Also the following standard corresponds to their manufacture.

<table>
<thead>
<tr>
<th>Design</th>
<th>-</th>
<th>API602/BS5352</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face to Face/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>End to End</td>
<td>-</td>
<td>ANSI B 16.10</td>
</tr>
<tr>
<td>Flange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimension</td>
<td>-</td>
<td>ANSI B 16.5</td>
</tr>
<tr>
<td>Butt Weld Ends</td>
<td>-</td>
<td>ANSI B 16.25</td>
</tr>
<tr>
<td>Pressure/Temperature</td>
<td>-</td>
<td>ANSI B 16.34</td>
</tr>
<tr>
<td>Testing</td>
<td>-</td>
<td>API 598</td>
</tr>
</tbody>
</table>

6.3 BALL VALVE

The ball valve shall be of high pressure type and shall be of sizes as specified in the BOQ. The normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed. All exposed ball valves in the kitchen shall be chrome plated or stainless steel. The ball and the shaft shall be of stainless steel. The seat shall be of PTFE

6.4 FOOT VALVES

Foot valves body and the strainer shall be of stainless steel construction of approved quality wherever shown.
6.5 BUTTERFLY VALVES

Butterfly valves shall be slim seal, short wafer type with standard finish. The valves shall be suitable for mounting between flanges drilled to ANSI 125. The valve body shall be cast iron. The disc shall consist of disc pivot and driving stem shall be in one piece centrally located. The disc shall move in bearings on both ends with ‘O’ ring to prevent leakage. The seat shall be moulded with black nitrile rubber or nylon and shall line the whole body. The spindle shall be AISI 41 steel. The valve shall be suitable for a working pressure of 16.5 kg/sq.cm and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts. These valves conform to BS 5155 with electrosteel nickel coated SG Iron (N) and seat material EPDM3.

Also the following standard corresponds to their manufacture

<table>
<thead>
<tr>
<th>Design</th>
<th>API609 / BS5155</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face to Face/</td>
<td></td>
</tr>
<tr>
<td>End to End</td>
<td>ANSI B 16.10</td>
</tr>
<tr>
<td>Flange</td>
<td></td>
</tr>
<tr>
<td>Dimension</td>
<td>ANSI B 16.5</td>
</tr>
<tr>
<td>Butt Weld Ends</td>
<td>ANSI B 16.25</td>
</tr>
<tr>
<td>Pressure/Temperature</td>
<td>ANSI B 16.34</td>
</tr>
<tr>
<td>Ratings</td>
<td></td>
</tr>
<tr>
<td>Seating</td>
<td>moulded in situ resilient lining of black Nitrile rubber</td>
</tr>
<tr>
<td>Body</td>
<td>Heavy duty CI to IS210 Gr FG220 &amp; BS 1452</td>
</tr>
</tbody>
</table>

lining of black nitrile rubber.

<table>
<thead>
<tr>
<th>Disk</th>
<th>Nylon coated SG iron of IS 1865 / SF400 / 127BS2729 Gr. 420 / 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft</td>
<td>Shafts are to be made of SS AISI 431 Only, flanged valves to be used with Flanges drilled to BS10 table F, valves Shall be capable of being locked in open Position. Hand wheel shall be with Worm and worm wheel operated for Smooth opening and closing. Key rod with MS Coated extended spindle to be provided wherever the valves are not approachable from the ground surface.</td>
</tr>
</tbody>
</table>

6.6 CHECK VALVES

Check valves / Non-Slam Non-return valves are designed to prevent reversal of flow. These are also called Non-return valves or reflux valves to avoid reversal of flow. Check valves shall be Dual Plate check valves with CI body, Aluminium bronze plate SS 316 hinge pins and springs and Buna-N seals.
to ANSI series 125. They can also conform to IS 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

Also the following standard corresponds to their manufacture

<table>
<thead>
<tr>
<th>Design</th>
<th>BS1873 / IS 5312 Part I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face to Face/</td>
<td></td>
</tr>
<tr>
<td>End to End</td>
<td>ANSI B 16.10</td>
</tr>
<tr>
<td>Flange</td>
<td></td>
</tr>
<tr>
<td>Dimension</td>
<td>ANSI B 16.5</td>
</tr>
<tr>
<td>Butt Weld Ends</td>
<td>ANSI B 16.25</td>
</tr>
<tr>
<td>Pressure/</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>Ratings</td>
<td>ANSI B 16.34</td>
</tr>
</tbody>
</table>

**6.7 STRAINERS**

“Y” strainers up to 50mm shall be of gunmetal and above 50mm shall be of cast iron body. Strainers shall incorporate a removable bronze screen with 3.175 mm (1/8”) perforations and a permanent magnet. Strainers shall be provided with flanges at both inlet and outlet. They shall be designed to enable blowing out of accumulated dirt and facilitate removal and replacement of the screen without disconnection of the main pipe.

All strainers shall be provided with equal size isolating “Slim Seal” butterfly valves of approved brands as shown in drawings so that the strainer may be cleaned without draining the system.

**6.8 FLANGES AND UNIONS**

Sufficient number of flanges and unions shall be provided as required to facilitate maintenance work after the piping is installed. Mild steel flanges shall be used for pipes. The flanges shall be connected to the pipeline by screwing or welding depending on the requirement. The flanges shall conform to the relevant ASTM standard for the particular material used for its manufacture. The flanges shall also conform to IS 5211.

**6.9 BRASS BIB COCK AND STOP COCK**

A bibcock is a draw off tap with a horizontal inlet and free outlet and stop cock (stop tap) is a valve with a suitable means of connections for insertion in a pipeline for controlling or stopping the flow. They shall be of specified size and shall be screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer which shuts against water pressure on a
seating at right angles to the axis of the threaded spindle, which operates if. The handle shall be either crutch or butterfly type securely seated pattern. The cocks (taps) shall open in anticlockwise direction.

The bibcock and stopcock shall be polished bright (Chrome plated). The minimum finished weights of bib tap (cock) and stop tap (cock) as given in the IS specification are reproduced in the table:

<table>
<thead>
<tr>
<th>Size (Mm)</th>
<th>Bib tap (kg)</th>
<th>Stop tap (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>10</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>20</td>
<td>0.75</td>
<td>0.7</td>
</tr>
</tbody>
</table>

7.0 INSTALLATION OF VALVES

Valves should be installed in true tolerance of +/-5mm with respect to the center line of the pipe. Where threaded joints are encountered the threads should be initially sealed with PVC tape to avoid leakage due to improper tightening and leakage from threading.

Proper care has to be taken in welded installation so that the centerline of valve should not deviate from the pipe causing uneven load on the pipe and further stress during its operation. The welding should be done only after proper inspection of the joint by the Engineer in the tacked position of the joint.

Before putting the line in operative mode the valves should be checked for free and easy operation of the hand wheel. Any burrs or foreign materials should be removed by flushing before final operation so that no choking in the valves should occur which might damage the valve seat.

8.0 P.C.C PIPE SUPPORTS.

Constructing P.C.C. pipe supports using P.C.C 1:2:4. The concrete surface shall be plastered smooth using 1:6 cement mortar including all the necessary metal insertions for pipe anchorage. The size of the support shall be as per the detailed drawing/ B.O.M. The maximum spacing of the supports shall be 2.5mtrs.

.
9.0 Mode of Measurements

Valves shall be measured in number only and the cost shall include:

a) Cost of valves and jointing materials.
b) Fixing and jointing with necessary bolts, nuts, rubber inserting, etc.,
Testing and making good the defects if any.

10.0 WATER HAMMER ARRESTORS

The effective fluid hammer which results in breaking of pipeline caused due to series of hydraulic shock should be arrested by means of a water hammer arrestor. The arrestor shall be capable of withstanding pressures upto 500 P.S.I. It shall be maintenance free with a companion flange to suit in the pipeline. The following materials are used for its manufacture.

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrel</td>
<td>Type ‘K’ hard drawn copper.</td>
</tr>
<tr>
<td>Cap</td>
<td>Standard wrought copper fittings attached to Barrel with 95-5 solder.</td>
</tr>
<tr>
<td>Piston &amp; Thread Adaptor</td>
<td>Machined of free turning brass.</td>
</tr>
<tr>
<td>Seals</td>
<td>“O” rings shall be of Parker spec. EP-5778-80</td>
</tr>
<tr>
<td>Seal Lubricant</td>
<td>Dow-corning silicone compound #111, FF &amp; DA Listed for use in potable water system or Nickel plated for seawater application</td>
</tr>
</tbody>
</table>

11.0 PRESSURE REDUCING VALVE

Pressure reducing valves shall be of approved make, Bronze body, pilot operated spring loaded for reducing pressure as per BOQ suitable for the specified dia of pipe.

For all other areas the pressure reducing valves shall be of approved make in Bronze material.
4.0 INTERNAL SANITARY SYSTEM (SOIL, WASTE AND VENT AND RAIN WATER PIPES)

SCOPE OF WORK

Work under this section consists of furnishing all labour, materials, equipment and appliances necessary and required to completely install soil, waste, vent and rain water pipes as indicated in the specifications and as per the instructions of the Engineer.

Without restricting to the generality of the foregoing, the soil, waste, vent and rainwater piping system shall include the following:

a) Vertical and Horizontal Soil, waste, vent, rain water pipes and fittings, joints, clamps and connections to fixtures.

b) Connection of all pipes to sewer lines as shown on the drawings.

c) Floor and urinal traps, cleanout plugs and inlet fittings.

d) Testing of all pipe lines and all accessories as per Bureau of Indian Standards.

2.0 CODES AND STANDARDS

Unless specifically mentioned otherwise, all the applicable codes and standards published by the Bureau of Indian Standards and their subsequent revision shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

Nothing in this specification shall construe to relieve the CONTRACTOR of his responsibility. The material supplied shall comply with the latest applicable Indian and / or British Standards. Other National Standards are acceptable, if they are established to be equal or superior.

Following are the standards and codes are made part of this specification.

IS 10446 – 1983       Glossary of terms relating to water supply and sanitation.
IS 11208 – 1985       Guidelines for registration of Plumbers
SP – 35               Hand book of water supply and drainage (with special emphasis on plumbing)
IS 1172-1983          Code of Basic Requirement for Water Supply, Drainage & Sanitation
                      (Third Revision)
                      (Part 1 earth work)
SP 7 – 1983           National building code of India (Part IX – Plumbing services)
IS 1742 – 1983        Code of Practice for Building Drainage (Second Revision)
IS 301 – 1971         Code of practice for Building Drainage
3.0 GENERAL REQUIREMENTS

Materials shall be of the approved make and quality specified. They shall conform to the respective Bureau of Indian Standards, British Standards Specifications, supported by Manufacturing Certificate and any other specification referred to herein.

Pipes and fittings shall be fixed truly vertical, horizontal or on slopes as required in neat manner.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, and in suspended ceilings.

Pipes shall be fixed securely to walls and ceilings by suitable pipe supports at intervals specified.

Access door for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

4.0 POLYVINYL CHLORIDE (PVC) PIPES AND FITTINGS

PVC (SWR) class pipes and fittings of dia 75mm OD, 90mm OD, 110mm OD and 160mm OD of Type A for use in rain water and ventilation and of Type B for soil and waste discharging system of pressure rating Max 6Kg/cm² and conforming to IS 13592: 1992, shall be used. The pipes shall be supplied in nominal lengths of 2, 3, and 4 or 6 meters, tolerance on specified lengths shall be +/-10mm. Any physical test requirements shall be as per IS13592-1992.

Rain water pipes higher than 160mm OD in diameter shall be conform to IS 4985-1988. The pipes used for rainwater disposal system shall not be less than 4kg/cm² and fittings shall be of injection moulded PVC conforming to IS 7634 (Part1) - 1975.

4.1 HANDLING

Because of their lightweight, there may be a tendency for the PVC pipes to be thrown much more. Reasonable care should be taken in handling and storage to prevent damage to the pipes. Contractor should hold the fullest responsibility in this case. On no account the pipes should be dragged on the ground. Pipes should be given adequate supports at all times.
4.2 LAYING

The PVC pipes shall be laid under the floors below slab or on walls either buried or exposed as the case may be, as per the specifications and instructions of the Engineer. The minimum thickness of fittings shall be of 3.2 mm. The fittings shall be of injection-moulded type with solvent cement joint or rubber ring joint. The pipes and fittings shall be capable of withstanding sun’s rays. PVC pipes laid below slab or suspended in ceiling shall be supported by angle brackets / MS supports as detailed in the drawings and as per the instruction of the Engineer. The cost of drilling holes in RCC slab, floor, RCC/masonry retaining wall with the core cutting machine and making good the same with approved quality cement concrete etc. is at its own cost. If the pipes laid above the floor level (sunken level), it should be rigidly fixed with PCC bedding and levelled at every 1 metre intervals.

4.3 JOINTING

The jointing of pipes to fittings shall be done as per the manufacturer’s instructions / recommendations and as per the Engineer instruction.

The PVC pipes and fittings shall be joined with Solvent Cement and jointing shall be carried out as follows:

1. Cut the spigot end of the pipe square.
2. All burrs from the internal and external surfaces should be removed.
3. The spigot should be marked with a pencil line and a distance equivalent to the socket depth. Clean the surface within the marked area.
4. Apply uniform coat of solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.
5. Insert the pipe end into the socket of the fitting and push it in upto the mark.

Remove the excess solvent cement and hold the joint firmly in position for 30 seconds to dry. Gluing should be avoided in a rainy or foggy weather.

The other method of jointing shall be by rubber rings. The material of rubber ring should conform to IS 5382-1969. The ring is housed in groove formed in a plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and housing. Lubricating paste should be applied before compressing the rubber. Where natural rubber ‘O’ rings are used, mineral oil or petrol or grease should be used.

4.4 TESTING

PVC pipes and fittings shall be tested in accordance with IS 13592 - 1992. The openings of the pipes shall be sealed for the section to be tested. The water pressure of 0.5Mpa (50m of H2o or 5.0 kg/cm²) shall be maintained for a minimum period of 15 minutes and there should be no leakage at any joint. The Engineer shall examine carefully all the joints for leakage. The cost of equipments and accessories required for testing the system shall be supplied by the contractor at his own cost.
5.0 RIGID PVC PRESSURE PIPES AND FITTINGS

The PVC pressure pipes and fittings shall be used for conveying wastewater from washbasins, kitchen sinks, urinals, floor drain connecting to washing machines and condensate drain etc.

The pipes shall be 10 Kg/cm². PVC pipes and fittings shall be jointed with solvent cement. Fittings shall be of injection moulded PVC conforming to IS 7634 (Part1) - 1975.

5.1 LAYING AND FIXING

The pipe laying and jointing shall be done in accordance with IS 7634 (Part 3) – 1975. Pipes shall be cut to size and chamfered well. Burrs if any shall be removed. Pipes and fittings shall be jointed using solvent cement or rubber ring joints. The pipes and fittings shall be jointed accurately without any stress to achieve leak proof joints. The cost of drilling holes in RCC slab, floor, RCC/masonry retaining wall with the core cutting machine and making good the same with approved quality cement concrete etc., to the satisfaction of the Engineer shall be included in the quoted rate. Separate rate for core cutting shall not be paid to the contractor.

5.2 TESTING

The method, which is commonly in use, is filling the pipe with water, taking care to evacuate any entrapped air and slowly raising the system to the test pressure. The test shall be done in accordance with IS 2065 – 1983 – code of practice for water supply in buildings. The test pressure shall be 5 kg/cm² or the maximum working pressure plus 50%, whichever is greater. The pressure shall be maintained for at least 4 hours. The Engineer shall examine carefully all the joints for leakage. The cost of equipments and accessories required for testing the system shall be supplied by the contractor at his won cost.

6.0 MODE OF MEASUREMENT

PVC PIPES

PVC Pipes shall be measured along the centreline of the pipeline including the specials in running meter (Rm.) between:

a) Chambers: Shall be recorded from the inside of one chamber to inside of another chamber.

b) Gully trap and Chamber: Shall be recorded between socket pipe near gully trap and inside of chamber.

The quoted rate shall include the following:

I) The cost of pipes, specials and other jointing materials.

ii) Laying, jointing and curing.

iii) Testing and making good the defects, if any.

7.0 PVC FLOOR TRAPS

The PVC floor trap shall be of multi-inlet and one single outlet type. The floor trap shall be deep seal type with an effective seal of minimum 50mm. The waste from sanitary fixtures shall be
directly discharged to the floor trap. Jointing of the waste pipe to the floor trap shall be done as per manufacturer's instructions. The height riser fitting shall be made use of, wherever the floor drain is located in deep-sunk floors or is suspended from the ceiling. The floor trap shall be of reputed make and preferably of the same make as of the pipes used. The floor trap shall be provided with 150 x 150mm square cast chrome plated or stainless steel grating with rim of approved design. Minimum thickness of the grating shall be 4 to 5mm.

The urinal trap shall be provided with 150 x 150mm square cast chrome plated or stainless steel sealed cover with rim of approved design. Minimum thickness of the cover shall be 4 to 5mm.

The cost of removing and refixing of tiles and making good as per the instructions of the Engineer for fixing the grating floor trap and urinal cover shall not be paid be separately.

The AHU floor drains shall be fitted with chrome plated funnel shaped grating.

8.0 VENT COWL

The supply and installation of PVC vent cowl shall conform to local codes and or British standards whichever is applicable code of practice. The cost of supply and installation of vent cowl shall be measured as part of the soil and waste pipe.

9.0 ROOF DRAIN

The supply and installation of PVC roof drain and grating with water proofing flashing around the drain shall conform to the requirements of local codes and or British standard specifications whichever is applicable. The cost of supply and installation of roof drain shall be measured as part of the rain water pipe.
5.0 EXTERNAL SEWERAGE SYSTEMS

1.0 SCOPE OF WORK

Work under this section consists of furnishing all labour, materials, equipment and appliances necessary and required to completely install the external sewer pipes, construction of manholes and inspection chambers as indicated on the drawings and specifications.

External sewerage system consisting of construction of gully trap, inspection chambers, and manholes, lying of sewer pipes, earth work and backfilling as specified in the drawings and bill of quantities.

Testing of all pipe lines and all accessories as per Bureau of Indian Standards

The General character and the scope of work to be carried out under this section is illustrated in the drawings and specifications attached herewith. The contractor shall carry out and complete the said work under this contract in every respect in conformity with the rules and regulations of the local authority. The Contractor shall furnish all labour, materials, appliances, tools and equipment necessary for the external sewerage services installation including testing and commissioning as specified herein, and as per the relevant Bureau of Indian Standards (BIS), British Standards codes. This also includes any material, appliances and equipment not specifically mentioned herein or noted on the drawings as being furnished or installed which are necessary and customary to make a complete installation properly connected and in working order.

Carryout all incidental works connected with external drainage services installation such as excavation of trenches and backfilling.

Furnish and install complete workable external drainage services installation as shown on the drawings and described in this specification and as per the latest Bureau of Indian Standards (BIS), British Standards (BS) specifications.

Complete installation of the external sewerage and sewerage appurtenances within the site boundary.

Co-operation with other trades in putting the installation in place. Any work done without regard or consultation with other trades, shall be removed by the contractor without additional cost to the Employer, to permit proper installation of all other work, as desired by the Engineer.

Repair all damage done to the premises as a result of this installation and remove all debris left by those engaged for this installation to the satisfaction of Engineer.

It is the responsibility of the contractor to take care of all the installed materials until the time of handing over to the Employer.

Assume full responsibility for getting the entire installation duly approved by the authorities concerned and for all expenses in connection with the same. Assume responsibility for obtaining and delivering to the Employer certificate of final inspection and approval by the concerned authorities.

2.0 CODES AND STANDARDS

2.1 Unless specifically mentioned otherwise, all the applicable codes and standards published by the Bureau of Indian Standards and their subsequent revision shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

Nothing in this specification shall construe to relieve the CONTRACTOR of his responsibility. The material supplied shall comply with the latest applicable Indian and / or British Standards. Other
National Standards are acceptable, if they are established to be equal or superior.

Following are the standards and codes are made part of this specification.

IS 10446 – 1983  Glossary of terms relating to water supply and sanitation.
IS 11208 –1985  Guidelines for registration of Plumbers
SP –35  Hand book of water supply and drainage (with special emphasis on plumbing)
IS 1172-1983  Code of Basic Requirement for Water Supply, Drainage & Sanitation
               (Third Revision)
               (Part 1 earth work)
SP 7 – 1983  National building code of India (Part IX – Plumbing services)
IS 4111  Code of practice for Ancillary Structure In Sewerage System
       (Part 1) 1986
IS 301 – 1971  Code of practice for Building Drainage
IS 1726 -1991  CI Manhole Covers and Frame
BS 5572 -1978  (Amendment No.2) Sanitary pipe Works
IS 4127 – 1983  Specification for testing of stone ware pipes and fittings.

3.0 POLYVINYL CHLORIDE (PVC) PIPES AND FITTINGS

PVC (SWR) class pipes and fittings of dia 75mm OD, 90mm OD, 110mm OD and 160mm OD of Type A for use in rain water and ventilation and of Type B for soil and waste discharging system and conforming to IS 13592: 1992, shall be used. The pipes shall be supplied in nominal lengths of 2, 3, and 4 or 6 meters, tolerance on specified lengths shall be +/-10mm. Any physical test requirements shall be as per IS13592-1992.

All soil, waste and siphonage pipes and fittings used as vertical external pipes within the shafts shall be PVC SWR grade socket and spigot type pipes confirming to relevant IS or its subsequent revisions .

All pipes being used on exposed surface shall be UV protected with a UV inhibitor built in during Moulding / extrusion in case of PVC pipes

All such pipes shall use only rubber ring joints

No pasted joints shall be permitted on external piping

All external pipes shall be mounted on special sliding brackets of galvanised MS grouted to the duct wall, with the pipes being held to it using GI “U clamps”. These brackets shall provide for a least 50mm clear working space behind the pipes

3.1 MANHOLE AND INSPECTION CHAMBERS

Inspection chambers of Internal size 600mm x 600mm up to a depth of 0.9 m and manholes of varying sizes as per IS 4111 shall be constructed beyond 1.2m (depth of the sewer line from the Formation Ground
level). Both sides of the chamber / manholes / gully traps have to be water proofed with FOSROC water proofing material.

### 3.2 LOCATION AND SIZES

The size indicated in the drawings shall be the internal size of chamber. Unless otherwise specified, the clear internal diameter of the manhole shall be 1.2mtrs for depth up to 2.3mtrs. and the diameter of the manhole shall be 1.5 meters for larger depth up to 9mtrs. The inspection chambers are provided at all changes of direction of drains and where branch drain meets the main drain. Chambers shall be of such size as to allow necessary examination and clearance of drains. The minimum internal sizes shall be taken as per detailed drawings; standards specified and local byelaws if any. In the absence of local byelaws, the requirements stipulated in IS 4111 (Part I) Code of Practice for Ancillary Structures on Sewerage System shall be followed. The work shall be done strictly as per standard drawings and the following specifications: Depth of manhole shall be the clear vertical depth between the manhole cover to the outgoing invert of the main drain channel.

### 3.3 BED CONCRETE

Bed concrete shall be in 1:4:8 cement concrete and the thickness of bed concrete shall be as tabulated below. Both sides of the chamber / manholes / gully traps have to be water proofed with FOSROC water proofing material.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Depth of manhole/Inspection chambers</th>
<th>Thickness of bed concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspection Chambers upto 1.2 m depth</td>
<td>150mm</td>
</tr>
<tr>
<td>2</td>
<td>Manholes upto 1.65m depth</td>
<td>225mm</td>
</tr>
<tr>
<td>3</td>
<td>Manholes from 2.3m and above</td>
<td>300mm</td>
</tr>
</tbody>
</table>

### 3.4 BRICK MASONRY

Brickwork shall be with best quality table moulded bricks in 1:6 cement mortars as per specification for brick masonry. The thickness of masonry shall be as specified in the ISI specifications as per the table below.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Depth of manhole/Inspection chambers</th>
<th>Thickness of brick masonry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspection Chambers upto 1.2 m depth</td>
<td>230mm</td>
</tr>
<tr>
<td>2</td>
<td>Manholes upto 2.25m depth</td>
<td>230/345mm</td>
</tr>
<tr>
<td>3</td>
<td>Manholes from 3.0m to 5.0m.</td>
<td>230/345/460mm</td>
</tr>
<tr>
<td>3</td>
<td>Manholes from 5.0m to 9.0m.</td>
<td>230/345/460/575mm</td>
</tr>
</tbody>
</table>

205/498
3.5  PLASTER

Inside walls of chambers / manholes shall be plastered with 15mm thick cement plaster 1:3 mixed with waterproofing material and finished smooth with a floating coat of neat cement. External walls shall be plastered in CM 1:3 and sponge finished.

3.6  BENCHING

Sloping surfaces having slope in transverse direction constructed on either side of channels at the base of manholes or inspection chamber for the purpose of confining the flow of sewage, avoiding the accumulation of deposits and providing a safe working platform. Channels and benching shall be done in cement concrete 1:2:4 rendered smooth with neat cement. The following sizes of channels for the benching shall be adopted:

<table>
<thead>
<tr>
<th>Size of Drain</th>
<th>Depth at Centre</th>
<th>Depth at sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mm</td>
<td>150 mm</td>
<td>250 mm</td>
</tr>
<tr>
<td>150 mm</td>
<td>200 mm</td>
<td>300 mm</td>
</tr>
</tbody>
</table>

3.7  CHAMBER / MANHOLE COVERS

Manhole frame and cover shall be of heavy duty cast iron or fiber reinforced cement concrete as per bill of quantities with lifting hooks as per IS 1726 - 1974 and as per the details given in the drawings and fixed on CI frame or cement concrete embedded in concrete. Covers placed on the frames shall be airtight. The weight of frame and cover shall be as per bill of quantities.

3.8  STEPS

PVC Steps shall be provided in all manholes and inspection chambers over 800mm depth and shall preferably be of cast iron and of suitable dimensions. These shall steps may be staggered in two vertical runs, which may be 300mm apart horizontally and vertically and shall project minimum 100mm beyond the finished surface of the manhole wall. The top step shall be 450mm below the manhole cover and the lowest not more than 300mm above benching. Foot rest shall be painted with coal tar, the portion embedded in masonry on cement concrete block being painted with thick cement slurry before fixing.

3.9  DROP CONNECTIONS

In case the difference in invert levels between the main drain and the branch line requires a drop more than 600 mm, a drop connection should be provided with PVC or cast iron or stoneware four way
junctions, fixed at right angles to the drop pipe at the level where the branch pipe enters the manhole. Access for cleaning the bend with cast iron frame and cover should be provided at finished ground level. The necessary concrete encasement and reinforcement, required for the drop connection are included in the quoted rates.

3.10 GULLY TRAP CHAMBERS

Stoneware gully traps of specified size shall be provided as per IS 651. It shall be fixed on 150mm thick and 700mm square 1:4:8 cement concrete bedding and the gully outlet shall be jointed similarly to the jointing of stoneware pipes. A brick masonry chamber 300 x 300 mm (internally) shall be constructed in 1/2 brick masonry with 1:6 cement mortar and the spaces between the trap and the wall shall be filled up with 1:3:6 concrete and the upper portion of the chamber shall be finished with neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating and the bottom of the chamber shall not be less then 230 mm. In addition to 150mmx150mm CI grating, the chamber shall have a CI frame and cover (300mm x 300 mm). The cover and frame shall be placed on top of the brick masonry.

4.0 UNDERGROUND TRENCHES

4.1 ALIGNMENT AND GRADE

Drains are to be laid to correct alignment & grade shown in the drawings but subject to such modifications as necessary to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown in the plans and sections shall be permitted except by the express direction in writing of the Engineer. The pipe shall be laid to slope with the socket and spigot ends on higher and lower side respectively.

4.2 OPENING OUT TRENCHES

In excavating the trenches, the road metalling, pavement kerbing, etc., are to be placed on one side and preserved for reinstatement and the trench or other excavation shall be filled up and laid back to original condition at no extra cost. Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Employer. The contractor shall not cut or break down any live fence or trees in the line of the proposed works but shall tunnel under them unless the Employer orders the contrary. The contractor shall scrub and clear the surface over the trenches and other excavations of all stumps, roots and other encumbrances affecting execution of work and shall remove the same from the site as per the directions of the Engineer.

4.3 EXCAVATION TO BE TAKEN TO PROPER DEPTH

Trenches shall be excavated in all conditions of soil and to such a depth that the sewers shall rest as described in the several clauses relating thereto and so that the inverts may be at the levels given on the
section. In bad ground, the Engineer may order the contractor to excavate the trench to a greater depth than shown on the drawings and to fill up the excavation to the level of the sewer with concrete, sand, gravel, or other materials. For such works the contractor shall be paid extra at the rates laid down for such works in the schedule, if the extra work was ordered by the Engineer in writing. But if the contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer, the extra depth shall have to be filled up with concrete at the contractors own cost to the requirements and satisfaction of the Engineer.

4.4 TRANSFERRING LEVELS TO TRENCH BOTTOM FROM SITE RAILS BY USING BONING ROD

Excavation of trench shall be preceded to the correct depth less 75mm by fixing actual depths to be excavated true to the specified gradient. Spot levels shall be fixed at every 3mtrs. Spacing in the trench prior to the last 75mm depth excavation using boning rod and the bottom of the trench trimmed to correct gradient and level.

4.5 REFILLING

After the sewer or other work has been laid and proved to be water-tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this so that no damage is caused to the sewer and other permanent works. Filling in the trenches upto 50 cms. Above the crown of the sewer shall consist of the finest selected materials placed carefully and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms. Layers with material taken from the excavation, each layer being watered and consolidated.

4.6 BACK FILLING OF TRENCH

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench of its top, for the purpose of refill materials to be used.

ZONE A: - From the bottom level of the trench to the centre line of the pipe.

ZONE B: - From the centre line of the pipe to a level 30 cm above the top of the pipe.

ZONE C: - From a level 30 cm above the top of the pipe to the top of the trench.
4.7 BACKFILL MATERIALS

All backfill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetable or organic materials, lumpy or frozen materials boulder, rocks or stone or other materials which in the opinion of the Engineer, is unsuitable for deleterious. Excavated earth, which shall pass through a sieve of aperture size 20mm, can be used for filling in zones A & B. However, material containing stones upto 20mm as their greatest dimension may be used in zone C only unless otherwise specified by the Engineer. Where excavated material considered by the is Engineer not suitable for back filling, clean river sand shall be used for the same.

4.8 BACK FILL SAND

River sand used for back fill shall be natural sand graded from fine to coarse. The total weight of clay in it shall not exceed 10 percent. All material shall pass through a sieve of aperture of size 20mm (IS-2405-1980) and not more than 5 percent shall remain on IS sieve of aperture size 6.30mm.

4.9 BACK-FILL GRAVEL

Gravel used for back fill shall be natural gravel and having durable particles graded from fine to coarse in a reasonably uniform combination with no boulders or stone larger than 50mm in size. It shall not contain excessive amount of loam and clay and not more than 15 percent shall remain on a sieve of aperture size 75 micron.

Back filling in zone A shall be done by hand with fine excavated material or river sand, fine gravel or other approved materials placed in layers of 8cm and compacted by tamping. The back filling material shall be deposited in the trench for its full width on each side of the pipe, fittings and appurtenances simultaneously.

Back-filling in zone B using fine excavated material shall be done by hand or approved mechanical methods using the fine excavated material special care being taken to tamping and to avoid injuring or moving the pipe. If excavated material is not suitable the type of back-fill material to be prescribed by the Engineer to suite individual locations.

Back filling in zone C shall be done by hand or approved mechanical methods and well compacted. Excavated earth having stones of size not exceeding 20mm can be used for zone C. If the excavated earth unsuitable for back fill the filling material shall be specified by Engineer.

4.10 BACKFILL WITH EXCAVATED MATERIALS
Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back fill to the sub-grade of the structures shall be made with sand or cement concrete in accordance with Para 5.7 The method of place and consolidating the back fill material shall be prescribed by the Engineer.

4.11 CONCRETE SLABS OVER PIPES

When pipes are laid under roads and pavements subjected to heavy traffic loads the trenches may be covered with reinforced concrete slabs of suitable dimension, supported on edges to relieve the load on pipes to the adjoining earth.

4.12 SITE CLEANING ON COMPLETION OF WORK

All surplus pipes and fittings, valves, etc., and all tools and temporary structures shall be removed from the site as directed by the Engineer. All dirt, rubbish and excess earth from the excavation shall be removed and transported and disposed at a suitable place as directed by Engineer and the construction site left clean to the satisfaction of the Engineer.

PART 1 -

4.13 CONTRACTOR SHALL RESTORE SETTLEMENT AND DAMAGES

The Contractor shall at his own cost make good promptly, during the whole period that the works are in hand, any settlement that may occur on the surfaces of roads, beams, footpaths, gardens, open spaces, etc. whether public or private caused by his trenches or his other excavations and he shall be liable for any accidents caused thereby. He also shall, at his own expense and charge, repair and make good any damage done to the buildings and other properties.

4.14 DISPOSAL OF SURPLUS

The Contractor shall at his own cost dispose within the site or as directed all surplus excavated materials not required to be used in the work.

4.15 TIMBERING

The Contractor shall at all times support efficiently and effectively the sides of trenches and other excavations by finest selected timbering, piling, sheeting material, etc. The trenches shall be close timbered in loose or sandy strata and below the surface of the sub-soil table. All timbering, sheeting and piling with their wallings and supports shall be of adequate dimensions and strength and fully braced and strutted so that there is no risk of collapse or subsidence of the walls of the trench. The Contractor shall be held accountable and responsible for the adequacy of all timbering, bracing, sheeting and piling used and for all damages to persons and property resulting from the improper quality, strength, placing, maintenance, or removing of the same.
4.16 **REMOVAL OF WATER**

The Contractor shall at all times during the progress of work keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to public health nor to public or private property, to the work completed or in progress, to the surface of any roads or streets and cause any interference with the use of the same.

4.17 **TRENCH WIDTH**

The width of excavated trenches shall be as per the table given below:

<table>
<thead>
<tr>
<th>Excavation upto:</th>
<th>Upto100mm dia pipe</th>
<th>Upto 150mm dia pipe</th>
<th>Upto 300mm dia pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>900 to 1500 mm depth</td>
<td>650 mm</td>
<td>700 mm</td>
<td>850 mm</td>
</tr>
<tr>
<td>1500 to 3000 mm depth</td>
<td>900 mm</td>
<td>950 mm</td>
<td>1100 mm</td>
</tr>
<tr>
<td>3000 to 5000 mm depth</td>
<td>1100 mm</td>
<td>1150 mm</td>
<td>1300 mm</td>
</tr>
</tbody>
</table>

4.18 **PROTECTION OF EXISTING SERVICES**

All pipes, water mains, cables, etc. met with during the course of excavation shall be carefully protected and supported.

4.19 **ROAD CROSSINGS**

All pipelines laid below roads shall be taken through suitable underground trenches. The size of trenches shall be as per drawings.

4.20 **CONSTRUCTION ACROSS ROADS**

All works across roads shall be carried out as per the directions of the Employer.

4.21 **MODE OF MEASUREMENT**

Measurement for excavation of pipes trenches shall be made per linear meter under the respective category of soil classification encountered at site.

All types of soil like soft soil, hard soil, soft rock and disintegrated rock requires chiselling. Hard rock requiring blasting
6.0 STORAGE TANK RESERVOIR INSERTS

1.0 SCOPE:

Work under this section consists of furnishing all labour, materials, equipment and appliances necessary and required to completely install the reservoir inserts such as inlet, outlet, overflow, drain, ladder, manhole frame and cover including all other materials required to complete the work as indicated on the drawings and specifications.

2.0 CODES AND STANDARDS

Unless specifically mentioned otherwise, all the applicable codes and standards published by the Bureau of Indian Standards and their subsequent revision shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

Nothing in this specification shall construe to relieve the CONTRACTOR of his responsibility. The material supplied shall comply with the latest applicable Indian and / or British Standards. Other National Standards are acceptable, if they are established to be equal or superior.

Following are the standards and codes are made part of this specification.

IS 2062 –1992 Structural steel for general purposes
IS 226 Galvanization of structural steel
IS 816 and 823 Welding of structural steel

3.0 PUDDLE FLANGES FOR RESERVOIR (INSERTS)

Inlets, outlets, interconnection sleeves and drain outlets for the reservoir shall be made through mild steel bath galvanised puddle flanges obtained from reputed manufacturers and to be inserted at suitable levels as indicated on the drawings. The Contractor shall be responsible for placing the inserts at required level well in advance and before making the final shuttering layout for casting the walls. All the overhead water tank terraces shall be provided with efficient rainwater disposal system. The necessary sleeve in the tank wall shall be provided for running the level controller wires/probes.

The plate used for fabricating the puddle flanges shall be MS 6mm thick with fillet welding. The length of the puddle flanges shall be minimum 600mm unless otherwise specified.

Puddle flanges shall have threaded ends upto 80mm dia and flanged ends above 80mm dia. All puddle flanges shall be hot-dip galvanised after fabrication.

All the underground water tanks shall be fitted with heavy duty CI manhole frame and cover. The overhead water tanks are provided with light duty CI manhole frame and cover.

The tanks are provided with aluminium step ladder for efficient maintenance of the water tanks.

Adequate number of vent pipes of minimum 100mm dia with mosquito proof mesh shall be provided above the overflow level at regular intervals as per the detailed drawings and as per the instructions of the Engineer.
4.0 MANHOLE COVERS

The manhole covers shall be of medium duty/light duty type (cast iron) with double seal, locking arrangement and lifting hooks manufactured as per IS-1726. The shape of the cover to be as per the drawings.

5.0 ALUMINIUM STEP LADDER

For effective maintenance of the reservoir portable Aluminium step ladder to suit the depth of the tank shall be provided with necessary hooks and fixing accessories.
1.0 SCOPE

This specification covers the design requirements, materials, and features of construction, inspection and testing and commissioning of Horizontal Centrifugal Pumps for lifting the water from underground sump to overhead tank.

Also the scope of work included with supply and installation of interconnecting piping works including all the related valves, specialties and all other accessories.

The pump set offered shall be generally horizontal centrifugal pump, single stage or multistage or mono-bloc pump to satisfy the duty conditions stipulated in the bill of quantities.

The pumps shall be selected having their maximum efficiency at average operating conditions. The maximum speed at which a pump shall run is determined by the net positive head available at the pump, the quantity of liquid being pumped and the total head.

Following standards and codes are made part of this specification.

IS 8418 – 1977 Specifications for horizontal centrifugal pumps.

IS 8034 – 1976 Specifications for submersible pumpset for clear, cold, fresh water (First revision).

IS 5120 for handling water.

IS 5600-1970 for pumping storm water and sewage.


2.0 SCOPE OF SUPPLY AND ERECTION

The CONTRACTOR shall supply, install, test and commission all pumps and accessories, interconnecting material like pressure gauges & accessories, specialties and other items as required.

Contractor to provide flanged metal/rubber bellows at the suction and delivery side of pumps that are assumed to be a part of the equipments.
Scope of erection to be performed by the CONTRACTOR is outlined below:

The CONTRACTOR shall unload from carriers at plant site, handle, and check, receive, transport, store, erect and test all materials furnished by him and others in accordance with this specification and General Conditions of Contract. The EMPLOYER shall be informed of any loss of damage within seven days of receipt of material.

The CONTRACTOR shall also install small accessory piping and any specialties furnished for equipment such as built-in bypass and other equipments of this type.

The CONTRACTOR’s scope under this includes the following:

Jointing material as required for all screwed joints. Fasteners (bolts, nuts, studs washers etc.) and gaskets is required for all flanged joints.

Erection tools, tackles drilling machines, chasing machines as required.

3.0 TESTS AND INSPECTION

3.1 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the maximum discharge head or twice the rated discharge head, whichever is higher. While arriving at the above pressure, the maximum suction head shall be taken into account. (Maximum discharge head = Shut off head + maximum suction head). The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.

3.2 PERFORMANCE TEST

Standard Running Test

The pumps shall be tested as per IS 5120, at rated speed at SUB-Contractor’s works to measure capacity, total head, efficiency and power. The negative tolerance on efficiency shall be limited to 2.5% (not 5 % as indicated in IS 5120). These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one hour. Minimum five readings approximately equidistant shall be taken for plotting the performance curves.

NPSH Tests

NPSH tests shall be conducted with water as the medium.
3.3 MECHANICAL BALANCING

In addition to static balancing, impeller and balancing drum shall be balanced dynamically at or near the operating speed.

3.4 FIELD TESTING

After installation, the pumps shall be subjected to testing at site also. If the field performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the CONTRACTOR, at no extra cost to the EMPLOYER.

3.5 TENDER DRAWINGS

The contractor to submit preliminary outline dimensional drawing of pump and motor including suction and discharge connections and the foundation details required for the pump to be installed along with the Bids

Performance curves (capacity vs. total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.

Pump Catalogues.

3.6 PAINTING

All metal surfaces shall be painted with two coats of enamel paint over a coat of approved oxide primer. However the components of the pumps shall not be painted before inspection.

4.0 GASKETS, SEALS AND PACKINGS:

The gaskets, seals and packing are used in special purpose pumps shall be suitably chosen so as to withstand the effect of liquid being pumped.

Clear cold fresh water Mechanical seal or cotton yard (lubricated) seal.

5.0 ACCESSORIES:

Essential for pumpset used for pumping water.

Oil lubricator with oil level indicator if the pump is lubricated.
Grease cup for grease lubricated bearings.
Flanged ball valve/Gate valve on suction side if there is positive suction.
Flanged ball valve/Gate valve on delivery side.
Flanged horizontal/vertical check valve on delivery side.
Pressure relief valve.
Pressure gauge (for delivery pipe) and vacuum gauge (for suction pipe) with copper tubing and winch cock.
Priming funnel with separate or integral air cock.
Float switches or automatic level operated control switch.
Base plate.
Foundation bolts and nuts.

6.0 FOR WATER PUMPSET:

In case of more than one duty point, the performance range is to be indicated and the prime mover should be of sufficient power to take the entire load in this range. Head (restrictions) shall be indicated in the nameplates to avoid overloading of the prime mover.

For working in parallel pumps should be with stable head capacity characteristics.

Arrangement for cooling of bearings where required.

Balancing water leakage connection should be provided in case of multistage pumps with balancing discs.

Thrust bearing of adequate size.

6.1 PUMP TEST:

Pump tests are made to determine the following:

The discharge against the specified head when running at the rated speed under specified suction lift or head.
The power absorbed by the pump at the pump shaft (BP) under the above specified conditions and Efficiency of the pump under the above specified conditions.

The pump has to be tested at manufacturers works and a test certificate furnished before supply and tested at site after installation as per procedure as per clause 13 of 5120 – 1968.
6.2 PUMP INSTALLATION:

Installation:

Certain precautions must be observed in both planning a pump installation and erection

Piping: Both the suction and discharge lines should be independently supported so as no strains will be thrown on the casing such strains may cause distortions and rubbing.

The suction line should be as short and straight as possible. Any elbows should have large radii. For pumps operation with suction lifts no valves other than a foot –valve should be placed in it. Generally, the diameter is made one or two sizes larger than the pump flange size. All these precautions insure the maximum available suction head on the pump. When an oversize line is used an eccentric reducer, which is horizontal at top, is placed between it and the pump flange size.

It is very important to have the suction line airtight and to avoid high spots at which dissolved gases or air might separate out and destroy the vacuum. After piping is installed and the pump is running all joints should be inspected with a flame, as air leakage will draw the flame to the opening. The same method can be used to determine leakage through the packing box; the eccentric reducer is used at the suction flange to avoid high spot at which the air might collect. The inlet end of the suction line i.e., submergence should be 1 to 2 metres below the minimum water level of the sump (not less than 1 metre.) to prevent air from being drawn into the pipe with the water.

It is desirable to have a long length of straight piping between the elbow and suction flange as possible to even out the flow of the water as it enters the pump. The pump should be placed to secure the greatest possible suction head and yet to be available for inspection and repair work.

A non-return valve and isolation valve are usually placed in the discharge line. The isolation valve is used to regulate the flow and the non-return valve prevents backflow into the pump, which might cause it to operate like a turbine and perhaps be damaged on account of over speed. The non-return valve is placed between the isolation valve and the pump so that it may be inspected or removed without emptying the discharge line.

Foundation: The foundation should be heavy to reduce vibrations and should be rigid to avoid any twisting or misalignment. A space of 2 to 4 cm is allowed between the base plate and top of the foundation, which is filled with grouting to secure a uniform load distribution. Alternatively, rubber cork anti-vibration pad shall also be placed.

When the grouting had dried the base plate should be drawn down evenly to avoid springing it. After this has been done the shaft is finally aligned both radially and axially with the driver by means of
shims or wedges so that it turns freely. If the shaft is not properly aligned there will be vibration and excessive wear on the bearings, packing and wearing rings.

6.3 PUMP OPERATION:

**Trail operation:** The operation of centrifugal pump is quite simple and safe. There are relatively few valves and the pump will not be damaged even if the discharge valve is closed for short periods of time.

**Starting:** The pump must be primed before it will deliver any fluid. Failure to prime the pump may cause the wearing, rings, and rub and seize or the shaft may be scored at the packing boxes. During starting it is wise to have the vent cock in the casing open slightly to remove any dissolved air in the water.

It is best to have the discharge valve set so that the least load is thrown on the driver when the pump is started. The valve should be opened gradually to avoid throwing a large sudden load on the driver and to prevent a sudden surge in the discharge line. The discharge valve should be fully open when starting mixed flow or propeller pumps because the brake horsepower will then be a minimum.

**Running:** When the unit is running it requires very little attention beyond occasionally checking to see that the journal and thrust bearings are running cool and has a sufficient supply of oil. The packing is adjusted to permit a slight leakage to cool and lubricate it, and the water is flowing to the water seal of the suction gland to prevent air from leaking in.

**Shutting Down:** When shutting down, the discharge valve should be in the same position as when starting up by closing the discharge valve gradually so that less power is dropped from the line and any sudden pressure surges in the pipe system are avoided.

**Inspection and Maintenance:** Manufacturer supply instruction manuals, which give directions for the operation and maintenance of each pump.

The wearing ring clearance should be checked as they will increase with time and thus cause a decrease in efficiency. The frequency of the inspection will depend upon the liquid handled. If the liquid contains gritty materials or is corrosive, inspection may be made monthly, but if clear water is pumped it may be sufficient to check them annually. A general rule is to replace the rings when the clearance has increased 100 percent above the original.

The packing should be replaced after it becomes hard and tends to score the shaft. When the packing is being replaced the finish of the shaft sleeves should be examined for smoothness. It is essential that the lantern ring shall be placed directly under the water inlet when putting in the new packing to insure a
circulation of the water and a satisfactory seal. The packing should be gradually compressed with the pump running. It should not be compressed too much as local heating of the shaft and consequent misalignment will result. A slight leakage will insure proper lubrication and cooling.

If the base is not too rigid the shaft alignment should be checked occasionally when the pump is at a temperature corresponding to running conditions. This must be done with the packing removed. At the same time the clearance of the journal bearings should be checked for wear.

The oil should be changed as required band at that time inspected for the presence of water. If water appears in the oil the pump casing should be examined to find the leak.

6.4 GUARANTEE OF PERFORMANCE OF PUMPS:

The pumps shall be guaranteed by the manufacturer/supplier against defects in material and workmanship under normal use and service for a period of at least one year from the date of dispatch.

**Guarantee of performance:** the supplier shall indicate the working range of the pump and the efficiency of the pump shall be guaranteed at a specified point of rating only and shall not be guaranteed to cover the performance of the pump under conditions varying there from nor for a sustained performance for any period of time. If the purchaser so desires, the manufacturer shall guarantee the non-overload of the prime mover for variations in the head in the working range. In the case of pumps where acceptance tests cannot be conducted on the liquid for which the pump is designed, the manufacture shall indicate the liquid performance of the pump based on the results of the tests conducted by him on the pump with water as indicated under 13 and interpolated as explained under 14 (IS 5120). However, in these cases, the manufacture shall guarantee for the performance of the pump with water for the specified range.

**Tolerance:** A tolerance of ±2.5 percent shall be permissible on discharge. However, for small discharge up to 9000 litres per minute, a tolerance of ±2.5 percent or +24 litres per minute whichever is higher is allowed. While the negative tolerance 2.5 percent is maintained.

The pump efficiency shall be not less than the specified valve by more than 2.5 percent. This tolerance may be raised to 5 percent in case the prime mover does not get overloaded.

6.5 GENERAL REQUIREMENTS:

The specified range shall lie on the stable portion of the head characteristic curve. This is applicable in case of parallel operations of pumps only.
**Suction and delivery ends:** The size of the suction end of a double suction pump should preferably be one size larger than that of the delivery. This is to offset the increased loss in the suction. Typical practices of piping used are: 80/65m, 100/80m, 125/100m, 150/125m, 200/150m and 250/200m etc.,

For a high-pressure pump, a reflux valve shall be connected on the delivery side and a pressure relief valve installed in pumping main outside pump house. Need for surge control devices verified.

**Fluid passages:** All the liquid passages in the casing and the impeller which are inaccessible to machining shall be finished to smooth surface as far as possible.

**Drainage plugs:** Tapped drain holes with plugs shall be provided for draining the fluid that may drip from the sealing arrangement. The sealing arrangement shall be sufficiently deep to provide for sufficient quantity of packing to prevent leakage of air.

**Lantern ring:** In case, where a lantern ring is used in a stuffing box, it shall be sandwiched between rows of pickings and shall be easily removable.

**Casing:** Casing shall be of robust construction and tested to withstand 1.5 times the shut-off pressure or twice the rated pressure whichever is higher.

**Impeller:** The impeller shall be properly balanced along with any other un-machined rotating parts on proper balancing equipment so as not to cause any vibrations.

**Shaft:** The shaft shall be finished to close tolerance at the impeller coupling, pulley and bearing diameters. The impeller, pulley and shaft sleeves shall be firmly secured to the shaft by keys or nuts of both.

**Shaft couplings:** Shaft couplings, where provided, shall be properly aligned and firmly secured to the shaft by keys or nuts on both. The size of the shaft shall be calculated on the basis of the maximum combined shear stress. This shall not exceed 30% of the elastic limit in tension or 18% of the ultimate tensile strength.

The next higher standard size of shaft in accordance with the relevant standard shall be chosen.

The design of the shaft shall also be taken into consideration the critical speed of the shaft, which shall differ from the actual working speed by at least ten percent on either side.

**Bearings:** The bearings should be designed for a minimum life of 20,000 hours. The bearing housings
are designed in such a manner that no liquid being pumped should enter the housing.

The bearing may be ball, roller or sleeve bearings. In the latter case, some sort of thrust bearings is necessary. If sleeve bearings are used, they are to be machined for close running fit. The bearings shall be so designed as to take up the necessary radial load as well as the net hydraulic axial thrust. Bearings shall be lubricated properly.

Where there is a possibility of fluid entering the bearing the pump shall be provided with suitable preventive arrangements for example deflectors.

**Stuffing Boxes:** The stuffing boxes shall be extra deep and provided with a cooling water jacket if so required. In addition, provision for tapping off the leakage liquid shall also be make. The packing materials employed shall be suitable for withstanding special conditions such as temperature, corrosion due to the fluid being handled etc. Wherever possible, suitable mechanical seals may be used.

**Base plates:** The base plates which accommodate the pump and the prime mover, when provided shall be rigid so that alignment is not affected under normal working conditions.

**Prime mover:** the prime mover shall be of such capacity to provide, under working site conditions a power which is more than maximum power required by the pump at any point in the specified range. Should be a specific margin be required by the customer in the power of the prime mover, he should go advise the manufacturer for obtaining the proper recommendations.

**Nameplate:** Every pump shall have a nameplate indicating:

Name and address of the pump manufacturer  
Type, size and serial number of the pump and  
Speed, total head, capacity and corresponding pump input for the duty point.

For corrosive liquids the material of the nameplate shall suitable to withstand the corrosive atmosphere.

7 **MODE OF MEASUREMENT:**

7.1 Representatives from the Contractor and Engineer shall conduct a joint inspection of the Equipments. All the discrepancies observed either incomplete works or defective work should be clearly indicated in the joint inspection report. The mode of measurements given below is for the purpose of measurement and payment and the scope of works shall be as specified elsewhere in the specification.
7.2 MATERIAL SPECIFICATION FOR INTERCONNECTING PIPES, VALVES & ACCESSORIES

The material specification for piping, valves & specialities shall be as explained in earlier sections.

Colour code shall be used to identify pipe material. The CONTRACTOR shall be able to identify on request all random piping prior to any field fabrication/ installation.

The CONTRACTOR shall furnish six (6) copies of certificates for piping for –

Dimensions and Hydrostatic test

7.3 PRESSURE GAUGES

Bourdon type pressure gauges with aluminum casing with a minimum 100 mm dial and appropriate range complete with needle valves shall be provided at the inlet and outlets of pressure reducing valves and the discharge of pumps.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>ITEM DESCRIPTION</th>
<th>OPTIONS / UNIT</th>
<th>DESIGN REQUIREMENT</th>
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<td>2.6</td>
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<td>Base Plate</td>
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Note: For components marked * material test certificates shall be furnished

4.0 ACCESSORIES
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DATA SHEET – B

DATA TO BE FURNISHED BY TENDERER ALONG WITH OFFER
(DOMESTIC WATER PUMPS)

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<td>Make</td>
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<td>Model</td>
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<td>Hydrostatic test pressure</td>
<td>Kg / cm² (g)</td>
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<td>Pump efficiency</td>
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<td>Power input to motor at duty point</td>
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<td>Motor rating –BKW / KW</td>
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CHECKLIST AND PERFORMANCE TEST DATA TO BE PROVIDED AFTER INSTALLATION

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<td>Hydraulic test for casing at 1.5 times design pressure</td>
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Run Test shall be conducted on the following Pumps.

1. Storm water from rain water sumps to raw water sump – submersible pumps
2. Treated cold water sump to OHTs – Variable speed monoblock pump/Hydro-pneumatic pump
3. Flush water sump to OHTs – Variable speed monoblock pump/Hydro-pneumatic pump
4. Sea water sump – Submersible pump
5. Reed bed treated water sump to Flush water sump – submersible pump
6. HVAC pump – submersible pump
DATA TO BE FURNISHED BY THE CONTRACTOR AFTER AWARD OF CONTRACT AND BEFORE INSTALLATION

Quality Assurance Plan (QAP)

Detailed dimensioned general arrangement drawing of pump and driver.

Foundation drawing of pump and driver with static and dynamic loads, details of fixing, grouting and all relevant data required for design of foundation

Cross-section drawing of the pump with complete part list, materials of construction and relevant standards for each part

Pump performance curves flow rate Vs head, BKW, efficiency, NPSHR from zero flow to maximum flow and torque-speed curve

Scheme for pump sealing, lubrication and cooling

Driver dimensional drawing

Surface preparation and painting procedures

Catalogues, data sheets and drawings for instruments

Installation, operation and maintenance manual

Isolation pads and SS or Hot dip galvanised foundation bolts provided by the Contractor.

Core-rubber make metallic bellows shall be provided at suction and discharge.

Pressure gauges with needle valve provided at suction and discharge lines.

All accessories provided to complete the pump installation.

Run Test shall be conducted on the following Pumps.
1.) Storm water from rain water sumps to raw water sump – submersible pumps.

2.) Treated cold water sump to OHTs – Variable speed monoblock pump/Hydro-pneumatic pump.

3.) Flush water sump to OHTs – Variable speed monoblock pump/Hydro-pneumatic pump.

4.) Sea water sump – Submersible pump

5.) Reed bed treated water sump to Flush water sump – submersible pump

6.) HVAC pump – submersible pump
8.0 SOLAR WATER HEATER

DESIGN

Solar capacity: 1000L of 1 number
: 500 L of 1 number
: 250L on 1 number

Solar Collectors
Temperature: 60º C
Solar Energy absorption: 5.5 kwh /sqm /Day
Collector Inclination: 24/32 degree

HEADER PIPE

Material: Birla Copper, 99%
Dia: 25.5mm
Wall thickness: 0.71mm

RISER PIPE

Material: Birla Copper, 99%
Dia: 12.5mm
Wall thickness: 0.56mm
No. of raiser: 2 Nos.
Absorber Absorptivity: 0.93
Emmisivity: 0.18
Bonding between Header and Riser: Continuous Ultrasonic tig welding
Bonding Between Riser and Sheet: Continuous Brazing

ABSORBER SHEET

Material: Birla Copper, 99%
Thickness: 0.19 mm
Absorber Coating: Black chrome
STORAGE TANK

Material: 304-2B Stainless steel

Thickness: 1.5mm for 1000 ltrs capacity
Insulation: 100mm thick 100Kg/m3 density-LRB water proofing 22SWG Alum cladding

OUTER CLADDING

Material: Precision engineered and non-corrosive outer shell, providing high quality of insulation for winter conditions.

Inter connecting pipes: Stainless steel 304

Insulation and Sheet: Thermal PU foam insulation with a solimide mix (thermal grade) Over 40% energy saving and more efficient than rock wool. Rated for up to 160 deg C.

ELECTRICAL BACK-UP

Make: Swarna (ISI marked)
Capacity: Depends on capacity
Thermostat: 0 to 90 degrees

SACRIFICING ANODE

Material: Aluminium
Application: For avoiding hardness in water

STORAGE TANKS STANDS

Material: Mild Steel

Thickness: 35x35x5mm for 1000LPD system
9.0 WATER TREATMENT PLANT – TECHNICAL SPECIFICATIONS

A. GENERAL

As the source of raw water is still to be decided, the following characteristics are referred as guidelines for the tenderers to submit the offers for the Softener Plant.

B. BASIC DATA ON RAW WATER (BASED ON WATER TEST REPORT)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>52 KLD</td>
</tr>
<tr>
<td>pH</td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td></td>
</tr>
<tr>
<td>Total Hardness as Caco3</td>
<td></td>
</tr>
<tr>
<td>Chloride as Cl</td>
<td></td>
</tr>
<tr>
<td>E-Coli per 100 ml</td>
<td></td>
</tr>
</tbody>
</table>

C. TREATED WATER QUALITY

The Treated Water quality shall be within the following values for various parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.0 – 7.5</td>
</tr>
<tr>
<td>TDS</td>
<td>&lt; 50 mg/L</td>
</tr>
<tr>
<td>Total Hardness as Caco3</td>
<td>&lt; 10 mg/L</td>
</tr>
<tr>
<td>Chloride as Cl</td>
<td>&lt; 200 mg/L</td>
</tr>
<tr>
<td>E-Coli Bacteria per 100 ml</td>
<td>Nil</td>
</tr>
</tbody>
</table>

All other Parameters as per desirable limit BIS (IS 10500-91) for drinking water standard

Treated water to meet the Drinking water, Boiler input quality standards

D. EQUIPMENT SPECIFICATION

a) Filter Feed Pumps

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>2 nos. (1 working + 1 standby)</td>
</tr>
<tr>
<td><strong>Duty</strong></td>
<td>To transfer clear water.</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Horizontal centrifugal non-clog open impeller, pumps each to deliver <strong>3.5m³/hr @ 30m</strong> head</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td>TEFC Motor, with IP-55 protection and suitable for 400/440 V, 50 Hz A/c</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Body in CI and impeller in Bronze</td>
</tr>
<tr>
<td><strong>Accessories</strong></td>
<td>Air cock with priming funnel, flexible coupling with guard, Base frame, foundation bolts etc.,</td>
</tr>
</tbody>
</table>

b) Transfer Pumps

<table>
<thead>
<tr>
<th><strong>Quantity</strong></th>
<th>2 nos (1 working + 1 standby)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duty</strong></td>
<td>To transfer treated effluent From softener to treated water tank</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Submersible non-clog pumps each to Deliver <strong>3.5m³/hr @ 30m</strong></td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td>TEFC Motor, with IP-55 Protection and suitable for 400/440 V, 50 HZ A/c</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Body in CI and impeller in Bronze</td>
</tr>
<tr>
<td><strong>Accessories</strong></td>
<td>Air cock with priming funnel, Flexible Coupling with guard, Base frame, foundation Bolts etc.</td>
</tr>
</tbody>
</table>
c) **RO FEED PUMPS**

- **Quantity**: 2 No. (1 Work + 1 Std by)
- **Capacity**: 3500 LPH
- **Material of Construction**: CI Pump with SS impeller, Shaft & Casing

d) **Pressure Sand and Activated carbon filter**

- **Quantity**: 1 no. each
- **Flow rate**: 3.5 m3/hr
- **Working hours**: 16 hrs (range - 16 to 18 hrs)

f) **ANTISCALANT DOSING SYSTEM**

- **Dosing pump**: 1No
- **Capacity**: Max 2 LPH
- **Dosage**: 3 gm/1000 L

g) **MICRON FILTER**

- **Capacity**: 3500 LPH
- **Operating Pressure**: 4 to 4.5 kg/sq cm max

h) **REVERSE OSMOSIS SYSTEM**

- **Feed Flow rate**: 3400 LPH
- **Treated Water Flow Rate**: 2300 LPH
- **Reject (Waste) Water Flow Rate**: 980 LPH
- **No. of High Pressure Pumps**: 2 No. (1 W + 1 S)
- **Treated Water Quality**:
  - TDS < 50 PPM
  - Hardness < 10 PPM
  - PH 6.0 to 7.0

i) **Softener feed Pumps**

- **Quantity**: 2 nos (1 working + 1 standby)
- **Duty**: To transfer filtered water
- **Type**: Monoblock pumps each to Deliver **3.5m3/hr @ 30m** Head
Motor : TEFC Motor, with IP-55 Protection and suitable for 400/440 V, 50 HZ A/c supply of

Material of Construction : Body in CI and impeller in Bronze

Accessories : Air cock with priming funnel, Flexible Coupling with guard, Base frame, foundation Bolts etc.

j) Softener : 1 No.
Flow rate : 3.5m3/hr

k) pH CORRECTION DOSING SYSTEM

Dosing pump : 1No
Capacity : Max 2 LPH

Chemical : Caustic Soda
Dosage : 3-5 gm/1000 L

E. LIST OF MAKES FOR WTP

<table>
<thead>
<tr>
<th>SL NO</th>
<th>DESCRIPTION</th>
<th>RECOMMENDED MAKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FILTER FEED PUMPS</td>
<td>GRUNDFOS/ KIRLOSKAR</td>
</tr>
<tr>
<td>2</td>
<td>PRESSURE SAND FILTER</td>
<td>CONTRACTORS MAKE</td>
</tr>
<tr>
<td>3</td>
<td>ACTIVATED CARBON FILTER</td>
<td>CONTRACTORS MAKE</td>
</tr>
<tr>
<td>4</td>
<td>SOFTENER FEED PUMPS</td>
<td>GRUNDFOS/KIRLOSKAR/ JHONSON</td>
</tr>
<tr>
<td>5</td>
<td>SOFTENER SYSTEM</td>
<td>THERMAX/ION EXCHANGE</td>
</tr>
<tr>
<td>6</td>
<td>CHLORINATOR</td>
<td>ASIA LMI/SAFEX</td>
</tr>
<tr>
<td>7</td>
<td>LT PANEL</td>
<td>L&amp;T</td>
</tr>
<tr>
<td>8</td>
<td>CABLES</td>
<td>FINOLEX</td>
</tr>
</tbody>
</table>
DATA SHEET

CHEMICAL DOSING UNIT WITH METERING PUMP

TANK:

Capacity in Litre : 

Diameter : 

Height : 

Design flow : 

Chemicals required at : 

Design flow rate : 

Holding period : 

Dia of Inlet : 

Dia of Outlet : 

Dia of Drain : 

MATERIAL OF CONSTRUCTION

Tank : 

Valves : 

Piping : 

METERING PUMP
Make : 
Model No : 
Construction detail : 
Duty Conditions : 
Accessories Included : 

With the pump

Note:
1) All information to be filled by Supplier
2) This Data Sheet to be filled for each unit separately

DATA SHEET

FILTER FEED PUMPS

Make : 
Model : 
Type : 
Flow rate lts/Sec : 
Discharge pressure : 
Material : 
Casing : 
Impeller : 
Seal : 
Motor : 
Type : 
Make : 
Drive : 

Rating : 
RPM : 
Enclosure : 
Class of Insulation :
PRESSURE SAND FILTERS

DATA SHEET

Make : 
Model : 
Material : 
Capacity : 
Design Flow : 
Size of inlet/outlet : 
Type of vessel : 
Dia of vessel : 
Design pressure : 
Height : 
Media : 
Dished end thickness : 
Shell thickness : 
Corrosion allowance : 
Dia of man way : 
Internal protection : 
External protection : 
Applicable code for design and fabrication : 
Rate of filtration : 
Filtering area : 
Filtering media : 
Back wash duration : 
Back wash time : 

238/498
SAND FILTERS

<table>
<thead>
<tr>
<th>Material</th>
<th>Cum.Vol</th>
<th>Layer</th>
<th>Thickness</th>
<th>Eff</th>
<th>Size</th>
<th>Uniformity Co-efficient</th>
</tr>
</thead>
</table>

Valves to be supplied by the filter supplier shall be furnished in the following table:

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Dia</th>
<th>Type</th>
<th>Make</th>
<th>Number</th>
<th>Material</th>
<th>Applicable Code</th>
</tr>
</thead>
</table>

ACTIVATED CARBON FILTERS

DATA SHEET

Make : 
Model : 
Material : 
Capacity : 
Design Flow : 
Size of inlet/outlet : 
Type of vessel : 
Dia of vessel : 
Design pressure : 
Height : 
Media : 
Dished end thickness : 

239/498
Shell thickness :
Corrosion allowance :
Dia of man way :
Internal protection :
External protection :
Applicable code for design and fabrication :
Rate of filtration :

Filtering area :

Filtering media :
Back wash duration :
Back wash time :

**ACTIVATED CARBON FILTERS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Cum.Vol</th>
<th>Layer</th>
<th>Thickness</th>
<th>Eff</th>
<th>Size</th>
<th>Uniformity Co-efficient</th>
</tr>
</thead>
</table>

Valves to be supplied by the filter supplier shall be furnished in the following table:

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Dia</th>
<th>Type</th>
<th>Make</th>
<th>Number</th>
<th>Material</th>
<th>Applicable Code</th>
</tr>
</thead>
</table>


<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Flow rate lts/Sec</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>Casing</td>
<td></td>
</tr>
<tr>
<td>Impeller</td>
<td></td>
</tr>
<tr>
<td>Seal</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Make</td>
<td></td>
</tr>
<tr>
<td>Drive</td>
<td></td>
</tr>
<tr>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>RPM</td>
<td></td>
</tr>
<tr>
<td>Enclosure</td>
<td></td>
</tr>
<tr>
<td>Class of Insulation</td>
<td></td>
</tr>
</tbody>
</table>
DATA SHEET

ANTISCALANT DOSING SYSTEM

Dosing Pump
a Nos :
b Make :
c Type :
d Capacity :
e Mounting :
  Storage Tank Capacity, Type :
  Chemical :
  Dosage :

pH CORRECTION DOSING SYSTEM

Dosing Pump
a Nos :
b Make :
c Type :
d Capacity :
e Mounting :
  Storage Tank Capacity, Type :
  Chemical :
  Dosage :

DATA SHEET

WATER SOFTENER SYSTEM

Make :
Model :
Diameter (mm) :
Height (mm) :
Internal Finish :
External Finish :
Resin Quantity :
OUTPUT / REGN
Inlet Hardness : 
Material of construction : 
Working Pressure (kg/cm^2) : 
Service flow rate (M3/hr) : 
Salt required/Regn : 

MICRON FILTER

Make : 
Model : 
Capacity : 
MOC of housing : 
No of Cartridge : 
Size of Cartridge : 
Cartridge Rating : 
Operating Pressure : 

DATA SHEET

REVERSE OSMOSIS SYSTEM

Make : 
Model : 
Feed Flow rate : 
Treated water Flow rate : 
Reject (Waste) water flow rate : 
No of RO Membrane : 
Membrane Type : 
Membrane size : 
Membrane specification : 
Membrane Make : 
No of Membrane housing : 
Size of module housing : 
High Pressure pump : 
No of High Pressure Pump : 
Motor HP : 
Instrumentation : 
Accessories : 
DATA SHEET

DATA TO BE FURNISHED BY THE CONTRACTOR AFTER AWARD OF CONTRACT AND ‘BEFORE’ INSTALLATION

1. Quality Assurance Plan (QAP)

2. Detailed dimensioned general arrangement drawing of pump and driver.

3. Foundation drawing of pump and driver with static and dynamic loads, details of fixing, grouting and all relevant data required for design of foundation

4. Cross-section drawing of the pump with complete part list, materials of construction and relevant standards for each part

5. Pump performance curves flow rate Vs head, BKW, efficiency, NPSHR from zero flow to maximum flow and torque-speed curve

6. Scheme for pump sealing, lubrication and cooling

7. Driver dimensional drawing

8. Surface preparation and painting procedures

9. Catalogues, data sheets and drawings for instruments

10. Installation, operation and maintenance manual

11. Isolation pads and SS or Hot dip galvanized foundation bolts provided by the Contractor.

12. Cork-rubber make metallic bellows shall be provided at suction and discharge.

13. Pressure gauges with needle valve provided at suction and discharge lines.

14. All accessories provided to complete the pump installation.
## DATA SHEET

**CHECKLIST AND PERFORMANCE TEST DATA TO BE PROVIDED AFTER INSTALLATION**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Unit</th>
<th>10.00</th>
<th>12.00</th>
<th>14.00</th>
<th>16.00</th>
<th>18.00</th>
<th>20.00</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Suction pressure</td>
<td>Kg/cm²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Discharge pressure</td>
<td>Kg/cm²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Water flow rate</td>
<td>M³/hr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Current</td>
<td>Amps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Bed plate levels and alignment checks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Hydraulic test for casing at 1.5 times design pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Noise level from pump</td>
<td>1.8m dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Discharge Vs head</td>
<td>Mtr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Discharge Vs efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Discharge Vs BkW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Run Test shall be conducted on the following Pumps.

1. Filter feed pumps.
2. Softener feed pumps.
3. RO feed pumps
CHECKLIST AND PERFORMANCE TEST DATA TO BE PROVIDED AFTER INSTALLATION

A  RAW WATER

Quantity : 52 KLD

pH :
TDS :
Total Hardness as Caco3 :
Chloride as Cl :
E-Coli per 100 ml :

B  TREATED WATER QUALITY

pH :
TDS :
Total Hardness as Caco3 :
Chloride as Cl :
E-Coli Bacteria per 100 ml :
10.0 WASTE WATER TREATMENT – TECHNICAL SPECIFICATIONS

A. GENERAL

As the source of raw water is still to be decided, the following characteristics are referred as guidelines for the tenderers to submit the offers for the Softener Plant.

B. BASIC DATA ON RAW WATER (ASSUMED)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>10 KLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.0 – 8.5</td>
</tr>
<tr>
<td>BOD₅ @ 20 ºC</td>
<td>100 mg/L</td>
</tr>
<tr>
<td>COD</td>
<td>150 mg/L</td>
</tr>
<tr>
<td>TSS</td>
<td>140 mg/L</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>60 mg/L</td>
</tr>
</tbody>
</table>

C. TREATED WATER QUALITY

The Treated Water quality shall be within the following values for various parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.0 – 9.0</td>
</tr>
<tr>
<td>BOD₅ @ 20 ºC</td>
<td>≤ 10 mg/L</td>
</tr>
<tr>
<td>COD</td>
<td>&lt; 20 mg/L</td>
</tr>
<tr>
<td>E-Coli</td>
<td>Nil</td>
</tr>
<tr>
<td>Turbidity</td>
<td>≤ 2 NTU</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>Nil</td>
</tr>
<tr>
<td>Residual chlorine</td>
<td>≥1 mg/L</td>
</tr>
</tbody>
</table>

Treated water to meet the Drinking water, Boiler input quality standards

D. EQUIPMENT SPECIFICATION

a) Filter Feed Pumps

<table>
<thead>
<tr>
<th>Quantity</th>
<th>2 nos. (1 working + 1 standby)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty</td>
<td>To transfer clear water.</td>
</tr>
<tr>
<td>Type</td>
<td>Horizontal centrifugal non-clog open impeller, pumps each to deliver <strong>1 m³/hr @ 30m head</strong></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Motor</td>
<td>TEFC Motor, with IP-55 protection and suitable for 400/440 V, 50 HZ A/c</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Body in CI and impeller in Bronze</td>
</tr>
<tr>
<td>Accessories</td>
<td>Air cock with priming funnel, flexible coupling with guard, Base frame, foundation bolts etc.,</td>
</tr>
</tbody>
</table>

b) Transfer Pumps (if required)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>2 nos (1 working + 1 standby)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty</td>
<td>To transfer treated effluent</td>
</tr>
<tr>
<td></td>
<td>From reed bed treated water collection tank to treated water sump</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Submersible non-clog pump each to Deliver <strong>1 m³/hr @ 30m</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>TEFC Motor, with IP-55 Protection and suitable for Body in CI and impeller in Bronze</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Body in CI and impeller in Bronze</td>
</tr>
<tr>
<td>Accessories</td>
<td>Air cock with priming funnel, Flexible Coupling with guard, Base frame, foundation Bolts etc.</td>
</tr>
</tbody>
</table>
c) Pressure Sand and Activated carbon filter

Quantity : 1 no. each

Flow rate : 1 m3/hr

Working hours : 16 hrs (range - 16 to 18 hrs)

**Treated Water Quality**

- TDS < 50 PPM
- Hardness < 10 PPM
- PH 6.0 to 7.0

h) pH Correction Dosing System

Dosing pump : 1No

Capacity : Max 1 LPH

Chemical : Caustic Soda

Dosage : 3-5 gm/1000 L

E. LIST OF MAKES FOR WTP

<table>
<thead>
<tr>
<th>SL NO</th>
<th>DESCRIPTION</th>
<th>RECOMMENDED MAKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FILTER FEED PUMPS</td>
<td>GRUNDFOS/KIRLOSKAR</td>
</tr>
<tr>
<td>2</td>
<td>PRESSURE SAND FILTER</td>
<td>CONTRACTORS MAKE</td>
</tr>
<tr>
<td>3</td>
<td>ACTIVATED CARBON FILTER</td>
<td>CONTRACTORS MAKE</td>
</tr>
<tr>
<td>4</td>
<td>SOFTENER FEED PUMPS</td>
<td>GRUNDFOS/KIRLOSKAR/ JHONSON</td>
</tr>
<tr>
<td>5</td>
<td>SOFTENER SYSTEM</td>
<td>THERMAX/ION EXCHANGE</td>
</tr>
<tr>
<td>6</td>
<td>CHLORINATOR</td>
<td>ASIA LMI/SAFEX</td>
</tr>
<tr>
<td>7</td>
<td>LT PANEL</td>
<td>L&amp;T</td>
</tr>
<tr>
<td>8</td>
<td>CABLES</td>
<td>FINOLEX</td>
</tr>
</tbody>
</table>
DATA SHEET

CHEMICAL DOSING UNIT WITH METERING PUMP

TANK:

Capacity in Litre : 

Diameter : 

Height : 

Design flow : 

Chemicals required at : 

Design flow rate : 

Holding period : 

Dia of Inlet : 

Dia of Outlet : 

Dia of Drain : 

MATERIAL OF CONSTRUCTION

Tank : 

Valves : 

Piping : 

METERING PUMP

Make : 

Model No : 

Construction detail :
Duty Conditions  :
Accessories Included  :
With the pump

Note:
1) All information to be filled by Supplier
2) This Data Sheet to be filled for each unit separately

DATA SHEET

FILTER FEED PUMPS

Make  :
Model  :
Type  :
Flow rate lts/Sec  :
Discharge pressure  :
Material  :
Casing  :
Impeller  :
Seal  :
Motor  :
Type  :
Make  :
Drive  :
Rating  :
RPM  :
Enclosure  :
Class of Insulation  :

PRESSURE SAND FILTERS
DATA SHEET

Make : 
Model : 
Material : 
Capacity : 
Design Flow : 
Size of inlet/outlet : 
Type of vessel : 
Dia of vessel : 
Design pressure : 
Height : 
Media : 
Dished end thickness : 
Shell thickness : 
Corrosion allowance : 
Dia of man way : 
Internal protection : 
External protection : 
Applicable code for design and fabrication : 
Rate of filtration : 
Filtering area : 
Filtering media : 
Back wash duration : 
Back wash time : 

SAND FILTERS

<table>
<thead>
<tr>
<th>Material</th>
<th>Cum.Vol</th>
<th>Layer</th>
<th>Thickness</th>
<th>Eff</th>
<th>Size</th>
<th>Uniformity Co-efficient</th>
</tr>
</thead>
</table>

252/498
Valves to be supplied by the filter supplier shall be furnished in the following table:

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Dia</th>
<th>Type</th>
<th>Make</th>
<th>Number</th>
<th>Material</th>
<th>Applicable Code</th>
</tr>
</thead>
</table>

**ACTIVATED CARBON FILTERS**

**DATA SHEET**

Make : 
Model : 
Material : 
Capacity : 
Design Flow : 
Size of inlet/outlet : 
Type of vessel : 
Dia of vessel : 
Design pressure : 
Height : 
Media : 
Dished end thickness : 
Shell thickness : 
Corrosion allowance : 
Dia of man way : 
Internal protection : 
External protection :
Applicable code for design and fabrication:
Rate of filtration:
Filtering area:
Filtering media:
Back wash duration:
Back wash time:

**ACTIVATED CARBON FILTERS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Cum.Vol</th>
<th>Layer</th>
<th>Thickness</th>
<th>Eff</th>
<th>Size</th>
<th>Uniformity Co-efficient</th>
</tr>
</thead>
</table>

Valves to be supplied by the filter supplier shall be furnished in the following table:

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Dia</th>
<th>Type</th>
<th>Make</th>
<th>Number</th>
<th>Material</th>
<th>Applicable Code</th>
</tr>
</thead>
</table>

**DATA SHEET**

**ANTISCALANT DOSING SYSTEM**

Dosing Pump
a Nos : 

b Make : 

c Type : 

d Capacity : 

254/498
pH CORRECTION DOSING SYSTEM

Dosing Pump

a Nos : 
b Make : 
c Type : 
d Capacity : 
e Mounting :
  Storage Tank Capacity, Type :
  Chemical :
  Dosage : 

DATA SHEET

DATA TO BE FURNISHED BY THE CONTRACTOR AFTER AWARD OF CONTRACT AND 'BEFORE' INSTALLATION

15. Quality Assurance Plan (QAP)

16. Detailed dimensioned general arrangement drawing of pump and driver.

17. Foundation drawing of pump and driver with static and dynamic loads, details of fixing, grouting and all relevant data required for design of foundation

18. Cross-section drawing of the pump with complete part list, materials of construction and relevant standards for each part

19. Pump performance curves flow rate Vs head, BKW, efficiency, NPSHR from zero flow to maximum flow and torque-speed curve

20. Scheme for pump sealing, lubrication and cooling

21. Driver dimensional drawing

22. Surface preparation and painting procedures

23. Catalogues, data sheets and drawings for instruments
24. Installation, operation and maintenance manual

25. Isolation pads and SS or Hot dip galvanized foundation bolts provided by the Contractor.

26. Cork-rubber make metallic bellows shall be provided at suction and discharge.

27. Pressure gauges with needle valve provided at suction and discharge lines.

28. All accessories provided to complete the pump installation.
DATA SHEET

CHECKLIST AND PERFORMANCE TEST DATA TO BE PROVIDED AFTER INSTALLATION

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Unit</th>
<th>Time</th>
<th>Date</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.00</td>
<td>12.00</td>
<td>14.00</td>
</tr>
<tr>
<td>21.</td>
<td>Suction pressure</td>
<td>Kg/cm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Discharge pressure</td>
<td>Kg/cm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Water flow rate</td>
<td>M³/hr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>Current</td>
<td>Amps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Bed plate levels and alignment checks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>Hydraulic test for casing at 1.5 times design pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Noise level from pump</td>
<td>1.8m dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>Discharge Vs head</td>
<td>Mtr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>Discharge Vs efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>Discharge Vs BkW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Run Test shall be conducted on the following Pumps.

1. Filter feed pumps.
2. Softener feed pumps.
CHECKLIST AND PERFORMANCE TEST DATA TO BE PROVIDED AFTER INSTALLATION

A  RAW WATER

Quantity :  10 KLD

pH :
TDS :
Total Hardness as Caco3 :
Chloride as Cl :
E-Coli per 100 ml :

B  TREATED WATER QUALITY

pH :
TDS :
Total Hardness as Caco3 :
Chloride as Cl :
E-Coli Bacteria per 100 ml :
### 11.0 LIST OF RECOMMENDED MAKES OF MATERIALS

#### INSTALLATION

<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Recommended Brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Galvanized Pipes</td>
<td>TATA/JINDAL / Jindal-Hissar / Prakash-Surya / B.S.T., SAIL, Bansal</td>
</tr>
<tr>
<td>2</td>
<td>GI fittings</td>
<td>R Brand / New Brand (ISI) / Unik, K.S. / Zoloto</td>
</tr>
<tr>
<td>3</td>
<td>CPVC pipes &amp; fittings</td>
<td>Ashirvad / Astral / Ajay / Supreme</td>
</tr>
<tr>
<td>4</td>
<td>Gate valves/Non-return valves</td>
<td>Audco/Hawk/Zoloto</td>
</tr>
<tr>
<td>5</td>
<td>Foot valves</td>
<td>Audco / Hawk/Zoloto / Leader</td>
</tr>
<tr>
<td>6</td>
<td>Pipe supports</td>
<td>Hi-Tech pipe Support System</td>
</tr>
<tr>
<td>7</td>
<td>Liquid level indicator</td>
<td>Techtron / SBEM</td>
</tr>
<tr>
<td>8</td>
<td>Liquid level controllers</td>
<td>Techtron / SBEM</td>
</tr>
<tr>
<td>9</td>
<td>UPVC pipes &amp; fittings</td>
<td>Supreme/Kisan/Prince</td>
</tr>
<tr>
<td>10</td>
<td>Pipe protection tape (PVC) underground</td>
<td>Pipe coat / Tapex</td>
</tr>
<tr>
<td>11</td>
<td>Manhole frame &amp; cover</td>
<td>Southern Concrete Industries</td>
</tr>
<tr>
<td>12</td>
<td>Manhole PVC steps</td>
<td>Southern Concrete Industries</td>
</tr>
<tr>
<td>13</td>
<td>CI manhole frame &amp; Cover</td>
<td>Neco / RIF / NECO / B.C. / B.I.C.</td>
</tr>
<tr>
<td>14</td>
<td>Butterfly valve</td>
<td>Audco/Leader</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Manufacturer/Supplier</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>15</td>
<td>Connection pipe</td>
<td>Kohinoor (High Pressure)</td>
</tr>
<tr>
<td>16</td>
<td>UPVC pressure pipes (schedule 40) &amp; fittings</td>
<td>Supreme/Kissan/Prince</td>
</tr>
<tr>
<td>17</td>
<td>Ball Valve</td>
<td>Zoloto/ RB / Leader / Sant / Jayco</td>
</tr>
<tr>
<td>18</td>
<td>Pressure Gauge</td>
<td>H Guru / Bourdon / Gluck / KI international</td>
</tr>
<tr>
<td>19</td>
<td>Pumps &amp; Motors</td>
<td>Kirloskar</td>
</tr>
<tr>
<td>20</td>
<td>Pressure relief Valves</td>
<td>Leader / CG/Teleflo</td>
</tr>
<tr>
<td>21</td>
<td>RCC pipes</td>
<td>Indian hume pipes / Spun pipe co</td>
</tr>
<tr>
<td>22</td>
<td>PVC Special trap</td>
<td>Clarion Engineering</td>
</tr>
<tr>
<td>23</td>
<td>Water meter</td>
<td>Kaycee / Capstan/Aqua met</td>
</tr>
<tr>
<td>24</td>
<td>Anchor bolts, nut &amp; fastener</td>
<td>Hilti</td>
</tr>
<tr>
<td>25</td>
<td>Perforated pre cast cover slab for drain and catch basin</td>
<td>Southern concrete industries</td>
</tr>
<tr>
<td>26</td>
<td>HDPE pipes</td>
<td>HASTI / MANIKYA / GODAWARI / KISAN</td>
</tr>
<tr>
<td>27</td>
<td>PVC Gully trap</td>
<td>Supreme/ Kisan</td>
</tr>
<tr>
<td>28</td>
<td>Air vents</td>
<td>Hwak/Zoloto/Anergy</td>
</tr>
<tr>
<td>29</td>
<td>Pressure reducing valves</td>
<td>Hawk/Zoloto</td>
</tr>
<tr>
<td>30</td>
<td>Insulation for hot water piping</td>
<td>Vedoflex / Armaflex</td>
</tr>
<tr>
<td>31</td>
<td>Y strainers</td>
<td>Leader/Hawk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>32</td>
<td>C.P. Fittings Mixer/Pillar taps Washers, C.P. brass accessories and Sanitary fittings</td>
<td>Parryware / Hind ware / Toto / Hindustan Sanitary ware / Cera / Neycer / Jaquar / Hansgrohe / Sanfire / Parko / Kingston / Aquaplush / Ceramix / Zoloto, Sant, L&amp;K / Nova or equivalent</td>
</tr>
<tr>
<td>33</td>
<td>Gunmetal Valves</td>
<td>Zoloto, Leader, Sant, Kilburn</td>
</tr>
<tr>
<td>34</td>
<td>Stainless Steel Sink</td>
<td>AMC / Orient / Nirali / Suhag / Jayna / Commander</td>
</tr>
<tr>
<td>35</td>
<td>Plastic seat cover of W.C</td>
<td>Commander / Bestolite / Diplomat / Jaquar / Sona</td>
</tr>
<tr>
<td>36</td>
<td>Check valve/ Non return Valve</td>
<td>Advance / Intervalve</td>
</tr>
<tr>
<td>37</td>
<td>Solar Water Heater</td>
<td>Tata BP / EMMVEE</td>
</tr>
<tr>
<td>38</td>
<td>Geysers</td>
<td>A O Smith / Spherehot / Racold / Batliboi / Venus / Voltas / Usha Lexus</td>
</tr>
<tr>
<td>39</td>
<td>Drain Elbow, End Seal Coupling, End Seal</td>
<td>Victaulic</td>
</tr>
<tr>
<td>40</td>
<td>Centrifugally / Sand cast iron pipes &amp; fittings</td>
<td>R.I.F., j.NECO, B.C., B.I.C., ISP, SKF</td>
</tr>
<tr>
<td>41</td>
<td>Water tank</td>
<td>Sintex, Polycon, or equivalent</td>
</tr>
<tr>
<td>42</td>
<td>Mirror</td>
<td>Golden / Atul / Modi guard (GG)</td>
</tr>
</tbody>
</table>
## 12. SANITARY & CP FITTINGS

<table>
<thead>
<tr>
<th>Sl no.</th>
<th>Description of fitting &amp; Make</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>European Water Closet</td>
<td><img src="image1" alt="European Water Closet" /></td>
</tr>
<tr>
<td>5</td>
<td>Cistern (2/4)</td>
<td><img src="image2" alt="Cistern (2/4)" /></td>
</tr>
<tr>
<td>8</td>
<td>Wash Basin (Top Counter)</td>
<td><img src="image3" alt="Wash Basin (Top Counter)" /></td>
</tr>
<tr>
<td>9</td>
<td>Urinal with Sensor</td>
<td><img src="image4" alt="Urinal with Sensor" /></td>
</tr>
<tr>
<td>10</td>
<td>Urinal without sensor</td>
<td><img src="image5" alt="Urinal without sensor" /></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Pillar Cock with Aerator</td>
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</tr>
<tr>
<td>12</td>
<td>Urinal Partition</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Health Faucet with 8mm dia, 1 meter long flexible tube</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Angular Stop Cock</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Two way bib cock</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Bib Cock</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Towel Ring</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Kitchen Sink</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Kitchen Sink Without Drain Board</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Hinged Grab Bar</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Bottle Trap (with internal Partition) 32mm size with 250mm long wall connection pipes &amp; Wall Flange</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Long body bib cock</td>
<td></td>
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</tbody>
</table>
13. LIST OF DRAWINGS

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>DRAWING NO.</th>
<th>DRAWING TITLE</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>P-101</td>
<td>GENERAL NOTES, LEGENDS, ABBREVIATIONS &amp; LIST OF DRAWINGS</td>
</tr>
<tr>
<td>02</td>
<td>P-102</td>
<td>RAIN WATER DISPOSAL &amp; WATER SUPPLY LAYOUT- SITE PLAN</td>
</tr>
<tr>
<td>03</td>
<td>P-103</td>
<td>SEWAGE &amp; WASTE WATER DISPOSAL LAYOUT- SITE PLAN</td>
</tr>
<tr>
<td>04</td>
<td>P-104</td>
<td>TOILET &amp; SHAFT INDICATION LAYOUT-GROUND FLOOR PLAN</td>
</tr>
<tr>
<td>05</td>
<td>P-105</td>
<td>TOILET &amp; SHAFT INDICATION LAYOUT- FIRST FLOOR PLAN</td>
</tr>
<tr>
<td>06</td>
<td>P-106</td>
<td>TOILET &amp; SHAFT INDICATION LAYOUT- SECOND FLOOR PLAN</td>
</tr>
<tr>
<td>07</td>
<td>P-107</td>
<td>TOILET &amp; SHAFT INDICATION LAYOUT- THIRD FLOOR PLAN</td>
</tr>
<tr>
<td>08</td>
<td>P-108</td>
<td>RAIN WATER DISPOSAL – TERRACE FLOOR PLAN</td>
</tr>
<tr>
<td>09</td>
<td>P-109</td>
<td>WATER SUPPLY LAYOUT – TERRACE FLOOR PLAN</td>
</tr>
<tr>
<td>10</td>
<td>P-110</td>
<td>PLUMBING LAYOUT TOILET DETAILS : 01, 02, 03 AND 11 GROUND FLOOR PLAN</td>
</tr>
<tr>
<td>11</td>
<td>P-111</td>
<td>PLUMBING LAYOUT TOILET DETAILS : 05, 06, 08 AND 12 GROUND AND 1ST TO 3RD FLOOR (TYPICAL) PLAN</td>
</tr>
<tr>
<td>12</td>
<td>P-112</td>
<td>PLUMBING LAYOUT-TOILET DETAILS-04, 07, 09, 10 GROUND &amp; 1st TO 3rd TYP FLOOR PLAN</td>
</tr>
<tr>
<td>13</td>
<td>P-113</td>
<td>WATER RISER DIAGRAM</td>
</tr>
<tr>
<td>14</td>
<td>P-114</td>
<td>SEWAGE, WASTE WATER DOWN COMER DIAGRAM</td>
</tr>
<tr>
<td>15</td>
<td>P-115</td>
<td>RAIN WATER DOWN COMER DIAGRAM</td>
</tr>
<tr>
<td>16</td>
<td>P-116</td>
<td>FIRE, RAW, TREATED &amp; FLUSH WATER SUMP PLAN &amp; SECTION DETAILS</td>
</tr>
<tr>
<td>17</td>
<td>P-117</td>
<td>RAIN WATER COLLECTION SUMP &amp; FILTRATION CHAMBER PLAN &amp; SECTION DETAILS</td>
</tr>
<tr>
<td>18</td>
<td>P-118</td>
<td>FIRE, DOMESTIC &amp; FLUSH WATER OHT PLAN &amp; SECTION DETAILS</td>
</tr>
<tr>
<td>19</td>
<td>P-119</td>
<td>STANDARD FIXING DETAILS</td>
</tr>
<tr>
<td>20</td>
<td>P-120</td>
<td>REED BED SYSTEM, PLAN AND SECTION DETAILS</td>
</tr>
<tr>
<td>21</td>
<td>P-121</td>
<td>DRAIN &amp; PERCOLATION PIT SECTION AND SCHEMATICS</td>
</tr>
</tbody>
</table>
C. Technical Specifications for Electrical

1. GENERAL NOTES:

01. THE RATES QUOTED SHALL INCLUDE ALL TAXES.

02. TAX COMPONENT TO BE SHOWN SEPARATELY IN SUMMARY.

03. MAKE OF THE EQUIPMENTS ALONG WITH TECHNICAL SPECIFICATIONS AND SUPPORTING BROCHURES SHALL BE SUBMITTED ALONG WITH BOQ IN SEALED COVER.

04. TENDER DOCUMENT SHALL BE SUBMITTED AFTER FILLING THE DATA FORM AVAILABLE IN IT DULY SIGNED.

05. HARD COPY OF BOQ DULY SIGNED ONLY WILL BE ACCEPTED (SOFT COPY WILL NOT BE CONSIDERED).

06. WHERE BRAND NAMES AND MAKES ARE SPECIFIED IN THESE TECHNICAL SPECIFICATIONS BELOW, ALL OR ANY EQUIVALENT BRAND OR MAKE WILL ALSO BE ACCEPTABLE. THE SELECTED BIDDER WILL PROVIDE DOCUMENTARY EVIDENCE IN SUPPORT OF THE EQUIVALENCE OF BRAND(S) AND MAKE(S), AND WILL USE SUCH EQUIVALENT BRAND(S) AND MAKE(S) AS AND IF APPROVED BY THE ENGINEER.
2. PHASE 11 KV (22.6 KA) 800A SWITCH GEAR

INTRODUCTION
The switch gear shall be Outdoor type and rated for a fault level of 350 MVA 800 Amps continuous current and shall be suitable for operation on 3phase 3 wire 11 KV earthed system.
The subject Load break switch is to be supplied in accordance with IS regulations and should satisfy EB requirements.
The outdoor Load break switch with kiosk as per the equipment description shall be completely factory assembled and ready for installation at site. The outdoor kiosk shall be of MS sheet metal enclosure having sloppy canopy at the top for the instant draining out water during rain and this enclosure shall be tested for IP 55.

EQUIPMENT DESCRIPTION
The Load break switch shall be the Outdoor type and shall consist of 2 Nos, 11 KV, 800 A, 22.6 KA short time rated, Air break / Load Break Switch and suitably interlocked earth switch, front operated, spring assisted, manual closing mechanism for controlling the incoming supply.
It shall be capable of continuous and reliable operation at full load rating specified, where continuity of operation is of prime importance. Workmanship shall be of highest grade and the entire construction in accordance with the best modern practice. The Load break switch shall be capable of withstanding the severest stress likely to occur in actual service and resisting rough handling.
The Load break switch, Vacuum Circuit breaker and all accessories in the Load break switch shall be as per the detailed specification for each of them and suitable for operation for the system voltage indicated

SYSTEM
The Load break switch shall be suitable for the following system.
Rated voltage : 11 KV 3 phase
Rated frequency : 50 HZ
Fault level : 350 MVA

STANDARD
The design, manufacture and testing of the various equipment covered by this specification shall comply with the latest issue of the following standards:

S 13118 - General requirements of circuit breaker for voltage above 1000 V
IS3427 - Metal enclosed switchgear & Control gear (1 kV to 11Kv)
IS37 - Marking and arrangement of switchgear Bus-Bars
IS 2705 - Specification for current transformers
IS 3156 - Specification for voltage transformers
IS 3231 - Electrical relays for power system protection
IS 1248 - Electrical indication instruments
IS 722 - Integrating meters
IS 6875 - Control switches and push buttons
IS 694 - PVC insulated cable with copper conductor for voltages up to 1100 V for control wiring.
CONSTRUCTION

The switchgear shall be metal clad, free standing, floor mounted, totally enclosed, dust and vermin proof with Load Break Switches assembles in vertical units to form a continuous line up of uniform height and depth.

The panel structure shall house the components with major weight of the equipment such as Load breaker, main horizontal bus-bars and other auxiliary components adequately supported without deformation or loss of alignment during transit & operation.

The Switchgear shall have necessary internal sheet metal barrier to form separate compartments for buses, instruments, realism cable connections etc.

Adequate barriers shall permit the personnel to work safely within an empty compartment with the bus-bars energized. Checking and removal of components shall be possible without disturbing the feeder. All auxiliary equipment shall be easily accessible to facilitate their operation and maintenance. It shall be possible to set all relays and measuring instruments without de-energizing the Switchgear.

Metal clad switchgear cubicle shall comprise rigidly welded structural frame enclosed completely by sheet steel of minimum 2.5 mm (hot rolled) or 2.00 mm (cold rolled) thickness, smooth finished, leveled and free from flaws. All doors, panels and removable covers shall be provided with neoprene gasket all around to make the cubicle dust and vermin proof.

The panels shall have a rear cable chamber housing the cable tri-pod and connections. The design shall ensure generous availability of space for easy installation and maintenance, cabling and adequate safety for working in one section without coming into accidental contact with live part in adjacent section.

The HT switchboard shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as well as the effects of humidity, which are likely to be encountered in normal service. All insulating materials used in construction of the equipment shall be non-hygroscopic materials, duly treated to withstand the effects of high humidity, high temperature tropical ambient service conditions. Creepage distances shall comply to those specified in relevant standards.

The height of the panel shall not be more than 2400 mm. The total depth of the panel shall be adequate to cater for proper cabling space.

Provision shall be made for permanently earthing the frames and the metal parts of the HT switchboard through a copper earth bus-bar running throughout the full length of the switchboard at the bottom.

It shall be possible to extend the switch gear in either direction at a future date. Ends of bus-bars shall be suitable drilled for this purpose.
Suitable eyebolt for lifting of panel shall be provided. On removing the eyebolts no holes offering access to panel shall be provided.

**BUSBARS**

The bus-bars shall be epoxy molded or PVC sleeved and made of high conductivity copper grade. The current in all current carrying paths should not exceed 1.20 A/ sq. mm.

The bus bar chamber shall totally maintenance free.

The switchboard shall comprise 3 phase main bus-bars. The bus bars shall be of uniform section throughout and shall be sized to continuously carry the rated current without exceeding the temperature of 40°C over the maximum ambient temperature of 45°C. The bus bars shall be colour coded for easy identification of individual phases.

Bus-bars shall be supported at regular intervals and both bus-bars and supports shall be adequately sized ad braced to withstand short circuit level without defamation. All bus supports shall be non-carbonizing material resistant to acid alkali and shall have nonhygroscopic characteristics.

For long bus-bars suitable expansion joints shall be provided. Thermal design of the bus-bars shall be based on the installation of the switchgear in poorly ventilated condition.

Bus-bars shall be housed in a separate chamber, which shall be accessible for inspection only with special tools.

The rating of bus-bars shall be same of incomer breaker rating.

**INSULATION LEVELS FOR 11 KV SWITCH UNITS**

The insulation levels corresponding to the rated voltage are:

- Normal voltage : 11 Kv
- Highest system voltage : 12 Kv
- High voltage withstand test for one minute : 28 KV rms
- 1.2/ 50 micro second impulse : 28 KV peak

**Air insulated bus-bars clearance**

- Phase to phase : 130 mm
- Phase to earth : 90mm

**VACCUM/ AIRBREAK/ LOAD BREAK SWICTH PANEL 2 INCOMING 1 OUTGOING**

The air break / load break switch panel shall consist of the following:

One number 11 KV, 800 Amps, 22.6 KV rated HT air break suitable interlocked with earth switch. It shall be with front operated spring assisted manual mechanism & with 2 No + 2 No auxiliary contacts and operating handle.

- ON/OFF indication lamps : 2 nos.
- 800 A copper bus-bars : 1 Set
- Space heater with thermostat and switch control : 1 Set
- Lamp holder with door switch and lamp : 1 Set

Provision to receive the incoming 11 KV, XLPE cable at bottom
The main frame shall be of welded steel and contacts shall be mounted in Epoxy insulation. The upper fixed contact shall house the arc quenching chamber and connecting the terminal. It shall be equipped with spring assisted mechanism due to which constant speed can be achieved during opening and closing and shall be provided with stored energy tripping device. They shall be built as per IS9920/IEC 263. They shall be capable of make and break the normal rated current and shall also make the short current earthed without endangering the operator.

Fully rated earth interlocked with Load break switch shall be provided as per the requirement of EB as a Factory fitted accessory.
3. **11 KV HT METERING PANEL**

**INTRODUCTION**

This specification covers the design, manufacture and supply of 11 KV Switchboard incorporating draw-out vacuum circuit breaker suitable for 11 KV, 3 phase 50 Hz supply system.

The subject breaker is to be supplied in accordance with the GSEB Regulations and requirements.

The 11 KV Switchboard shall be capable of continuous and reliable operation at the full load rating specified where continuity of operation is of prime importance. Workmanship shall be of the highest grade and the entire construction in accordance with the best modern practice. The HT Breaker shall be capable of withstanding the severest stresses likely to occur in actual service and of resisting rough handling during transport.

The HT Switch board shall have only an incoming feeder and two outgoing at present and the panel is to be of extendable type for adding vacuum circuit breaker Panel at later date for receiving/supplying additional source of supplies, if required.

**SYSTEM**

**INCOMER Qty: 1 No**

The HT system shall be suitable for the following:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>11 kV, 3 phase</td>
</tr>
<tr>
<td>Rated Current</td>
<td>800A</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Fault level</td>
<td>500 MVA</td>
</tr>
</tbody>
</table>

**Cubicle Content:**

- **Bus**: Copper
- **Enclosure**: IP55
- **Maximum busbar temp**: 85 °C
- **Circuit breaker type**: Vacuum
- **Operating duty**: O-3 min-CO-3 min CO
- **Control voltage**: 110 V AC

**OUTGOING Qty: 2 Nos**

The HT system shall be suitable for the following:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>11 kV, 3 phase</td>
</tr>
</tbody>
</table>
Rated Current : 800 A  
Rated frequency : 50 Hz  
Fault level : 500 MVA

Cubicle Content:

Bus : Copper  
Enclosure : 1P55  
Maximum busbar temp : 85 ° C  
Circuit breaker type : Vacuum  
Operating duty : O-3 min0-CO-3 min CO  
Control voltage : 110 V AC

STANDARDS

The design, manufacture and testing of the various equipments covered by this specification shall comply with the latest issue of the following standards:

IS 13118 : General requirements of circuit Breaker for Voltages above 1 000V

IS 3427 : Metal enclosed switchgear & Control gear (1 kV to 11 kV)

IS 37 : Marking and arrangement of Switchgear Busbars

IS 2705 : Specifications for current HT Panels

IS 3156 : Specifications for voltage HT Panels

IS 3231 : Electrical relays for power System Protection

IS 1248 : Electrical indicating instruments

IS 722 : Integrating meters

IS 6875 : Control switches and push buttons

IS 694 : PVC insulated cable with copper Conductor  
For Voltages up to 1100 KV for control wiring
SPECIFIC REQUIREMENTS FOR EACH OF INCOMING AND OUTGOING PANELS

Construction

The panel structure shall house the components to the major weight of the equipment such as circuit breaker, main horizontal bus bars and other components that are adequately supported without deformation or loss of alignment during transit & operation.

The Switchgears shall have necessary internal sheet metal barrier to form separate compartments for buses, instruments, relays, cable connections, etc.

Adequate barriers shall permit personnel work safely within an empty compartment with the bus bars energized. Checking and removal of components shall be possible without disturbing the feeder. All auxiliary equipment shall be easily accessible to facilitate their operation and maintenance. It shall be possible to set all relays and measuring instruments without de-energizing the Switchgear.

All doors and openings shall be fitted with neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to prevent the entry of dust.

The panel shall have a rear cable chamber housing the cable and connections. The design shall ensure generous availability of space for easy installation and maintenance. Cabling and adequate safety shall be done for working in one section without coming into accidental contact with live part in an adjacent section.

The HT switchboard shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as well as the effects of humidity, which are likely to be encountered in normal service. All insulating materials used in construction of the equipment shall be non hygroscopic materials, duly treated to withstand the effects of high humidity high temperature tropical ambient service conditions. Creepage distances shall comply with those specified in relevant standards.

The panel shall be provided with space heater to prevent condensation and the same shall be equipped with differential thermostat to automatically cut in and cut out the heater so as to maintain interior at 5 °C above the ambient and should have manual disconnect switch having porcelain base.

The height of the panel shall not be more than 2100 mm the total depth of the panel shall be adequate to cater for proper cabling space.
Provision shall be made for permanently earthing the frames and other metal parts of the HT switchboard through copper earth busbar running throughout the full length of the switchboard at the bottom. Draw-out type switching units shall have sliding ground contact. It shall be possible to earth the switchboard at two independent points on either end for connections to the external earthing network of the plant.

**It shall be possible to extend the switchgear in either direction at a future date. Ends of bus bars shall be suitably drilled for this purpose.**

Suitable lifting Hooks for lifting of panel shall be provided. On removing the lifting hooks suitable plugs shall be provided in order to plug lifting hooks holes. No holes offering access to panel shall be provided.

**BUSBARS**

The bus bars shall be PVC sleeved and made of high conductivity electrolytic grade copper. The current in all current carrying paths should not exceed 1.20 A/sq mm.

The bus bar chamber shall be totally maintenance free.

The switchboard shall comprise 3 phase main bus bars. The bus bar shall be of uniform section throughout and shall be sized to continuously carry the rated current without exceeding the temperature rise of 40°C over the maximum ambient temperature of 45°C. Busbars shall be color coded for easy identification of individual phases.

Bus bars shall be supported at regular intervals and both bus bars and supports shall be adequately sized and to withstand short circuit level without deformation. All bus supports shall be non carbonizing material, resistant to acid alkalis and shall have non hygroscopic characteristics.

For long bus bars, suitable expansion joints shall be provided. Thermal design of the bus bars shall be based on the installation of the switchgear in poorly ventilated condition.

Busbars shall be housed in a separate chamber, which shall be accessible for inspection only with special tools.

The rating of bus bars shall be same as that of incomer breaker rating.

**INSULATION LEVELS**

The insulation levels corresponding to the rated voltage are:
• Normal Voltage : 11KV
• Highest system voltage : 12KV
• One minute Power Frequency : 28KV

Withstand voltage
12/50 micro second impulse : 75 kV

Air insulated Busbar Clearance
Phase to phase : 150 mm
Phase to earth : 115 mm

CIRCUIT BREAKERS

Circuit Breakers shall be triple pole, vacuum circuit breaker, and draw out type.

The normal current rating of breakers should be at least 16 times the maximum loading of circuit it controls. The rupturing capacity of breaker should be at least 125 times the calculated fault level of bus bars.

The breakers shall have motor operated spring charged mechanism with anti pumping contactor. The control circuit shall be suitable for local as well as remote control.

The breaker sockets and plugs should be heavily silvered plated. It should have adequate auxiliary contacts required by plant control schematics plus 20% spare contacts for future use. Auxiliary contactors or relays should be used to multiply the contacts.

The operating mechanism shall be robust design with a minimum number of linkages to ensure maximum reliability. The operating mechanism shall be such that the breaker is at all times free to open immediately after the trip coil is energized. It is to be ensured that all the three poles open/close in unison to avoid any eventuality of single phasing of operation.

The breaker shall have the distinct positions indicating:

`Service` Position : With main and auxiliary contacts connected
`Test` Position : With power contacts fully disconnected and control circuit contacts connected
`Isolated` Position : With both power and control Circuit Contacts fully disconnected

Earthing : While drawing in the Breaker earth shall contact before test position while draw-out the Breaker earth shall disconnect after test position

The breaker trolley shall remain inside the cubicle even in the draw out position.
The trolley of the circuit breaker shall be so interlocked that:

It shall not be possible to isolate the breaker from the connected position, or to plug it in from the isolated position with the breaker closed position.

When the breaker is in “Closed” mode it shall not be possible to isolate or to bring to other positions such as test, etc.

Means shall be provided for charging the spring mechanism both by electrical motor and by manual charging of spring by handle.

It shall not be possible to open the breaker compartment door unless the breakers drawn to the isolated position or test position.

Inadvertent ‘pushing in’ of the draw out circuit breaker in service position, with auxiliary circuit plug not in the position shall be prevented.

Automatic safety shutters shall be provided to ensure the inaccessibility of live parts after the breaker is drawn-out.

The circuit breaker trolley shall be provided with a heavy duty self aligning earth contact, which shall make before and break after the main isolating contacts during insertion into and withdrawal from the service position of the breaker even in the isolated position, positive earthing contact should exist.

Circuit breakers of identical rating shall be interchangeable.

**EARTH SWITCHES**

Each breaker shall be provided with independent earth switch (make proof) to earth the cable side terminals optionally. An earth trolley shall be provided for all the breakers.

**CURRENT TRANSFORMERS**

The Current Transformer shall be cast resin insulated type of adequate capacity and proper characteristics on secondary as specified the current density should not be more than 1 amp/sq mm.

CTs shall withstand stresses originated from short circuit they shall have ratios, output and accuracy as specified.

They shall be mounted on the switchboard stationary part.
The secondary CT leads from all panels should be terminated on the front of the board on easily accessible shorting type terminal connectors so that operation and maintenance can be carried out when the panels are in service.

CT’s shall be given the heat run test.
Incoming 250-200 / 5-5 Amps
Outgoing 100-75 / 5-5 Amps

CTs shall be of class 05 accuracy for indication / integrated meter 15VA 5P10 for Protection.

VOLTAGE TRANSFORMER

The Voltage Transformer shall be cast resin insulated and shall be draw out type and easily accessible so that the same can be attended to or replaced when the panels are in service condition.

The voltage HT Panels shall be protected through HRC fuses on both primary and secondary side they shall have ratios, outputs and accuracies specified.

The draw out mechanism shall disconnect the primary connection before the VT or its primary flies become accessible.

INDICATING INTEGRATING METERS

All indicating instruments shall be of flush mounting, Digital type with integral selector switches and they shall be of 96 sqmm flush type.

All auxiliary equipment’s such as shunts, transducers, CT’s, VT’s that are required shall be included in the draw out type

INDICATING LAMPS

Indicating lamps shall be of the LED type low watt consumption, provided with series resistor where necessary and with translucent lamp covers. Bulbs and lenses shall be easily replaceable from the front.
Following indicators are required on the panel having lens colors as follows:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Color</th>
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<tbody>
<tr>
<td>Breaker ON</td>
<td>RED</td>
</tr>
<tr>
<td>Breaker OFF</td>
<td>GREEN</td>
</tr>
<tr>
<td>Breaker racked IN</td>
<td>RED</td>
</tr>
<tr>
<td>Breaker racked OUT</td>
<td>GREEN</td>
</tr>
<tr>
<td>Auto trip</td>
<td>AMBER</td>
</tr>
<tr>
<td>Trip circuit healthy</td>
<td>WHITE</td>
</tr>
</tbody>
</table>
RELAYS
All protective relays shall be back connected, draw out type, suitable for flush mounting and fitted with dust tight covers. All relays shall be mounted on the front of the panel and shall be specified as per requirement. The current and the voltage coils shall be treated as specified.

All relays shall have built-in flag to indicate operation. It shall be possible to reset the flag without opening the relay case. All tripping relays shall be suitable to operate on the specified DC voltage.

CONTROL SWITCHES AND PUSH BUTTONS

Control switches shall be of the heavy duty rotary type with nameplates duly marked to show the operation. They shall be semi flush mounting with only the front plate and operating handle projecting.

Circuit breaker control switches shall be of the spring return neutral switch, while local / remote selector switches and instrument selector switches shall be of stay out type.

INTERNAL WIRING

Internal wiring and inter panel wiring for all circuit shall be carried out with 1100V grade, single core, multi strand; PVC insulated copper wire of minimum 2.5 sqmm for CT and other control circuit.

The wiring shall be neatly bunched adequately supported and properly routed and terminated in the respective terminals with suitable lugs there shall not be more than two wires connected at a terminal.

Wires shall be identified by numbered ferrules at each end the ferrules shall be of ring type and non deteriorating material.

All control circuits shall have HRC fuses mounted in front of the panel and shall be easily accessible.

TERMINAL BLOCKS

Terminal blocks for the LT connections shall be of 660 V grade of stud type and of adequate current rating.

The insulating barriers shall be provided between adjacent terminals. Provision shall be made for
label inscription on terminal block. Cables should never be terminated directly on components. Provision shall be made for CT terminals shorting links, remote ON/OFF pushbutton, remote ON/OFF indication and remote ammeter 20% spare terminals shall be provided on each terminal block.

**CABLE TERMINATION**

The HT switchboard shall be designed to facilitate the power connection of incoming 11KV. I Run of 3core 185 Sqmm XLPE and outgoing 11 KV each have 1 Run of 3core 185 Sqmm XLPE insulated armored cables or as specified.

Ample space for connection of these cables and suitable bifurcation between incoming and outgoing cables are to be provided at the rear of the Switchboard. The cable termination arrangement shall be of adequate size and design to receive the required number of cables as specified. Proper cable clamping arrangements shall be provided.

Detachable gland plate of adequate thickness shall be provided for the cable entry into the panel sufficient space shall be provided to avoid sharp bending and easy connection.

Suitable shrouds shall be provided to prevent accidental contact with live outgoing terminations of other feeders while carrying out maintenance on one feeder.

**LABELS**

Nameplates of approved design shall be provided to represent circuit designation for each feeder. Material for nameplates shall be PVC sheet with rear engraving they shall be firmly secured with fasteners.

**PAINTING**

All metal surfaces shall be chemically cleaned, degreased and pickled in acid to produce a smooth clean surface, free of scale, grease and rust.

After cleaning, phosphate and passivation treatment, the surface shall be given two coats of zinc rich epoxy primer and baking in the oven.

After primer, it shall be given two coats of stoving type Epoxy paint in light grey as per ISS shade sufficient quantity of touch up paint shall be furnished for application at site.

**TESTS**

The 11 kV switchboards shall be tested for routine tests as per the relevant Indian Standards act manufacturing end, prior to dispatch. Also to be carried out Pre commissioning Checks and Tests at
site prior to energization of panel and certification issued certificate should be issued.

POWER PACK:

Power pack of 110V AC / 110V DC shall be provided for operation, indication circuits for each of the panels.

INSPECTION

Stage 1 Inspection: During Assembly of Panel.
Stage 2 Inspection: Before Dispatch.
The readiness should be informed at least one week before.

COMMISSIONING

The quoted price shall be inclusive of all necessary commissioning spares. Commissioning should be done at free of cost by you.

 AUXILIARY SWITCHES

Each circuit breaker shall be provided with auxiliary switches to interrupt the supply to the closing mechanism and complete the trip circuit, when the circuit breaker is in the ‘Closed’ position and to cover all the necessary indication, interlocking and control facilities.

All secondary connection between the fixed and moving portions of circuit breaker equipment shall be by means of plug and socket connections, arranged so as to eliminate positively any false indication when the moving portion is racked in to the service location.

Each circuit breaker shall be provided with 4 NO + 4 NC auxiliary contacts as spare in addition to the other functional requirements.

DRAWINGS AND MANUALS

Following drawings and manuals shall be submitted in six sets, for approval

General arrangement of circuit breaker showing
Overall dimensions
Terminal locations
Total weight
Operating mechanism
Bill of materials
<table>
<thead>
<tr>
<th>SL</th>
<th>DESCRIPTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>QUANTITY</td>
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<tr>
<td>2</td>
<td>RATING</td>
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<tr>
<td>3</td>
<td>BREAKING CAPACITY</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CURRENT RATING</td>
<td></td>
</tr>
<tr>
<td>4A</td>
<td>CLOSING COIL VOLTAGE</td>
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<tr>
<td>4a</td>
<td>TRIP COIL VOLTAGE</td>
<td></td>
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<tr>
<td>4b</td>
<td>DUTY CYCLE</td>
<td></td>
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<tr>
<td>4c</td>
<td>HIGHEST SYSTEM VOLTAGE</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>INSULATION LEVEL</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>BUSBARS</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PAINTING (POWDER COATED / EPOXY)</td>
<td></td>
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<tr>
<td>8</td>
<td>NUMBER OF POLES</td>
<td></td>
</tr>
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<td>9</td>
<td>TYPE</td>
<td></td>
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<tr>
<td>10</td>
<td>CLOSING MECHANISM</td>
<td></td>
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<tr>
<td>11</td>
<td>MOTOR VOLTAGE</td>
<td></td>
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<tr>
<td>12</td>
<td>AUXILLARY CONTACT</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>MINATURE CIRCUIT BREAKER</td>
<td></td>
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<td>14</td>
<td>ANTI Pumping DEVICE</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>POWER PACK</td>
<td></td>
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<tr>
<td>16</td>
<td>CURRENT TRANSFORMER</td>
<td></td>
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<td>16a</td>
<td>QUANTITY</td>
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<tr>
<td>16b</td>
<td>RATIO</td>
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<td>16c</td>
<td>METERING CLASS</td>
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<td>16d</td>
<td>BURDEN</td>
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<td>16e</td>
<td>SHORT TIME RATING</td>
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<tr>
<td>17</td>
<td>POTENTIAL TRANSFORMER</td>
<td></td>
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<tr>
<td>17A</td>
<td>QUANTITY</td>
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<tr>
<td>17D</td>
<td>BURDEN</td>
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<tr>
<td>18</td>
<td>ACCESSORIES</td>
<td></td>
</tr>
<tr>
<td>18A</td>
<td>TRIP / NEUTRAL / CLOSE SWITCH</td>
<td></td>
</tr>
<tr>
<td>18B</td>
<td>LOCAL REMOTE SWITCH</td>
<td></td>
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</tbody>
</table>
C  INDICATING LAMPS
D  ALARM
E  SPACE HEATER WITH ON/OFF SWITCH! THERMOSTAT
F  CABLE ENTRY

19 RELAYS

A  2 OVER LOAD AND 1 EARTH FAULT WITH INSTANTANEOUS HIGH SET TRIPPING ARRANGEMENT
B  HIGH SPEED TRIP RELAY
C  AUXILIARY RELAY (SIX ELEMENT)

INPUT
20 Load Manager —( Digital)

21 POWER PACK

22 CABLE TERMINATION

SPECIFICATION AND SCHEDULE OF CONSUMER ISOLATION
11 KV OUTDOOR HT VCB OUTGOING

<table>
<thead>
<tr>
<th>SLNO</th>
<th>DESCRIPTION</th>
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<td>E</td>
<td>SHORT TIME RATING</td>
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<td>17</td>
<td>POTENTIAL Transformers with fuses for all sizes each comprising of following</td>
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<tr>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>B</td>
<td>LOCAL REMOTE SWITCH</td>
</tr>
<tr>
<td>C</td>
<td>INDICATING LAMPS</td>
</tr>
<tr>
<td>D</td>
<td>ALARM</td>
</tr>
<tr>
<td>E</td>
<td>SPACE HEATER WITH ON/OFF SWITCH/ THERMOSTAT</td>
</tr>
<tr>
<td>A</td>
<td>CABLE ENTRY</td>
</tr>
<tr>
<td>19</td>
<td>RELAYS</td>
</tr>
<tr>
<td>A</td>
<td>2 OVER LOAD AND 1 EARTH FAULT with instantaneous high set tripping arrangement</td>
</tr>
<tr>
<td>A</td>
<td>INPUT</td>
</tr>
<tr>
<td>B</td>
<td>OUTPUT</td>
</tr>
<tr>
<td>20</td>
<td>Multi Function Meter</td>
</tr>
<tr>
<td>21</td>
<td>BMS COMPATIABILITY</td>
</tr>
</tbody>
</table>
4. INSTALLATION

SCOPE
The specification covers the installation, testing and commissioning of all electrical equipments and accessories required for the switchyard for efficient and trouble free operation.

STANDARDS
The electrical installation work covered by this specification shall unless otherwise stated comply with the requirements of the latest edition of relevant Indian Standard, statutory regulations and codes of practices.

Indian Electricity Rules –1956
Tariff advisory committee – Approvals
IS – 10118: Code of practice for selection, installation & maintenance
Of Switch gear and control gear

GENERAL REQUIREMENTS
The installation shall be carried out by an electrical contractor holding a valid license as required by the respective State Government. The contractor shall provide particulars of the license held by him or his subcontractor to the purchaser. The installation shall require approval of the Chief Electrical Inspector to the Government of CHENNAI and the contractor shall prepare all necessary drawings / documents and submit to CEIG and get safety certificates from CEIG. He shall also fully assist the purchaser in obtaining approval from any other statutory authorities for the successful commissioning of the Substation. Getting approval for other areas like LT panels shall also be in the contractor’s scope for which the necessary details shall be arranged by Purchaser / Consultant.

Any modification in the equipment or installation that may be demanded by the inspector shall be carried out at no additional cost to the purchaser.
In accordance with the specific installation instructions or as directed by the purchaser, the contractor shall unload, erect, assemble, install, wire, test and commission all electrical equipments included in this contract. Equipments shall be installed in a neat workman like manner with highest regard for safety.

The purchaser shall not supply erection materials, tools, testing instruments or any other machinery of any nature. The contractor shall arrange for the same in a timely manner and he shall not be
allowed to claim for any delay or extra cost of any nature.

Consumable materials of any nature required for the erection job shall also have to be arranged by the contractor.

Clearing the site after completion of erection as well as regular clearance of unwanted, materials from site, returning all packing material and excess material and excess material shall also be covered under the scope of work.

All equipments and instruments of indoor and outdoor shall be inscribed with number, nomenclature, danger boards and other instructions.

The contractor shall touch up the surface for all equipments, which are scratched and / or damaged during transportation and erection. The paint used shall match exactly the surface being touched up.

The contractor shall employ skilled and semi-skilled laborers for erection, installation & testing as required. All electricians, cable jointers, wire men, welders and others employed shall be suitably qualified possessing valid certificates / licenses recognized by the competent authorities.

The contractor shall also furnish a list of Engineers/Supervisors and staff employed by him for erection and installation jobs, giving in brief, qualification and experience of such staff and indicating whether they hold such competency certificates / licenses to supervise the electrical installation jobs as required under Indian Electricity Rules & State electrical Inspectorate Rules.

The contractor shall set up his own workshop and other facilities at site to undertake fabrication jobs, pipe bending, threading etc.

The contractor shall be responsible for recording of all readings and observations during erection, testing and commissioning, in registers or on prescribed proforma. These shall be carried the presence of purchaser’s representative. All such test data and records shall be duly signed by the contractor’s Engineer / Purchaser’s representative and shall be submitted to Purchaser in triplicate.

The contractor shall carry out all tests at site for outdoor and indoor electrical equipment and commission the installation in the presence of Purchaser’s representative. The contractor shall be responsible for final adjustment of relays, instruments, meters breakers etc., and also for submission of relay settings and calculations.

**EQUIPMENT ERECTION**

All support insulators, Circuit breakers, Isolators, etc. shall be properly handled an erected as per the relevant codes of practice and manufacturer’s drawings and instruction manuals.
For power transformer, drying out and oil filling as required, after checking and testing the dielectric strength shall be carried out by the contractor. If required oil filtration shall be carried out and the contractor shall arrange for the necessary equipment.

Handling equipment, sling ropes etc. should be tested before erection and periodically for strength.

For cleaning the inside and outside of hollow insulators, only muslin or leather clothes shall be used.

Necessary Junction boxes for CT’s and PT’s shall be supplied and installed.

**POWER CABLES**

Contractor’s scope of work includes unloading, laying, fixing, jointing, bending and terminating of cables. Contractor shall also supply all the necessary hardware’s for jointing and terminating of cables. Cable shall be laid directly buried in earth, on cable racks in built up trenches, on cable trays and supports in conduits and ducts or bare on walls, ceiling etc. Where specific cable layouts are not shown in the drawing contractor shall route these cables as directed by Consultant/Purchaser.

It is the contractor’s responsibility to ensure that he acquaints himself with the nature of the ground conditions of the project site.

Markers shall be installed at all road crossing where the cables cross and as well as cable joint positions. Their provision and installation shall be included in the areas.

The contractor while designing, excavating trenches and installation of cables, must take all necessary care.

Contractor shall install, test and commission the cables specified in accordance with the latest revisions of Indian Standards.

All cable work and the allied apparatus shall be designed and arranged to reduce the risk of fire and any damage that may cause in the event of fire. Wherever cables pass through any floor or wall opening suitable bushes supplied shall be sealed using fire-resisting materials to prevent fire spreading.

Standard cable installation tools shall be utilized for cable pulling. Maximum pull tension shall not exceed the manufacturer’s recommended value. Cable grips, reels or pulleys used shall be properly lubricated. The lubricant shall not injure the overall covering and shall not set up undesirable conditions of electrostatic stress.

Sharp bending and kicking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified by manufacturer.
Power and control cables shall be laid in separate cable trays. The order of laying of various cables in trenches shall be as specified below:

11KV cables on top most tiers from top.
415V cables on middle tier.
Control cables in bottom most cable tier.

Where cables cross roads and water, oil, gas or sewage pipes the cables shall be laid in reinforced spun concrete pipes. For road crossing the pipe for the cable shall be buried at not less than one-meter depth. Cable shall be protected at all times from mechanical injury and from absorption of moisture.

Some extra length shall be kept in each cable run at a suitable point to enable one or two straight through joint to be made at a later date, if any fault occurs.

Cable jointing shall be in accordance with relevant Indian Standard Codes of practice and Manufacture’s special instruction. Contractor should supply materials and tools required for cable jointing work. Cable shall be firmly clamped on either sides of a straight through joint at not more than 300 mm away from the joints. Identification tags shall be provided at each joint and at all cable terminations. Before jointing insulation resistance of both sections of cables to be jointed shall be checked.

Metal sheath and armour of the cable shall be bonded to the earthing system of the station.

Each cable shall be identified with its designation number as indicated in the drawings.

Cable clamps shall be of 3 mm thick galvanized M.S. spaced at every 1.5-M interval.

**CABLE TRAYS, ACCESSORIES AND TRAY SUPPORTS**

Cable trays shall either be run in concrete trenches or overhead supports from building steel, floor slab, etc.

Cables shall be clamped to the cable trays in both horizontal runs and vertical runs by suitable prefabricated clamps.

All cable trays and fitting will be ladder type and fabricated from M.S. sheet. They shall be hot dip galvanized.
Cable trays shall be suitably supported at an interval of not more than one meter.
CIRCUIT BREAKER

The operating mechanism shall be installed and connected to the three poles and the control cubicle with compressor, air receiver, etc. shall be connected to the breather pole operating mechanism through pipes.

Each pole of the circuit breaker and operating mechanism shall be accurately positioned not to cause any undue strain on the terminals and they shall be properly earthed.

ISOLATOR
The contractor shall inspect, clean, assemble and install the isolator on the fabricated base structure.

The operating mechanism shall be installed on the structure and shall be tested by slowly bringing the isolator to the closed position and necessary adjustments shall be carried out as per manufacturer’s instruction.

Earth switches, frames, operating handles, etc. shall be earthed.

LIGHTNING ARRESTORS

The earth terminal of each lightning arrestor shall be connected to a separate earth electrode by as short direct lead as possible.

Insulating base and surge counter shall be installed as per manufacturer’s instruction.

INSTRUMENT TRANSFORMERS

The CT’s and PT’s shall be installed on the fabricated base structure.

The phase to phase clearance between three units of each set shall be accurately and adjusted so as not to cause strain on the terminals.

Oil in each unit shall be properly checked for insulation.

LIGHTING SYSTEM
The contractor shall provide lighting of the complete switchyard. Recess mounted light fixtures with energy efficient lamp shall be used and shall be mounted on false ceiling. The contractor shall prepare the lighting layout drawings showing the approximate location of lighting fixtures for approval. The Contractor will submit all foundation drawings. All illumination system including switchgear, lighting fixtures, poles, cabling, etc. shall be in contractor’s scope.

The switchyard lighting shall be designed to have mean illumination level of 50 lux.
Lighting wiring between lighting panel and lighting fixtures shall be done by PVC insulated 3 core (phase, neutral and earth) 2.5 sq.mm copper conductor armored cables. Wiring between power panel and 20A sockets shall be done with PVC insulated 3 core (phase, neutral and earth) 4 sq. mm. copper conductor armored cables.

Emergency DC lighting shall also be considered for switchyard for which necessary cabling, switch gear, etc. will be in contractor’s scope.

LIGHTING AND POWER PANELS

Lighting and Power Panels shall be located in the control room. The panel shall be made of 2.5mm CRCA sheet steel. The panels shall have hinged lockable doors with gaskets. Removable bottom gland plate shall be provided along with nickel plated double compression glands. An earth bus shall also be provided with two external grounding terminals.

MISCELLANEOUS ITEMS

The successful bidder shall supply and install the safety devices as required by the statutory authorities, but not limited to the following:

- Danger boards
- Fire extinguishing appliances
- Rubber mats for switchgear panels, power distribution board’s battery charges, control and relay panel, etc.
- Rubber gloves, first aid charts, first aid box, etc.
- Earthing rods

TESTING AND COMMISSIONING

GENERAL

The testing and commissioning for all electrical equipment at site shall be according to the procedure laid down below.

All electrical equipment shall be installed, tested and commissioned in accordance with the latest relevant standards and codes of practices published by Indian standards, institution wherever applicable and stipulations made in relevant general specifications.

The testing of all electrical equipment as well as the system as a whole shall be carried out to ensure that the equipment and its components are in satisfactory condition and will successfully perform its
The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards, as well as accepted codes of practice and stipulations made in the relevant general specifications.

The contractor using his own instruments, testing equipment as well as qualified testing personnel shall carry out all tests.

The results of all tests shall be conforming to the specification requirements as well as any specific performance data guaranteed during finalization of the contract. General

At the completion of the work, the entire installation shall be subject to the following tests in presence of Employer/Consultant.

- **Wiring Continuity Test**
- **Insulation Resistance Test**
- **Earth Continuity Test**
- **Earth Resistivity Test**

**PREPARATION OF THE ELECTRICAL SYSTEM FOR COMMISSIONING**

After completion of the installation at site and for the preparation of Electrical system commissioning, the contractor shall carry out check and testing of all equipment and installation in accordance with the agreed standards, codes of practice of Indian Standards Institution and specific instructions furnished by the particular equipment suppliers.

Checking required to be made on all equipment and installations at site shall comprise, but not be limited, to the following:

The following checks shall be made on all equipment and installation at site:

- Physical inspection for removal of any foreign bodies, external defects, such as damaged insulators, loose connecting bolts, loose foundation bolts etc.
- Check for grease, insulating/lubricating oil leakage and its proper quantity.
- Check for the free movement of mechanism for the circuit breakers, rotating part of the rotating machines and devices.
Check for tightness of all - cable, bus bars at termination joints ends as well as earth connections in the main earthing network.

Check for Clearance of live bus bars and connectors from the metal enclosure.

Check the proper alignment of all draw out device like thaw out type circuit breakers.

Continuity checks in case of power cables.

Checking of all mechanical and electrical interlocks including tripping of breakers using manual operation of relay.

Checking of alarm and annunciation circuits by manual actuation of relevant relays.

Check and calibrate devices requiring field adjustment! Calibration like adjustment of relay settings etc.,

Check proper connection to earth network of all non-current carrying parts of the equipment and installation.

Test reports for all meters are to be furnished.

These tests shall be carried out on the equipment shall include but not be limited to the above.

**CABLES**

Insulation resistance test with 2,500V megger for high voltage power cables rated above 1.1KV grade and 1,000V megger for cables rated up to 1.1KV grade.

All cables of 1.1KV and all H.V. cables shall be subjected to high voltage test after joining and terminating but before commissioning as per relevant standards.

In each test, the metallic sheath/screen/armor should be connected to earth.

Continuity of all the cores, correctness of all connections as per wiring diagram, correctness of polarity and phase of power cables and proper earth connection of cable glands, cable boxes, armor and metallic sheath, shall be checked.
EARTHING SYSTEM
Tests to ensure continuity of all earth connections.

Tests to obtain earth resistance of the complete network by using earth tester. The test values obtained shall be within the limits.

All documents / records regarding test data, oscillographs and other measured values of important parameters finalized after site adjustment shall be handed over to the Owner in the form of test reports for their future use and reference.

ELECTRICAL

The scope of work for testing and commissioning of the total installation shall be for the capital equipment’s like switchgears, cables, etc., and also for the associated equipment like relays Cts, Pts cable etc.,

The scope of work for testing and commissioning of electrical equipment for the above shall include but not limited to the following.

Providing sufficient number of experienced Engineers, supervisors, Electricians, so that the installation can be commissioned in stipulated time.

All the instruments, tools, and tackles required for carrying out the testing and the bidder shall provide commissioning.

The testing of electrical equipment’s shall be carried but as per the relevant Indian standards/codes practices/Manufacturer’s instructions.

Cleaning of Electrical equipment, contracts, cleaning and greasing etc., all the equipment’s and materials required for above shall be supplied by the bidder.

Correcting the panel equipment wiring for proper functioning for the schemes required /called etc.

Installation and wiring of additional equipment on panels like auxiliary contractors, timers, etc., which may be additionally required for proper functioning of the schemes.

Checking of equipment earthing and system earthing as a whole.
Testing of all the cables.

Co-ordination with other contractors for testing and commissioning of interface cables.
TEST TO BE CONDUCTED

All tests shall be performed in the presence of the bidder and customer/consultant. For all types of visual inspections, checking, precommissioning, commissioning test and acceptance tests, relevant IS for the tests given therein shall be followed in addition to the instructions in this technical specification the intention of giving the few test procedures, described below, is to provide a guideline for the bidder. However bidder shall not restrict themselves in carrying out only the tests described in this document.

Bidder shall submit their proposed test procedures for approval and shall not commence testing without such approval is given.

Bidder shall check and test all electrical equipment and system installed and supplied them, including equipment supplied by the owner.

Bidder shall ensure that no tests are applied which may stress equipment above the limits for field-testing recommended by the manufacturer. Bidder shall be responsible for any damage to personnel or equipment resulting from improper test procedure including the equipments supplied by Client.

All defective materials furnished by the bidder and defects due to poor workmanship revealed through field testing, shall be corrected at bidder expense without affecting the completion of the project.

CLIENT reserves the right to interpret and approve all test results prior to energisation of circuits or apparatus.

Bidder shall visually inspect all equipment for defects immediately results upon arrival at site including those supplied by CLIENT.

Bidder shall test the buried earth grid and shall record the values. Bidder shall inspect and test all earthing work carried out by him, including all interconnections between ground loops, grounding of equipment and ensure all connections are permanent and that the earthing circuit is continuous.

Bidder shall meger and record earth resistance at various earth connection points. Switchgear rated 433 volts or more shall be tested with a 1000 volts meger. Auxiliary wiring rated less than 415 volts shall be tested with a 500 volts meger. ALL protective relays shall be tested at sufficient points to establish their proper Functioning in accordance with manufacturer’s specification and curves. Operation checks and functional checks on all switchgear panels. Busbar wires and cables rated 433 volts or more shall be tested joints check with torque wrench for tightness.
Continuity testing of all wires and cables. Wires and cables with a 1000 volts megger. Cables rated less than 433 volts shall be tested with a 500 volts megger. No wires or cable having resistance between conductors or between conductors and ground if less than 100 mega ohm shall be accepted. All pre-commissioning test stated as per IS for respective items.

NOTE: THE TENDERERS SHALL NOTE THAT ALL THE RATES QUOTED BY THEM ARE INCLUDING THE TESTING CHARGES FOR DOING THE ABOVE TESTS. CLIENT SHALL NOT REIMBURSE SEPARATLY ANY AMOUNT FOR ANY TESTING OF MATERIALS.

The following specifications will apply under all circumstances to the equipment to be supplied and installed against this Contract. It is to be ensured that the Contractor shall obtain for himself at his own expense and on his own responsibility all the information which may be necessary for the purpose of submitting the tender and for entering into a contract, keeping in view the specifications of installation and inspection of site etc.,

**INDIAN STANDARD MV EQUIPMENT SPECIFICATIONS**

- **Distribution Boards** : IS 2675 Latest
- **Enclosures for low voltage Switch gears** : IS 2147
- **P V C cables (Heavy Duty)** : IS 1554 Latest
- **P V C cables (Working Voltage Up to and including 1100V)** : IS 694 Latest
- **Tabular Fluorescent lamps** : IS 2418 Latest
- **Tungsten filament lamps** : IS 415 Latest
- **Ceiling fan** : IS 374 Latest
- **Flood light** : IS 1947 Latest
- **Industrial light fittings** : IS 1771 Latest
- **Water proof electrical fittings** : IS 3553 Latest
- **Steel boxes for enclosure of** : IS 5133 Latest
<table>
<thead>
<tr>
<th>Electrical accessories</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Fittings for rigid steel conduit</td>
<td>IS 2667 Latest</td>
</tr>
<tr>
<td>Mild steel conduit for Electrical wiring</td>
<td>IS 653 Latest</td>
</tr>
<tr>
<td>Accessories for rigid steel Conduit for electrical wiring</td>
<td>IS 3837 Latest</td>
</tr>
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<td>Switch socket outlets</td>
<td>IS 4615 Latest</td>
</tr>
<tr>
<td>Three pin plug &amp; socket outlet</td>
<td>IS 1293 Latest</td>
</tr>
<tr>
<td>Switches for domestic and similar Purposes</td>
<td>IS 3854 Latest</td>
</tr>
<tr>
<td>Call bell and buzzers</td>
<td>IS 2268 Latest</td>
</tr>
<tr>
<td>Earthing</td>
<td>IS 3043 Latest</td>
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<tr>
<td>Electrical wiring installation</td>
<td>IS 732 Latest</td>
</tr>
<tr>
<td>Lighting protection</td>
<td>IS 2309 Latest</td>
</tr>
<tr>
<td>Current Transformer</td>
<td>IS 2705 Latest</td>
</tr>
<tr>
<td>MCCB</td>
<td>IS 2516 part I &amp; II/ Sector Latest</td>
</tr>
<tr>
<td>Relays</td>
<td>IS 3231 Latest</td>
</tr>
<tr>
<td>Indicating Instruments</td>
<td>IS 1248 Latest</td>
</tr>
<tr>
<td>Auxiliary contactors</td>
<td>IS 2959 Latest</td>
</tr>
<tr>
<td>PVC/Metal conduiting</td>
<td>IS 9357 Latest Part I, 2, 3 &amp; 4</td>
</tr>
<tr>
<td>Bus-bar support insulators</td>
<td>IS 2544 Latest</td>
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<tr>
<td>Voltage Transformer</td>
<td>IS-3156/BS-3941IEC- 44,186.</td>
</tr>
</tbody>
</table>
Electrical relays : IS-3231, 3842

Contactors for voltage not exceeding 1000V AC or 1200V DC Control Switches : IS-6875/BS-4794/IEC-377

Indicating instruments A.C. electricity meters : IS-722, 8530 / BS-5685 / IEC-of Induction type 45, 211

Resistance wire, tapes and strips for heating elements : IS-3725

Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes : IS-5082
5. HT CABLES

Cable shall be capable of satisfactory performance when laid on trays, trenches, Conduits, ducts and when directly buried in the ground.

Cables shall be capable of operating satisfactorily under a power supply system voltage variation of +10%, frequency variation +5%, and combined voltage and frequency variation of +10%.

Cables shall normally be laid under the following conditions:

1. In air : Ambient temperature of 45 °C
2. In ground : Ground temperature of 35 °C
3. Depth of laying in ground : 900mm(11KV):1050mm(22&33KV)
4. In conduits : Space factor of not more than 60%
5. In trays : Single layer, touching each other

The maximum conductor temperature for operation under Normal rated current carrying conditions and under short circuit conditions are as follows:

**Maximum conductor temperature & Standard Installation Conditions**

a) Maximum Conductor temperature at continuous load 90° C

b) Ambient Air temperature 45° C Ground Temperature 30° C

c) Thermal resistivity of XLPE 350 C cm/W

d) Thermal resistivity of PVC 70° C cm/W

e) Depth of laying in ground 11 KV Cables 900 mm 22 KV & 33 KV Cables 1050mm

f) 11KV XLPE cables shall rated to carry 18.3 KA FOR 0.5 Seconds.

g) Method of laying - Multi core cables laid singly - Single core cables laid in trefoil Touching / in flat formation

**XLPE Construction**

h) Voltage grade: 11KV

i) Conductor: Well compacted Aluminium
j) Conductor screen: This shall be extruded shield in the same operation as the insulation. The semiconductor polymer shall be cross liked.

k) Insulation: Shall be cross-liked polyethylene.

l) Laying up: The core shall be laid up with Polypropylene filling and tape.

Inner sheath: Shall be extruded PVC

m) Armor: Single galvanized steel wire/strip armor. The cable outer sheath shall be extruded ST-2 type PVC.

n) General: The cable shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

o) Operation and Maintenance Manuals

Conductor

The conductor consists of annealed Aluminium wires compacted having a smooth circular shape as per IS: 8130-84.

Conductor screen

The conductor screen consists of a layer of smooth black extruded semi-conducting XLPE compound firmly bonded with the insulation to eliminate electrical discharges at the interface between conductor and insulation.

Insulation

The insulation consists of super clean XLPE compound. The extrusion process is conducted in clinically clean environment. The insulation thickness conforms to IS: 7098.

Insulation screen

The screen consists of smooth black semi conducting XLPE compound firmly bonded with a smooth interface with the insulation. The conductor screen, insulation and insulation screen are extruded simultaneously in Dry cure process.
Moisture barrier

To make the cable longitudinally watertight a semi conducting tape is applied over the core to prevent water penetration in the cable. The tape is of non-woven material which has non-biodegradable characteristics.

Copper wire screen

Copper wires are applied to carry the necessary earth fault current. A counter open helix copper tape is provided over the copper wires.

Poly–Aluminum foil

Aluminum foil coated with polyethylene used longitudinally as a moisture barrier is designed for making cable lighter in weight.

Jacketing

The jacketing material consists of extruded black PVC or high-density polyethylene (HDPE). A graphite coat is provided over the outer surface of the sheath.

Current ratings of PVC cable shall be arrived on the basis of the circuits being protected by Class ‘ P ’ fuses or circuit breakers / contractors with a setting not exceeding 1.5 times the rated current for installation in air, and not exceeding 1.3 times the rated current for installation in ground.

The following letter designations shall be used to specify type of cables:

A - Aluminium conductor

C - Copper conductor

Y - PVC insulation or PVC sheath or overall
   PVC Jacket (over armored)

F - GI Flat steel (strip) armored

W - Galvanized round steel wire armored

Letter designations for cables shall be indicated in the following order:
Conductor size
Insulation
Sheath

Armored

**Overall jacket**

a) Cables for control circuits shall be of solid Copper Conductor for size of 2.5 sq.mm. Copper Conductor cables shall be designated by the absence of the letter. “A” is indicating the Aluminum conductor, which shall be the size of 4 sqmm. for control circuits.

b) Contractor has to work out complete requirement of cables.

**Testing of Cables**

**TESTS**

Cable Insulation Tests shall be conducted between phases and between phase and earth for each length of cable, before and after jointing. As such all phase cables may be checked before being laid for above tests. On completion of cable laying work, the following tests shall be conducted in the presence of the Consultant/Employer.

**Construction tests**

Test for conductor and compaction.

**Test for aluminium conductor:**

1. Tensile test
2. Wrapping test
3. Annealing test
4. Resistance test for both copper and aluminium

Test of eccentricity of insulation.

Test for thickness of insulation

Test for laying up along with Polypropylene tape and fillers.

Virgin material test for PVC insulation

Test for thickness of inner sheath

Test for armoring and armored coverage which should be more than 95%

Test for thickness of outer sheath

Insulation Resistance Test (sectional and overall)
Continuity resistance test

Sheathing continuity test

Cable size, sequential and manufacturers’ identification marking on the outer sheath

Earth test

All tests shall be carried out in accordance with relevant Indian Standard Code of Practice and Local Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Consultant/Employer.

CABLELING SYSTEM FOR COMPLETE PLANT

GENERAL

The cabling system covers the design as per relevant national / international standards. It shall be responsibility of contractor to work out a detailed layout for the complete plate cable system. The layout drawing shall be furnished for the approval of Engineer before commencement of installation including cable trays, cable trays, cable racks, accessories, tray supports, conduit etc.

CABLE LAYOUT

The following points shall be noted while planning cabling system for the plant inside the building either cable tray or cable trench shall be planned as per cabling requirement.

Laying of Cables
Cables shall be laid as per the specifications given below:

Cables - Outdoor Trenches

Cables shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 900 mm (11KV) below the final ground level. The width of the trenches shall not be less than 500 mm. However, where more than one cable is laid, a coaxial distance of not less than 450 mm shall be allowed between the cables. The trenches shall be cut square with vertical sidewalls and with uniform depth. Suitable shoring and propping may be done to avoid caving-in of trench walls. The floor of the trench shall be rammed level. The cables shall be laid in trenches over rollers placed inside the trench.

The cable drums shall be laid unrolled in the direction of the arrow marked on the drum for
unrolling.
Wherever cables are bent, the minimum-bending radius shall not be less than 12 times the diameter of the cable. After the cable is laid and straightened, it shall be covered with 150 mm thick layer of sand. The cable shall then be lifted and placed over the sand cushion. Over this, 450 mm thick layer of sand shall be covered and a course of cable protection tiles or burnt brick shall be provided to cover the cables by 50 mm on either side. Remaining trench shall be backfilled with earth and consolidated as original. Cables shall be laid in Hume pipes/stoneware pipes at all road crossings and in GI pipe at the wall entries. Cable route markers to be provided as per standards Excess depress shall be removed from sit at free of cost.

Joining Cables

All cable joints shall be made in suitable, approved cable joint boxes, and the filling in of compound shall be done in accordance with manufacturers’ instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be jointed colour- to- colour (should not be different colours); tested for continuity and insulation resistance before jointing. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be commenced and finished on the same day. During the time of joining the cables, sufficient protection from the weather shall be ensured. Joints shall be made by means of suitable solder for conductors, the conductors being firmly butted into the connections or thimbles or ferrules and the whole soldered with proper solder and soldering flux. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

The Cable entries through pipes from outside to inside the building shall run in GI pipes and shall be sealed water tight with approved type of sealant to avoid water entering the building.
6. LT PANEL

1. SCOPE.

This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, properly packed for transportation, supply and delivery testing and commissioning complete in all respects with all components, fittings and accessories for efficient and trouble free operation as specified hereinafter for the proposed project.

2. GENERAL INFORMATION.

2.1 The equipment’s shall be designed, manufactured and equipped with accessories in accordance with this specification and the applicable codes standards indicated below. Materials and components not specifically stated in this specification but which are necessary for satisfactory and trouble free operation and maintenance of the equipment shall be supplied.

2.2 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service life as specified herein.

2.3 Switchboards shall be suitable for an ambient temperature of 45 Deg C.

3. CODES AND STANDARDS.

The equipment covered by this specification shall unless otherwise stated be designed, constructed and tested in accordance with the requirements of the Indian Electricity Act and Rules and latest revision of the following standards.

IS 375 : Arrangement of bus bars, main connection and auxiliary wiring.

IS 335 : Insulating coils.

IS 722 : AC electricity meters.

IS 1248 : Direct acting electrical indicating :instruments.

IS 13947 : Motor starters AC, for voltage not IS 8544:exceeding 1000 V
(Part-4,Sec 1) : Direct online AC starters.

IS 2099 : Bushings.

IS 13947 : Degree of protection provided by :enclosures for low voltage (Part :- I)
switchgear and control gear
IS 2419 : Dimensions of panel mounted electrical
: Indicating and recording instruments.

IS 13947 : Circuit Breakers.
(Part 2)

IS 2607 : Air-break isolators for voltage not exceeding 1000 Volts.

IS 2705 : Current Transformers.

IS 4201 : Application guide for CT's

IS 13947 : Contractors for voltages not exceeding
(Part 4, sec 1) : 1000 V AC or 1200 V DC.

IS 3072 : Installation and maintenance of switchgear

IS 3231 : Electrical relays for power system protection.

IS 13947 : Air break switches, air break disconnectors and fuse
(Part 3) : combination units for voltages not exceeding 1000 V
: AC or 1200 V DC.

IS 3842 : Application guide for electrical relays : for AC System.

IS 4047 : Heavy duty air break switches and composite units of air break
: Switches and fuses for voltages not exceeding 1000 V.

IS 4146 : Voltage Transformers.
IS 3156

IS 13947 : General requirements for switchgear and control gear for
(Part 1) : voltages not exceeding 1000 Volts.

IS 4483 : Preferred panel cut-out dimensions for electrical relays.

IS 5124 : Induction motor starters, AC (voltage not exceeding 1000 V)
: Installation and maintenance of code of practice.

IS 5987 : Selection of switches (voltage not exceeding 1000 V)

IS 6875 : Control switches for voltages upto and including 1000V AC & 1200 DC.
4. **SCOPE_OF_SUPPLY_UNDER_THIS_SPECIFICATION/CONTRACT.**

As per Schedule of Quantities enclosed.

5. **EQUIPMENT/SCOPE EXCLUDED_FROM_THIS_SPECIFICATION/CONTRACT.**

All concrete foundations.

6. **DESIGN_REQUIREMENT.**

- The switchboards shall be designed for 415 V, 3 phase, 4 wire, 50hz supply.

- Switchboards shall be suitable for direct online starting of all motors.

- Switchboards shall be rated for minimum fault level as mentioned in data sheets / Drawings.

- Control power supply of the switchboards shall be 240 V, 1 Phase, 50 Hz AC supply tapped from the respective module itself.

- The switchboards manufacturers shall apply all derating factors necessary to all components of the switchboards to comply with the conditions detailed in this specification.

- The ratings of motors, control gears, fuse switches, etc. furnished in the drawings are for tender purposes only. Any changes in the above will be intimated at the time of placement of purchase order or before fabrication of panels.

- The MCC shall be modular, nondrawout type with DOL starters.

7. **CONSTRUCTIONAL_FEATURES.**

The switchboard shall be:
1. Of the totally metal enclosed, indoor, floor mounted, free standing cubicle type with µp based MCCB with electrical interlocking and fixed type fuse switch units, with compartmentalized design.

2. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switch boards.

3. Provide dust and damp protection, the degree of protection being no less than IP 54 to IS 2147.

4. Readily extensible on both sides by the addition of vertical sections after removal of the end covers.

5. Provided with access to the feeders, bus bars, cable termination, cable alley etc. from front only.

6. Each vertical section shall comprise:

7. A front framed structure rolled/folded sheet steel channel section, of minimum 3 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories.

8. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3 mm thickness and at least 75 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

9. Each compartment shall be provided with a hinged door interlocked with switch/breaker housed inside the compartment so that door cannot be opened unless the switch/breaker is in 'OFF' position.

10. A cable chamber housing of minimum width 300 mm shall be provided for the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space of ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in and adjacent section.

11. A cover plate at the top of the vertical section, provided with a ventilation hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.
12. Front and rear doors shall be fitted with dustproof tight neoprene gaskets with easy operating type fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. The doors shall have concealed hinges. Removable screwed covers shall be provided on the rear of the cubicles.

13. A set of horizontal main bus bars shall be provided at the top or bottom as required. The vertical bus bars shall be housed in separate fully enclosed chamber of min. width 350 mm and accessible from front and shall be tapped off from main horizontal bus bars.

14. All incoming/outgoing terminals of the individual feeders shall be provided with insulated shrouds to avoid accidental contact with live parts.

15. The height of the panel should not be more than 2200 mm. The working height shall be limited to a maximum height of 1800 mm. The total depth of the panel should be adequate to cater for proper cabling space. Panels arranged side by side or in the same room shall have same height and depth.

16. Covers and partitions shall be of minimum 16 Gauge sheet steel, whereas doors shall be of min. 14 gauge sheet steel. All sheet steel work forming the exterior of switchboards shall be smoothly finished, leveled and free from flaws. The corners should be rounded.

17. All switches, push buttons etc. shall be operatable from the front and shall be flush/semi flush mounted.

18. The apparatus and circuits shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

19. Apparatus forming part of the switchboards shall have the minimum clearances as per relevant IS. Clearances shall be maintained during normal service conditions. Creep age distances shall comply to those specified in relevant standards.

20. All insulating material shall be of DMC/FRP/SMC to withstand the effects of high humidity, high temperature, tropical ambient service conditions etc.

21. Each module of the draw out type switch boards shall have drawn out type contacts for power termination both incoming and outgoing sides. The controls leads shall also be wired through withdraw able contacts.

22. Foundation bolts and nuts for each panel shall be supplied along with the respective switchboard.
23. The lifting eyes for each shipping section and danger notice plates shall be provided for each switchboard.

24. Functional units such as circuit breakers and fuse switches.

25. Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

26. Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

27. Cable terminations of one functional unit, when working of those of adjacent unit/units.

28. All covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access.

29. Provision shall be made for permanently earthing the frames and other metal parts of the switchgear by the independent connections.

8. **METAL TREATMENT AND FINISH.**

1. All steel work used in the construction of the switchboards should have undergone a rigorous metal treatment process.

2. All surface to be painted including interior and exterior of panels, and other metal parts shall be chemically treated to remove all rust, scale, grease and other adhering foreign matters. All parts shall be coated with two coats of highly corrosion resistant primer followed by two coats of synthetic enamel paint of approved colour of approved manufacturer. The finish shall be glossy or matt as required.

3. The complete treatment, painting, and drying with compressed air operations shall be done in dry and dust free atmosphere.

4. Should finished paint chip off or crinkle during transit/handling/installation, the contractor shall arrange for repainting the equipment at site at his own cost.

9. **BUSBARS.**

1. The bus bars shall be air insulated and made of high conductivity, high strength aluminium alloy complying with the requirements of grade E91E of IS 5082 and suitable for 415 Volts, 4 wire 50 Hz system.
2. The bus bars and connections shall be suitably supported/braced with no hygroscopic DMC/FRP/SMC supports to provide a fault withstand capacity as specified.

3. High tensile bolts and spring washers shall be provided at all bus bar joints.

4. The bus bars shall be liberally sized and shall have uniform cross section throughout, and shall be capable of carrying the rated current at 415 V continuously. The bus bars shall be designed to withstand a temperature rise of 45 C above the ambient. A current density of 0.8 Amps/Sqmm shall not be exceeded for Aluminium bus bars.

5. All bus connections, joints and taps shall be short and as straight as possible, and applied with contact grease in the mating surface.

6. The main horizontal bus bars shall be run through the entire length of the panel and shall be accessible for maintenance from the front as well as rear. Bus bar chamber shall have separately screwed covers. All busbars, links etc. shall be provided with insulating cover to prevent accidental contacts. The neutral bus bars shall have a continuous rating of 100% of the phase bus bars.

7. Busbars shall be encased in colour coded heat shrunk PVC sleeves (snug fit type). An aluminium earth bus of size not less than 50 X 6 mm shall run through the length of switch boards at top or bottom as required.

10. **AIR CIRCUIT BREAKERS.**

1. Circuit breakers shall be TPN or 4P(neutral settable at 1 In), air break, horizontal draw out type. Microprocessor based protection release shall have self-diagnostics feature i.e. Alarm/Indication for abnormal temperature rise in protection unit & mP release malfunction.

2. The breakers shall comply with the requirements of IS 13947 (Parts I & II & II/Sec. I) . The circuit breaker shall confirm to Isolation as per annexure 7.1.2 of IEC. It shall have :

3. A short circuit breaking capacity of not less than 65KA RMS at 415 Volts 50 Hz AC.

4. A short circuit making capacity of 143 KA.

5. A short time withstand circuit of 65 KA for 1 second.

6. Mechanical and electrical endurance (without maintenance) for 8000 operating cycles each
7. Electrical overload performance at 6 times the rated current, 110% of the rated voltage as recovery voltage and 0.5 power factors.

8. Dielectric test of 2.5 KV applied for one minute on main circuits.

9. Test evidence from a recognized independent Laboratory / Institution shall be furnished for compliance of the breakers with the above requirements.

10. The circuit breakers shall be fitted with detachable arc chutes on each pole designed to permit rapid dispersion, cooling and extinction of the arc. Interface barriers shall be provided to prevent flashover between phases.

11. Arcing contacts shall be of hard wearing material of copper tungsten or silver tungsten and shall be readily replaceable. Main contacts shall be of pure silver of high pressure butt type of generous cross section.

12. The operating mechanism shall be of robust design, with a minimum number of linkages to ensure maximum reliability. Manually operated circuit breakers shall be provided with spring operated closing mechanism which are independent of speed of manual operation. Electrically operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor which shall be used solely for charging the closing spring.

13. The operating mechanism shall be such that the breaker is at all times free to open immediately the trip coil is energized.

14. Mechanical operation indicators shall be provided to show open and losed position of the breaker. Electrically operated breakers shall be additionally provided with mechanical indications to show charged and discharged conditions of the charging spring.

15. Means shall be provided for slow closing and opening of the breaker for maintenance purposes, and for manual charging and closing of electrically operated breakers during emergencies.

16. The microprocessor base releases shall have following protections settable through navigation buttons/membrane pad-
   i. Overload protection with time delay.
   ii. Short-circuit protection with time delay.
   iii. Earth-fault protection with time delay (wherever specified in SLD/BOQ) Earth-fault alarm prior to earth-fault trip with LED lamp / Hooter is required to enable take preventive measure against E/F trip.
17. Microprocessor release shall have Segregated fault alarm/indications for O/L,S/C,E/F & mP failure. shunt trip & ZSI contact (to provide discrimination for S/C &E/F) under voltage release(wherever specified in SLD/BOQ).COM port(wherever specified in SLD/BOQ)

18. Circuit breakers shall be individually housed in sheet metal cassettes provided with hinged doors. The breaker along with its operating mechanism shall be mounted on a robust carriage moving on guide rollers within the cassette. Isolating contacts for both power and control circuits shall be of robust design and fully self-aligning. The assembly shall be designed to allow smooth and easy movement of the breaker within its cassette.

19. The breaker shall have three distinct positions within the cassette as follows:

   a) 'Service' position : with main and auxiliary contacts connected.
   b) 'Test' position : with power contacts fully disconnected and control circuit contacts connected.
   c) 'Isolated' position : with both power and control circuit contacts fully disconnected.

20. It shall be possible to achieve any of the above positions with the cassette door closed. Mechanical position indicators shall be provided for the three positions of the breaker.

21. The moving portion of the circuit breaker shall be so interlocked that:

   • It shall not be possible to isolate it from the connected position, or to plug it in from the isolated position with the breaker closed.

   • The circuit breaker can be closed only when it is in one of the three positions or when it is fully out of the cassette.

   • It shall not be possible to open the hinged door of the cassette unless the breaker is drawn to the isolated position.

   • Inadvertent withdrawal of the circuit breaker too far beyond its supports is prevented by suitable stops.

22. Moving portions of breakers of the same ratings shall be interchangeable.

23. Provision shall be available for the padlocking of the circuit access flaps in any of the three positions.
24. Automatically operated safety shutters shall be provided to screen the fixed isolating contacts when the breaker is drawn out from the cassette.

25. The moving portion of the circuit breaker shall be provided with a heavy duty self aligning earth contact, which shall make before and break after the main isolating contacts during insertion into and withdrawal from the service position of the breaker. Even in the isolated position positive earthing contact should exist.

26. Auxiliary switches directly operated by the breaker operating mechanism and having 4 NO and 4 NC contacts, shall be provided on each breaker. The auxiliary switch contacts shall have a minimum rated thermal current of 10 Amps.

11. **MCCBs.**

11.1 **General.**

i) The circuit breaker 3 or 4 pole shall fully comply with IEC60947(1&2) & IS13947(1&2). Certificate for all the sequences (sequence 1,2 & 3) should be available. The circuit-breakers shall have no line-load restriction.

ii) All MCCBs shall have a rated operational voltage of 660V AC (50/60Hz).

11.2. **Construction.**

i) The breakers shall be operated by a toggle, which shall clearly indicate the three fundamental position ON, OFF & TRIPPED.

ii) If required all electrical accessories shall be fitted by manufacturer to avoid tampering at site.

11.3. **Characteristics.**

The protection release with thermal memory & EMC shall have –

i) Overload adjustable & Short circuit adjustable for ratings of 200A & above.

ii) For lower ratings overload protection shall be adjustable with fixed short-circuit protection.

iii) Earth fault protection (if specified) adjustable threshold with time delay.

iv) Upto 630A MCCBs shall be current-limiting type category A breakers. 800A & above the
MCCBs shall be Category B with Icw rating.

v) the settings shall be adjustable, with a common adjustable knob for all 3-phases/neutral, without opening the cover;

vi) The breaking capacity of breakers shall not be less than 35kA

11.4. **Operation.**

i) The breaker will be equipped with extended rotary handle with facility for padlocking and door interlocking.

ii) The MCCB shall be equipped with a “push to trip” button to test operation and opening of the poles.

11.5. **Options.**

i) It shall be possible to combine the following functions if required as specified in SLD/BOQ:

ii) Earth leakage protection, Under-voltage protection or shunt trip release.

iii) Remote indication of circuit breaker trip condition & operational conditions (ON/OFF).

iv) Auxiliary contacts for electrical indication of MCCB position.

v) Alarm contacts should be available for remote indication of tripping on fault.

vi) Stored energy Motor mechanism.

11.6. **Installation.**

It should be possible to terminate Aluminium cable of required size for the current carrying capacity. The requisite size should be mad available by means of extended terminals (as a standard offer) in case the direct terminals are not of adequate size. Adequate phase to phase clearance has to be ensured in case of extended terminations.

11.7. **Contactors.**

1. Contactors shall comply IS13947-4-1 for standards pertaining to contactors and motor starters.
The contactor shall be capable of withstanding breaking & making capacities per following:

<table>
<thead>
<tr>
<th>Category</th>
<th>AC3 Category</th>
<th>AC4 Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making Current</td>
<td>10 times Rated Current</td>
<td>12 times rated current</td>
</tr>
<tr>
<td>Breaking current</td>
<td>8 times Rated current</td>
<td>10 times rated current</td>
</tr>
</tbody>
</table>

The impulse voltage withstand will be 8KV and insulation voltage 1000V.

2. The Contactors should operate without any duration at 55 deg. C for AC3 application.

3. The coil insulation class shall be preferably H class, to sustain frequent switching operations. The auxiliary contact block shall have a switching capacity of 240V at 2A.

4. Contactors shall have one auxiliary in-built and it shall be possible to have additional NO & NC contacts in steps of two.

5. Contactors used for capacitor application shall have built in damping resistors & block of early make poles.

11.8. **Thermal Overload Relay.**

- The TOR shall be capable of withstanding short circuit equal to seventeen times the rated thermal current (17 Ie).
- The TOR will be tripping class 10A as a standard or class 20 for certain applications where specified.
- The TOR should have built in single phasing protection and phase unbalance protection as per IEC947-4.
- The TOR shall have in built NO & NC contact.
- The setting shall be of the adjustable type and there should be a provision of sealing to make the same tamper proof.
- The TOR shall be suitable for Aluminium termination, with a maximum permissible temperature rise of 65K, at the terminals, with an ambient temperature of 40 deg. C.

12. **MOTOR CIRCUIT BREAKER.**

1. Motor protection circuit breaker for control and protection of motors.(MPCB)

2. The MPCB shall comply with the latest IEC 947 –1 (general rules), IEC 947 – 2 (for circuit breakers) and IEC 947 – 4 (motor starters).
3. The MPCB shall have a minimum electrical life of 100000 operations (at AC3 duty).

4. The MPCB shall be of current limiting type with a minimum breaking capacity of 15 kA at 415 V, 50Hz.

5. The MPCB should have built in phase loss and phase unbalance prevention.

6. The MPCB shall have continuously adjustable thermal overload setting from 60% - 100% of frame ampere and the magnetic pick-up (for short circuit protection) should get automatically adjusted to offer coordinated protection.

7. The MPCB should be capable of 100% Discrimination and Type 2 coordination, and the manufacturer shall furnish a selection chart for the same.

8. The MPCB shall have built in facility for padlocking in ‘OFF’ position. Change over contact block should be provided for O/L & S/C fault indication.

9. The MPCB shall have provision for mounting electrical auxiliaries like ON / OFF indication, TRIP indication, Remote switch-OFF through shunt or under voltage coil and panel building accessories like door interlock, common bus bar, etc. the addition of electrical control or rotary control must neither hide or lock the adjustments of the breaker.

13. MINIATURE CIRCUIT BREAKERS (MCB).

1. MCB for ratings upto 100 Amps shall be available in 1,2,3 or 4 pole versions.


   i. It shall have trip free mechanism and toggle shall give positive contact indication.

   ii. Line supply may be connected to either top or bottom

   iii. The breaking capacity of the MCB shall be 10kA and energy limiting class 3.

3. The MCB shall be capable of being used as Incomer circuit breaker or as an isolator.

4. Electrical endurance of the MCB should preferably be 20,000 opns.
5. Power loss per pole shall be in accordance with IS8828 - 1996 and the same shall be furnished by the manufacturer. 'C' curve type MCB should be used for lighting loads and 'D' curve type for SMPS/UPS circuits & control transformer protection.

14. **RESIDUAL CURRENT CIRCUIT BREAKER RCCB**.

1. RCCB ratings from 25A to 125A shall comply with IS12640-1988/IEC1008.

2. The short circuit withstand capacity of the RCCB without the associated short circuit/overload protection shall be 6kA.

3. The Breaking Capacity shall be 1.5kA. Ratings and sensitivities shall be as specified in schedule of quantities.

4. There shall be clear identification of earth fault or overload/Short circuit fault on the RCCB.

5. The RCCB should be suitable for SMPS loads (i.e. unaffected by the d.c pulsated components, harmonics etc, lightning, line disturbances due to other equipments) and should not give nuisance tripping.

6. If RCBO is recommended for 2 Pole, it shall confirm to IEC1009 with B.C of 6kA.

7. If EL + MCB is recommended for 2/4 Pole, it shall confirm to IEC1008 with B.C of 10kA.

15. **AUTOMATIC SOURCE CHANGE-OVER SYSTEM (CIRCUIT BREAKERS)**:

15.1. **General**.

i) The Automatic Source Change-over System (ASCS) shall be both mechanically and electrically interlocked to exclude any possibility of coupling together the normal and emergency sources.

ii) To ensure continuity of service both circuit breakers shall have two stable position, CLOSED and OPEN. It shall be possible to manually operate each circuit breaker in the event of the absence of control voltage.

iii) For maintenance purpose, the ASCS shall have a neutral position with both circuit breakers in the OPEN position. It shall also be possible to lock each circuit breaker in the OPEN position.

iv) Each circuit breaker of the ASCS shall be equipped with auxiliary contacts and alarm contacts (TRIPPED status indication).
15.2. **Construction.**

i) Operations of the circuit breakers shall be by individually momentarily energized motor, mounted on each breaker.

ii) The ASCS shall include 2 circuit-breakers; 3 pole / 4 pole (draw out for ACBs type and fixed for MCCBs type).

iii) The ASCS shall have an Electrical interlock via microprocessor & mechanical interlock via base plate / flexible or rigid links for the 2 circuit-breakers to prevent both breakers to be in ON condition at same time.

15.3. **Circuit breakers:**

i) The circuit breakers shall confirm to IS 13947-1&2 / IEC60947-1&2, confirming to test sequence 1,2 & 3. It shall confirm to Isolation standard as per annexure 7.1.2 of IEC. The breakers shall have no line load restriction & shall be suitable for operation on 3 phase 415 Volts, 50Hz supply.

ii) Rating & Breaking Capacity:
The rating of the circuit breaker & breaking capacity shall be as per the drawings and schedule of quantities.

15.4. **Protection:**

The setting range shall cover the following:

Overload - adjustable.

Short-circuit – adjustable for ratings of 200A and above.

Instantaneous Earth fault(if specified)- adjustable threshold with time delay.

15.5. **Automatic Controller:**

The ASCS shall be provided by a micro-processor based controller.

The controller shall have 4 position selections –
1. Automatic operation.
2. Forced operation of ‘Mains’ source.
3. Forced operation of Standby’ source.
4. Stop (both ‘Mains’ and ‘Standby’ sources off).

The following settable time delays shall be possible:

1. Time delay between loss of voltage in Mains and switching OFF the Mains breaker.

2. Time delay between restoration of Mains voltage and switching OFF of Standby breaker.

3. Time delay between switching OFF of mains breaker and switching ON of Standby breaker during which load shedding can be done.

4. Time delay switching OFF of Standby breaker and switching ON of Mains breaker during which shed load can be reconnected.

5. Time delay for confirmation of presence of ‘Mains’ source voltage before stopping the Generator set.

6. The controller shall be provided with status indication: ON, OFF, Fault-trip, Automatic mode.

7. It should be possible to achieve the following functions:
   
i) monitor loss of one phase in the Mains supply and effect changeover; Automatically.
   
(ii) To transfer to ‘Standby’ source only if supplementary contact is closed (genset under-voltage, low frequency lock-out)
   
(iii) Maximum startup time for the ‘Standby’ source to be settable.

16. **ACCESSORIES:**

    CB shall be provided with following accessories, if specified, in schedule of quantities. Further these devices shall be field fittable from the front and common for all ratings.

    - Under-voltage
    - Shunt-trip
    - Closing coil
    - Auxiliary contacts:
17. **TEST CERTIFICATE:**

   Original Test certificate of the CB as per IS13947-2/IEC60947-2 shall be provided on request.

18. **COMBINATION-FUSE SWITCH UNITS (FSU's)**

   a. The fuse switch units shall be of the load break, fault make heavy duty, cubicle type.

   b. The fuse switch units shall be double break and have quick make and quick break mechanisms, designed to ensure positive operation even in the event of failure of operating springs.

   c. All fuse switch contacts shall be silver plated at current transfer surfaces.

   d. The unit shall be provided with a front operating handle. The ON and OFF positions of the switch handle shall be clearly marked.

   e. Interlocks shall be provided so as to prevent opening of the unit door when the switch is in the ON position, and also to prevent closing of the switch with the door not properly secured. It should, however, be possible to defeat the interlock mechanism to operate the switch with the door open intentionally.

   f. The switches shall be capable of withstanding the thermal and electro-magnetic stresses caused by short circuit currents for the time of operation of the associated fuse links.

   g. Fuse switch and air break switch operating handles shall be provided with padlocking facilities to lock them in OFF position.

   h. The interior arrangement of the switch unit shall be such that all 'live' parts are shrouded.

19. **INDICATING LAMPS (LED TYPE).**

   i) LED type indicating lamps confirming to IEC947-5-1, class 2, IP65; shall be provided
      Wherever called for in the control schematic diagrams. The lamps assembly shall be Complete with LED, holders and lenses.
20. **SPACE_HEATERS.**

- Each vertical section of the switch boards shall be provided with thermostat controlled space heaters rated for 240 Volts + or - 10%, single phase, 50 Hz. The heaters shall have individual ON-OFF switch.

- Wiring of space heaters in each switchboard shall be grouped and brought out to easily accessible terminals for connection to power supply, through switch fuse unit.

- Each switchboard shall be provided with plug socket with switch fuse for connection of hand lamp rated 240 V, 50 Hz. single phase.

21. **FUSES.**

- All control and power fuses shall be link type HRC fuses and they shall be provided with visible indication to show that they have operated.

22. **CURRENT_TRANSFORMERS.**

- Current transformers shall comply with the requirements of IS 2705. They shall have ratios, outputs and accuracy’s as specified/required.

- Current transformers wherever required and called for in the single line diagram and/or required shall be furnished.

- The CTs shall be bar primary, in epoxy encapsulated type, rated for 415 V. The CTs shall be designed to withstand the thermal and mechanical stresses resulting from the maximum short circuit current.

- The vendor shall ensure that the VA outputs of the CTs are adequate for the relays, meters and loads connecting them.

- The CTs shall be provided with Class A/Class B insulation and proper polarity markings in a suitable manner.

23. **INDICATING/INTEGRATING_METERS.**

- All indicating instruments shall be of flush mounting industrial pattern, conforming to the relevant standard.

- The instruments shall have non-reflecting bezels, clearly divided and indelibly marked scales and shall be provided with adjusting devices in the front.
• Integrating instruments shall be of flush mounting switchboard pattern, conforming to the relevant standards.

• Meters shall be provided with circular 90 scales with square casing of specified size.

24. **TESTS.**
**ROUTINE TESTS**

• During manufacture and on completion, all equipment shall be subjected to the IS routine tests.

The tests shall include but not necessarily limited to the following:

i) Operation under simulated service condition to ensure accuracy of wiring, correctness of control schemes, protection/ metering scheme and proper functioning of the equipment.

ii) All wiring and current carrying part shall be given appropriate High voltage tests.

iii) Primary current and voltage shall be applied to all instrument transformers.

iv) Routine tests shall be carried out on all equipment such as circuit breakers, instrument transformers, relays, and Ameter etc. shall be calibrated in accordance with relevant IS standards.

• MT instruments shall have + or - 1% accuracy on full scale. Each meter shall be magnetically screened.

25. **CABLE TERMINATIONS.**

• Cable entries and terminals shall be provided in the switchboard to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified in the detailed specifications.

• Switch board shall be designed either for top or bottom or combined entries and outgoings which will be confirmed by Architects at the time of drawing approval. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Removable undrilled plates shall be furnished for fitting the cable glands.
• Sufficient space shall be provided to avoid sharp bending and for easy connection. A minimum space of 200 mm from the gland plate to the nearest terminal block shall be provided.

• Multi way terminal blocks complete with screws, nuts, washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

• Power and control terminals shall be washer head screw type or stud type complete with crimping type connectors. Screw type terminals with screws directly impinging on conductor are not acceptable.

• Each control terminal shall be capable for connection of 2 Nos. 2.5 mm standard copper wire at each ends.

• Not more than two wires shall be connected to any terminal. If necessary a number of terminals shall be jumpered together to provide wiring points.

• At least 20% spare terminals shall be provided in each module.

• Terminal blocks for current transformer secondary lead wires shall be provided with shorting and earthing facility.

• Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

• Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

26. **CONTROL_WIRING.**

The wiring shall be complete in all respects so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be completed upto terminal blocks on the side of each unit module.

All control wiring shall be carried out with 1100/660 V grade single core PVC cable having stranded copper conductors of minimum 2.5 Sqmm.

Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wires shall not be spliced or tapped between terminal points.

Wires shall be identified by numbered ferrules at each end. The ferrules shall be of the ring
and of non-deteriorating material. They shall be firmly located on each wire so as to prevent free movement, and shall be interlocking type. Easily accessible.

All spare contacts of relays and switches shall be wired up to the terminal blocks.

Each of the DC circuit shall be provided with two fuses one in the positive and the other in the negative for 2 wire DC underground system of specified voltage.

27. **GROUND BUS.**

i) An aluminum ground bus rated to carry maximum fault current shall be furnished along the entire length of each switchboard. Each stationary unit shall be connected directly to this ground bus by two separate and distinct connections in accordance with Indian Electricity Rules.

ii) Grounding terminals on the ground bus shall be provided. Connectors shall be provided at either end of switchboard for connection to station ground mat.

28. **TERMINAL BLOCKS.**

Terminal blocks shall be of 660 Volts grade of stud type. Insulating barriers shall be provided between adjacent terminals.

Suitable provision shall be made to terminate control/power connections in the respective module.

Terminal blocks shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions. The wire termination’s to the blocks shall be of screw type suitable for crimp type socket.

29. **NAME PLATE.**

The panel as well as feeders compartments shall be provided with name plate of anodized aluminium, with white engraving on black background. They shall be properly secured with self tapping screws at the top of the cubicles. The panel/feeder descriptions shall be as indicated in the drawings/employers. The size of the name plates shall be proportionate to the respective equipment’s.

Also individual panel number and danger plate shall be furnished at back of panel.
30. **ACCESSORIES.**

The following accessories shall be furnished along with each switchboard.

1. One (1) no. fuse pulling handle for each switchboard.

2. One (1) no. winding handle for withdrawing breaker from the cubicle.

3. Other accessories as deemed necessary for trouble free and efficient operation of the equipment offered.

31. **DRAWINGS AND MANUALS.**

The following drawings shall be supplied for each switchboard.

- General arrangement drawing for each type of board showing constructional features and space required in the front for withdrawal of breaker, power and control cable entry points, location of various devices, terminal blocks, cross sectional details, bus bar supports.

- Number of buses, etc. shall be submitted within 15 days from the date of letter of intent for approval.

- Foundation plan and anchor hold details including dead load and impact load.

- Drawing and data sheet for each component.

- Electrical wiring diagram.

- Terminal block arrangement drawing for outgoing feeders.

- Complete relay technical particulars and recommended settings.

- Operation, maintenance and installation manuals, (one set to Consultants).

- Technical Catalogues/Leaflets of CTs, meters, lamps, etc. shall be submitted alongwith offer.

- The approval of the drawing does not absolve the vendor from his obligation of ensuring proper and correctness of functioning/operation of the system.
32  TESTS.

Routine And Type Test.

Type test certificates and results as per relevant Standards (Specification) for all the equipment offered under the scope of this specification shall be furnished. All routine tests on all major components shall be made as per relevant specification.

Inspection:

Inspection of the Switchboards including inspection of wiring and electrical operational tests by the Owner/Architect before dispatch should be arranged by the tenderer. The cost of transport and incidental expenses to be borne by the tenderer. Two weeks clear notice to be given for carrying out the inspection.

Dielectric Tests:

- Insulation of the main circuit that is the insulation resistance of each pole to the earth and that between the poles shall be measured.

- Insulation resistance to earth of all control wiring should be tested with 1000 V megger.

- Insulation test shall be carried out both before and after high voltage test.

- Each switch board will be completely assembled, wired, adjusted and tested for operation under simulated conditions to ensure correctness of wiring and proper functioning of all equipment’s.

33. HIGH VOLTAGE TEST.

A high voltage test with 2.5 KV for one minute shall be applied between the pole and earth. Test shall be carried out on each pole in turn with the remaining poles earthed. All units racked in position and the breakers closed. Originals test certificate shall be submitted along with panel.

34. PACKING AND TRANSPORT.

The switchboards shall be sent to site by Road Transport packed in Wooden Crates. The packing should be of high quality to avoid any damage to the equipment’s during transit. They shall be wrapped with polythene sheets before being placed in crates to prevent damage to the finish.
35. **SPECIAL REQUIREMENTS FOR OUTDOOR KIOSK.**

This specification shall be followed while fabricating outdoor kiosk. Precautions to be taken in providing a separate weather proof enclosure to bring it in conformity with IP55. This enclosure shall be painted with two coats of primer and epoxy paint to make it weather resistant.

36. **HANDLING:**

Switchgears and all its accessories shall be handled carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear. While using jacking pads utmost care shall be taken in proper application of jacks. Where switchgears is dragged or pulled on sleeper or rollers of the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

37. **STORAGE:**

Equipments shall be stored under shelter in a well ventilated, dry place and covered by suitable polythene or tarpaulin covers for protection against moisture.

38. **ERECTION:**

Panels shall be installed over a trench. The panels shall be aligned properly and bolted to the flooring by at least four bolts. The cables shall be terminated into the panel through bottom plate. The panel shall be bonded to the earth by connecting earthing leads to the panel earth bus.

Should finished paint chip off or crinkle during transit / handling/ installation, the Contractor shall arrange for repainting the equipment at site at his own cost.

39. **TESTS:**

The following preliminary checks and pre commissioning tests shall be carried out before commissioning the Switchgears in the presence of Buyer/Architect's representatives.

39.1 **PRELIMINARY_CHECKS:**

1. Check name plate details according to specification.

2. Check for physical damage.

3. Check tightness of all bolts, clamps and connecting terminals.

4. Check oil level, air pressure and leakage (wherever applicable).
5. Check earth connection.

6. Check cleanliness of insulators and bushings, arc chambers.

7. Check all moving parts are properly cleaned and lubricated.

8. Check space heaters provided.

40 **PRECOMMISSIONING CHECKS:**

1. Check alignment of breaker trucks for free movement. Check correct operation of shutters.

2. Slow closing/opening operation.

3. Check control wiring for correctness of connections, continuity and IR values.


5. Owner closing/opening operation manually and electrically.


7. Trip free and anti pumping operation.

8. I.R. values, resistance and minimum pick up voltage of coils.

9. Contact resistance.

10. Simultaneous closing of all three phases.

11. Pole discrepancy tests.

12. Single and three phase auto reclose operation.

13. Check electrical and mechanical interlocks provided.

14. Check on spring charging motor correct operation of limit switches and time of charging.

15. Check on C.Ts.
16. All functional checks with the relays, meters, alarm scheme, interlock as per scheme with primary injection kits.

17. High voltage tests on Control and Power Circuits (2.5 KV).

41. SPECIAL REQUIREMENTS FOR OUTDOOR KIOSK:

This specification shall be followed while fabricating outdoor Kiosk. Precautions to be taken in providing a separate weather proof enclosure to bring it in conformity with IP 55. This enclosure shall be painted with two coats of primer and epoxy paint to make it weather resistant.

LT PANELS

1. ACB : ABB/ Larsen & Toubro/ Seimens
2. MCCB : ABB/ Larsen & Toubro/ Seimens
3. CAPACITOR (Heavy duty gas/ mineral type) : BARON/MEHER/SIEMENS(EPCOS).
4. PF RELAY : EPCOS
5. PROTECTIVE RELAYS : ABB.
6. ELR. : PROK DEVICES / JVS/ MINILEC/EASUN REYROLLE.
7. SWITCH DISCONNECTOR FUSE UNITS : ABB
8. LOAD BREAK ISOLATOR : ABB/ Larsen & Toubro/ Seimens
9. LOAD BREAK CHANGEOVER SFU/ISOLATOR :
10. HRC FUSES/BASE : ABB
11. HRC FUSE LINK FOR FDSU : ABB
12. CTS-RESIN CAST : VOLTAMPS / KAPPA / KALPA
13. SELECTOR SWITCHES : L&T SALZER /SIEMENS/KAYCEE.
14. INDICATING LAMPS/PUSH BUTTONS : TECKNIK/SIEMENS/ESBEE/ VAISHNO.
15. PVC WIRES-1100V GRADE : FINOLEX/RRKABEL/KAMADHENU.
16 FRLS WIRES-1100V GRADE : FINOLEX/RRKABEL/KAMADHENU.

17 CONTACTORS/OL RELAYS : ABB

18 INDICATING METERS (ANALOG) : AE/IMP/MECO/RISHAB.

19 INDICATING METER (DIGITAL) : CONZERV / HPL SOCOMEC

20 DIGITAL METER/LOAD MANAGERS : CONZERV / HPL SOCOMEC

21 FABRICATED ENCLOSURES : SYSTEM VENDORS OF ABB

22 PVC TRUNKING : SALZER CABLE DUCTS (L&T)/ANY OTHER REPUTED MAKE.

Important:

1. Please Tick (✓) the make of material considered in tender.

2. Detail submittals in the form of catalogues specification sheets, and samples wherever called for, shall be submitted within one week from the date of order and approvals shall be obtained on the type of accepted make before procurement is made.

3. Out of the approved makes of materials mentioned above, the make of materials to be used on the work shall be as decided by the Consultant/Owner jointly.

4. In respect of materials for which approved makes are not specified above, these will be of makes to be decided by the consultant and as per sample approved before procurement.

Equipment's approved and supplied shall have local servicing facilities available in the region.
7. EARTHING

Scope
Supply, fabrication, installation, testing and commissioning of earth pits. Conforming to relevant IS Specifications and standards. The scope includes all related civil work for making pit, providing suitable covers and writing identifications marks etc.

General
All the non-current carrying metal parts of electrical installation shall be earthed as per IS: 3043. All equipment’s, metal conduits, rising main, cable armor, switch gear, distribution boards, meters, cable glands and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall be in conformity with the provisions of Rules 32, 61, 62, 67 and 68 IER 1956.

Construction
Copper Plate Earth Station
Plate electrodes shall be made of 6.3mm thick copper plate of 600X 600mm size. The plate shall be buried vertically in ground at a depth of not less than 2.5 meters to the top of the plate. The pit should be filled with charcoal in such a way that the electrode is encased to a minimum thickness of 3 00mm all round. The electrode, to the extent possible, should be buried in a depth where subsoil water is present. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers.

A GI pipe of not less than 40mm dia shall be clamped with bolts vertically to the plate and terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450mm x 450mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identification label tag.

Earthing Conductors
All earthing conductors shall be of high conductivity copper/GI strips and shall be protected against mechanical damage and corrosion. The connection of earth electrodes shall be strong, secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel conduits and cables by using suitable clamps.

Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage network.

Earthing conductors shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All Switch Boards, Distribution Boards, Disconnecting Switches and Isolators shall be connected to the earth bus. Earthing conductors shall be terminated at the equipment end using suitable lugs, bolts, washers and nuts.
All conduits, cable armouring etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/protective device and Circuit Breaker and shall not exceed 2 ohms.

**Precautions**

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance always. Joints shall be tinned, soldered and/or double riveted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

The following table gives an idea on selection of size of earth conductors for electrical equipments such as Transformers, Motors, Generators, Switch gears, Cable Glands, etc.,

**Size of the Conductor:**

<table>
<thead>
<tr>
<th>Rating of 50 Hz Equipment (KVA)</th>
<th>Bare Copper swg</th>
<th>Aluminum VC Insulated mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 V, 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upto 5</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>6 to 15</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>16 to 50</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>51 to 75</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>76 to 100</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>101 to 125</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>126 to 150</td>
<td>2 or 1”xl/16”</td>
<td>70</td>
</tr>
<tr>
<td>151 to 200</td>
<td>2 or 1”xl/16”</td>
<td>70</td>
</tr>
<tr>
<td>201 and above</td>
<td>” x 1/8”</td>
<td>185</td>
</tr>
</tbody>
</table>

Conductors shall be protected so that no mechanical damage could be caused.

Earth connections for all HT switchgears and equipments shall be carried out by not less than 0.1 sq. inch. Copper tapes or 185 Sq.mm PVC insulated stranded aluminium conductor or 2” * 1/4” galvanised iron strip.
8. STREET LIGHTING

Specification for Street Light Poles

The Street Light Poles shall be of steel tubular type with suitable arrangement at the top of the pole for fixing the lighting fixture. Poles shall be fabricated out of MS medium class pipes seamless type, in two or three stepped sections as per design and drawings. For reducing the section of street light poles for stepped design, “swaging” process only shall be used. Each pole would have one MS water tight box fabricated out of 16 SWG steel sheets complete with a suitable way connector, neutral link re-wirable fuse etc., as per design and drawing. The pole shall be painted with one coat of anti-corrosive oxide primer before dispatch to site and two coats of enamel/aluminium paint of approved make and shade after installation.

The earthing of each street light pole shall be carried out by connecting the Armour of the cable to the Earth Electrode, as specified in the design.

Bracket for Street Light Fittings on Buildings

The brackets shall be made of specified size NB MS class ‘B’ pipe approx. 1.8 M long, bent at the center at an angle of 120 degree, with necessary holding brackets, hold fasts etc. with special reducer at end to accommodate type of street light fitting to be fixed. The bracket shall have one coat of anti-corrosion paint before dispatch to site and two coats of approved make and shade of enamel paint.

Installation of Poles

Installation of poles shall be done as per design and drawing. The depth of pole to be buried in ground shall be 1/5th of total pole length or as specified in drawing, whichever is more. Special care shall be taken in erecting poles so that these are not strained or damaged during erection and are firmly stayed till the foundation is secured.

The pole shall be grouted inside ground pit (cross section 600 x 600 mm) with cement concrete 1:2:4 with necessary GI ‘A’ class pipes (not less than 38 mm dia, NB) to facilitate pulling of cables. Separate pipes shall be provided for incoming and outgoing cables. The cement concrete shall be protected from premature drying by curing for at least seven days after pouring. All concrete surfaces from 150 mm below ground level to top shall be finished smooth with cement mortar 1:4.

Installation of Street Light Fixtures

This includes fixing of streetlight fitting complete with accessories and lamps at the end of the pole/bracket, connecting it with designed capacity and size Aluminum conductor, PVC insulated cable from water tight MS box, testing and commissioning. The third core shall be connected to
earth point of marshaling MS box at the other end. If the pole has more than one light fitting, each fitting should have independent wiring from MS Box to fitting.
Fixing of street light fittings on bracket (6.10.2 above) is in Contractor’s scope and also it includes the supply, fixing of necessary conduit between MS Box and fitting.

**Installation of Post Top Lantern For Street Lighting**

This includes providing and fixing of specified size NB GI class ‘B’ pipe of 1.5M long in brick/RCC column, including MS water tight box (specification same as that of street light pole) and installation of post top lantern complete with all accessories and lamp, connecting it with designed capacity and size Aluminum conductor PVC insulated flexible cable, testing and commissioning. Painting of the exposed portion of the pipe with two coats of approved make and shade of enamel paint is also included.

**For open ground**

This includes providing and fixing of specified size MS class ‘B’ pipe of total length 4M (including 1 M in ground to be grouped with 450 x 450 x 1000 mm cement concrete 1:2:4) and water tight switch box (size 200 x 150 mm) fabricated out of 14 SWG steel sheet complete with a suitable way connector, neutral link and rewirable fuse etc., installation of post top lantern complete with all accessories and lamp connecting it with designed capacity and size Copper conductor, PVC FRLS insulated flexible cable, testing and commissioning. Painting of exposed pipe length with 2 coats of approved make and shade of enamel paint is also included.
9. **LIGHTNING ARRESTOR**

**SCOPE**
The scope of work shall cover supply; Installation, Testing and Commissioning of reputed make air, earth terminations and down conductors for the entire building as per the relevant Indian standards and specifications given below.

**STANDARDS**
The following standards shall apply:

- IS 3043 — 1966 : Code of practice for earthing
- IS 521 6— 1969 : Safety procedures and practice in electrical work.
- Indian Electricity Act 1910 and rules issued there under.

**AIR TERMINAL CONSTRUCTION**

The lightning arrestor should be made out of 100 mm dia (minimum) copper sphere consists of 5 pronged air terminal pointed probes at top. It shall be fitted on approximately 25 mm dia copper tube with not less than 2 mm wall thickness and 1200mm long shall be welded to suitable base plate of size 6” x 6” made out of G.I. with fixing arrangement shall be grouted to wall / slab terrace. Roof conductors down conductor 25x3 mm Cu. Strips as specified in Schedule of quantities shall be fixed on the highest point of the tallest building in the Project site. The number(s) of Lightning Arrestor(s) and it’s their location shall be shown in the drawing(s).

The air terminal shall be provided with means so that it is rigidly fitted in the location desired. Necessary GI Stray wires and porcelain thimbles shall have to be provided so that the air terminals can withstand the velocity of air at terrace level.

**T-OFF CONDUCTORS**

These shall be carried out if required under the advice of consultant to interconnect the various lightning arrestors of one building near the top to extend the zone of protection. These shall be of GI strip of size 40 x 6 mm as specified in Schedule of quantities and shall be fastened securely to the building surface by means of GI saddles maximum 1 m apart, with GI nails/screws and shall have minimum number of joints.

**DOWN CONDUCTORS**

These shall be used for connecting the lightning arrestors/roof conductors to each electrode of earth pit. Structures with a base area of up to 90 Sq.m. may, if height of the lightning arrestor gives
sufficient protection, be equipped with one down conductor only. These shall be of 25x3 mm size Cu. Strip, with minimum joints and shall be fastened securely to the building surface by means of GI Saddles, maximum 1 m apart with GI nails/screws. Each down conductor shall have its own independent earth pit.

**GENERAL**
The lightning protection system shall have as few joints as possible and they shall be mechanically and electrically effective. In general, joints for strips shall be tinned, soldered and at least double riveted. Bolted joints shall only be used on test points or on bonds to existing metals. Each down conductor shall be provided with a testing joint in a position convenient for testing and at the same time away from Guest areas.

All other metal objects such as water tanks, iron staircase/railings, water or gas pipes on top of, inside or by the side of a building should be at least 2 m away from the lightning roof conductor/down conductor system.

The Lightning Arrestor(s) should not be installed near any structure used for storage of inflammable materials. There shall not be any spire, flagstaff or other point close by the lightning arrestor, which can impair its efficiency or the efficiency of air terminals. No outdoor radio aerials or overhead line poles shall be located within a distance of 15 m from the lightning arrestor.

Earthing system used for lightning protection must be independent of the equipment / distribution earthing system.

**EARTHING - EARTH TERMINATION**
The earth terminals and earth leads shall be as specified for earth station and earthing leads under section ‘EARTHING’.

**TESTING**
The entire lightning conductor installation shall be tested in accordance with the Indian Standard Code and the following ground resistance values shall be recorded.

- Earthing Terminal (each)
- Earthing system (as a whole)

**MODE OF MEASUREMENT**
Each point air termination shall be measured as one unit for payment and shall include:

- Elevation rod and multiple point head
- Base plate and concrete block
- Terminal connection
- Bimetallic connection, if any
Strip conductors shall be measured per unit length.

Each earth terminations shall be measured as one unit for payment and shall include:

- Electrode, lead wire & fixing accessories
- Soil treatment
- Excavation and refilling
- Masonry chamber and cast iron cover
- Watering pipe

Ear thing lead shall be measured on the basis of unit length for payment and shall include:

- Earth lead, clamps and fixing accessories
- Excavation and corrosion treatment of the earth leads at the earth termination.
- Terminal connection at air and earth termination.
10. CONDUITS FOR COMMUNICATION

1. The conduits for the telephone system as well as Intercom System and Data System shall be same as explained and specified elsewhere for other work. The minimum size of conduits used for Telephone System / Intercom shall be of 19 mm dia.

2. All distribution boxes shall be flush mounting, flat fronted, 16 Gauge sheet steel enclosed boxes flush with wall and properly joined to conduits. The distribution boxes shall incorporate terminal strips of the combined soldering screw type/tag blocks as required.

3. The telephone outlet boxes made of 16 Gauge sheet steel shall be of minimum 75 x 75 x 75 mm. These shall be flush mounting type installed with an approved cover matching with all other outlets in the electrical system and consisting of a RJ 11 outlet and approved by the structured data and communication cabling system.

4. The telephone boxes shall be generally mounted at 450 mm FFL unless otherwise specified / indicated in drawing.

5. The contractor shall consult and co-operate with the telephone department when installing the telephone wiring and conduit system and shall abide by their requirements, rules and regulations, shall furnish all work and material to secure their approval of the completed installation.

6. Detailed drawings showing the telephone terminal and junction boxes fabricated in accordance with above requirements shall be submitted by the contractor for approval to the telephone department and the Architects.

7. Rates shall include a GI fish wire left in the conduit to draw telephone wires. The end of conduit shall be sealed to prevent dirt, dust, mortar or any foreign matter going into telephone conduits.

8. The telephone indoor wires shall be 0.5 mm annealed tinned copper conductor, PVC insulated, twisted into pairs, laid up, taped and overall PVC sheathed, or CAT 5E / CAT 6# UTP/STP cable.

9. The telephone outdoor cable shall be 0.5 mm annealed copper conductor, polythene insulated, color coded, twisted into pairs, laid up, jelly filled with petroleum jelly compound, wrapped with non-hygroscopic tape under moisture barrier poly-al-laminated foil tape and embedded with water proof polythene material.
11. **WIRING SYSTEM**

**System of Wiring**

The system of wiring shall consist of FRLS insulated copper conductor wires in Heavy gauge rigid MS / FRLS PVC conduits for concealed installation and metal conduits for surface installations as called for.

**General**

Prior to laying and fixing of conduits, the Contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and size of conduits, locating of junction boxes, size and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the Consultant/employer. Any modifications suggested by the Contractor shall be got approved by the consultants before the actual laying of conduits is commenced.

Generally concealed electrical wiring installation shall be in MS / FRLS PVC conduits and surface wiring in MS / FRLS PVC conduits

**MS / FRLS PVC Conduits**

Conduits and accessories shall conform to IS: Latest standards and the specifications given below. MS / FRLS PVC conduits shall be of black, round, heavy gauge Milled Steel (MS) / 2mm thick FRLS PVC. The internal surface of the conduit shall be smooth. All flexible conduits shall be of PVC insulated GI. Only approved quality as recommended by the consultant and factory made bends/accessories shall be used.

Conduits and Accessories shall conform to IS and tender specifications. The steel conduits shall be solid drawn, mild steel, 16 gauge, heavy duty electrical welded, thread type, having perfect circular tubing with tight fining joints and shall be capable of being cleaned easily. The conduit shall be protected from rust by one coat of paint applied inside and outside in its manufactured form. FRLS PVC shall be heavy duty 2mm thick rigid conduit.

Minimum Conduit Dia (OD) For Electrical Wiring Shall Be 25.0 mm.
Minimum Conduit Dia (OD) For Telephones and Audio/Video shall be 19.0 mm
Joints between conduits and accessories shall be securely made.
Where called for, buried wiring passing underground, shall run in galvanized steel conduit.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer. This shall be approved by respective Engineer-in-charge and same shall be submitted along with bills for payment.

The numbers of 650/1100 volts grade insulated copper conductor wires that may be drawn in the conduits of various sizes are given below. The space occupied by the wires shall not exceed 60% of the conduit Internal Area and 40% of conduit space should be left free.

Maximum permissible numbers of 650/1100 volt grade insulated wires that may be drawn into rigid non-metallic (FRLS PVC) or MS conduits are given below:

<table>
<thead>
<tr>
<th>Size of Wire Sq.mm within conduit of size (mm)</th>
<th>19</th>
<th>25</th>
<th>32</th>
<th>38</th>
<th>51</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>-</td>
<td>6</td>
<td>10</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>2.5</td>
<td>-</td>
<td>5</td>
<td>10</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>4.0</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>6.0</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>-</td>
</tr>
<tr>
<td>10.0</td>
<td>-</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>16.0</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>25.0</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>35.0</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>

**Bends in Conduit**

Conduit bends shall be of 14 SWG/ 2mm thick. Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet terminations. In case of recessed system each junction work shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 2'/2 times the outside diameter of the conduit. Ready-made bends shall be used where required.

Run of conduit pipes through expansion joints in RCC member should be avoided as far as possible and if unavoidable, flexible conduit pipe shall be used with ceiling outlet box on both sides of expansion joints, after getting approval from the Consultant.

Outlet boxes for lights/fans shall be protected at the time of laying by filling with Jute/earth cotton etc.

Locating junction boxes on outer surface of exterior walls of building should be avoided to prevent
exposure to weather as also to preserve aesthetics.

Junction boxes should never be closed permanently by plaster. The covers of the boxes should match the colour of the wall.

Junction boxes inside the guest room areas shall be avoided. In case these are unavoidable they can be located in toilet/corridor/service areas/stores etc., one bolt shall be welded to receive earth wire inside all switch points.

All switch points shall be fixed at a level accessible from floor level.

Conduits in wall crossing area shall be sealed with M-Seal epoxy compound after pulling the wires.

Switch Outlet and Junction Boxes
All concealed outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of thick Zinc passivated steel boxes having smooth external and internal surfaces.

All outlet boxes for receiving plug sockets and switches shall be of standard factory make and of approved size, and shape. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall have a minimum depth of 65 mm.

Light Outlet Boxes
The Light Outlet Boxes for concealed installation shall be round in shape and shall be made of MS knock out holes/projections to connect MS pipes. Light outlet boxes for surface installation shall be of MS (painted).

Inspection Boxes
Rust proof inspection boxes of 2 mm thick mild steel having smooth external and internal finish shall be provided to facilitate removal and replacement of wires, where required.

Switches, Receptacles and Fixture
Switches:
All 5/15 amps switches shall be enclosed type flush mounted for 240 volts AC. The box in which the switches are fixed shall have an adjustable plate cover. Ample space at the back and sides shall be provided for accommodating wires. Switch, controlling the light point shall be connected to the phase wire of the circuit. The Switch plate shall be white plastic or any other approved type and it should match the interior design.

Wall Socket Outlets:
Following types of socket outlet shall generally be used for interiors:
All sockets shall be of shutter type.
5A 3 Pin Switched Socket outlet in Toilet, office area, lobby, etc.

6/16A 3 pin switched socket with Indicator for power points near work station.

16 Amps socket controlled by 16 Amps SP switch near Pantry.
20A industrial socket with controlled by 20A switch near O T, MRI SCAN, CT SCAN & Lab areas.

**Installation of Conduits**

**Concealed Conduit System**

Unless otherwise specified all wiring shall be in heavy gauge rigid MS/ FRLS PVC conduit embedded in wall, or ceiling and concealed in the false ceiling. The size of the conduit shall be selected in conformity with relevant IS code and as specified in the table 6.8.3.b.6 given above. Factory made conduit bends and accessories shall be used. Conduit shall be jointed using solvent as recommended by the conduit supplier. The conduit in ceiling slab shall be straight as far as possible. Before the conduits are laid in the ceiling, the position of the outlet points, controls, junction boxes shall be set out clearly as per the dimensions and to minimize off-sets and bends. Conduits in ceiling shall be bonded to the reinforcement rods with GI bonding wire to secure them in position. MS light outlet/pull boxes shall be provided as required. The conduit in ceiling slab shall be laid above the first layer of reinforcement rods to avoid cracks in the ceiling surface.

Conduits concealed in the wall shall be secured rigidly by means of steel hooks/staples at minimum 750 mm intervals. Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper required dimensions to accommodate number of conduits.

The chased portion of the walls for electrical works shall be plastered by electrical Contractor to bring it to the finished wall surface. The outlet boxes, control switches, and inspection and draw boxes shall be fixed as and when conduits are being fixed.

The recessing of conduits in walls shall be so arranged as to allow at least 12 mm plaster cover on the same. Where conduit passes through expansion joints in the building, adequate expansion fitting or other approved devices shall be used to take care of the relative movement of expansion joints.

All grooves, chases etc., shall be refilled with cement mortar and finished up to wall surface before plastering of walls is taken up by the general civil Contractor. Whenever the conduits terminate into Control Boxes, distribution boards etc., conduits shall be rigidly connected to the boxes/boards with check nuts on either side of the entry to ensure electrical continuity. All opening of conduits, junction boxes shall be properly plugged with MS stoppers or any other suitable materials, so that water, mortar, vermin or any other foreign materials do not enter into the conduit system. All MS conduit ends terminating into an outlet shall be provided with bushes of MS or rubber after the conduit ends are properly filed to remove burrs and sharp edges. Necessary GI pull wires shall be inserted into the conduit for drawing wires. The Insulated Earth wires shall be run in each conduit.
originating from the panel board up to the Light, Socket and Switch boxes. If the Electrical Contractor forgets to install any conduit/boxes etc., before the plastering/painting work is done by other agencies, he may be permitted to install the same with prior permission of Owner/PMC/Consultant and the expenses towards redoing the wall, floor, ceiling etc., shall be borne by the Electrical Contractor.

**Open/Surface Conduit System**

Conduits on surface of walls/RCC slabs shall be avoided as far possible. In case it is not avoidable, prior approval in writing shall be obtained from Employer/Consultant on the exact route. Heavy gauge GI saddles shall fix conduit. Distance between two consecutive saddles shall not exceed 900 mm. No wooden gutties for fixing saddles/clamps shall be used. Use of Rawl plug/steel fastener with hard setting/scaling compound is recommended. Conduits shall be run in square and by metrical lines. Wherever couplers, bends, or similar fittings are used, saddles shall be provided at either side at a distance of 300 mm from the center of such fittings. Conduits shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers/junction boxes shall be provided.

Threading shall be long enough to accommodate pipe to the full threaded portion of the Couplers and accessories. Cut ends of conduits shall have neither sharp edges nor any burrs left, to avoid damage to insulation's of wires.

Using pipe-bending machine shall do bends in conduit runs. Sharp bends shall be accomplished by introducing solid bends, inspection bends or MS inspection boxes. Radius of solid bends shall not be less than 75mm. Not more than 90-degree bend shall be used in a conduit run from outlet to outlet.

All conduits opening shall be properly plugged with stoppers/bushes. MS Conduits shall be adequately protected against rust by applying two coats of approved synthetic enamel paint after the installation is completed and should be certified by the Site Engineer. The certificate shall be submitted along with bills for payment.

Wherever conduits terminate into control boxes, outlet boxes, distribution boards etc., it shall be rigidly connected to the box with check nuts on either side of the entry.

In ground floor, conduiting below the flooring should be avoided. Wherever it is unavoidable, GI pipe should be used with prior approval of Employer/Consultant.

The MS conduit system shall be bonded to the earth.

**Wiring**

All wires shall have been manufactured in accordance with the latest IS Specification (IS 694-Part II).

All wires shall be FRLS insulated, copper conductors of 650-volt grade. Cross section of the conductor
shall be as per the specification mentioned in schedule of quantities.

Minimum cross section of conductor for electrical wiring shall be 2.5 mm square.

For single phase wiring, the colour of the insulation of phase conductors shall be Red/Yellow/Blue and black for neutral. The colour coding adopted should be uniform for the entire Project.

Earthing is to be done by Green FRLS insulated copper conductor. For three phase the insulation of phase conductors shall be Red/Yellow/Blue, as per relevant phase and Black for neutral.

Earth wire shall always be of copper conductor FRLS insulated and colour of insulation shall be Green.

Whenever wires are being terminated in a Distribution Board/Switch Box/Plug point/Outlet Box etc., a minimum of 200 mm long extra wire should be provided in the form of a loop for further maintenance use.

For each lot of wires, the Contractor shall submit all relevant test certificates issued by the Manufacturer stating its origin, date of manufacture, constitution and standards to which it complies. All wires and cables shall bear the manufacturer’s label and shall be brought to site in original packing.

Only Authorized/certified wiremen and cable jointers shall be employed to do the cable jointing work.

Wires shall not be jointed inside the conduit or pull boxes. Where unavoidable, joints shall be made through approved mechanical connectors with prior permission of Employer/Consultant.

Control switches shall be connected in the phase conductors only; and shall be ‘ON’ when knob is down. Switches shall be fixed in galvanized steel boxes. Plated screws shall be used.

Power wiring shall be distinctly separate from lighting wiring.

Each circuit phase wire from the distribution boards should be followed with a separate neutral wire of the same size as that of the circuit wire.

Wires originating from two different phases shall not run in the same conduit.

**Drawing Conductors**

The drawing and jointing of insulated copper/aluminum conductor wire and cables shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be
taken to avoid scratches, etc., Care shall also be taken to ensure that the insulation is not peeled off either in portions or as a whole; and the conductor is not broken anywhere. There shall be no sharp bends that may lead to the breakage of the conductor.

FRLS Insulated copper conductor wire ends shall be soldered (at least 20 mm length) before inserting into the switch for termination and Conductors having nominal cross sectional areas exceeding 10 Sq.mm shall always be provided with cable sockets/lug of same material as that of conductor.

Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and shall be soldered. Connecting brass screws shall have flat ends. All looped joints shall be soldered and connected through block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

At all bolted terminals, brass flat washer of large area and approved steel spring shall be used. Brass nuts and bolts shall be used for all connections.

For all internal wiring, FRLS insulated wires of 650/1100 volts grade shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. If the use of joint connections are unavoidable due to any specific reason, prior permission, in writing, shall be obtained from the Employer/Consultant. No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire, is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of wire. Before the wires are drawn into the conduits, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other construction debris, by forcing compressed air through the conduits. All sub-circuit wiring for light points shall be with 2.5 Sq.mm FRLS insulated copper conductor.

Mains and sub-mains
Mains and Sub-Mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub-main wire shall be drawn into an independent adequate size conduit. An independent earth wire of the proper rating shall be provided for each sub main, two earth wires of proper rating shall be provided for every single phase sub main. For every 3-phase sub main, two earth wires of proper rating shall be provided along with the sub main. The earth wires shall be fixed to conduits by means of clips at not less than 1000 mm distance. For mains and sub-mains extra lengths of cable shall be provided to facilitate easy connections and maintenance.

Load Balancing
Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

Colour Code of Connectors
Colour code shall be maintained for the entire wiring installation as red, yellow, blue for three
phases, black for neutral.

**Measurements**

**Point Wiring**
All outlets connected on a lighting circuit shall be measured under point wiring. It shall include wiring from first switch point of the circuit up to light, fan, socket outlet via switches, regulators, controls etc., as called for. Generally, the following accessories shall be included.

- Light outlet box with ceiling rose
- Lamp holder
- Switches
- 5/15 A socket outlets with plug tops
- M.S. /G.I. outlet box
- Fan hook
- Fan regulator
- Small wiring from outlet to Fan / Light
- Conduit and accessories

**Circuit main for light circuit**
Circuit main is inclusive in the point wiring and however wherever called for separately in the BOQ alone shall be measured in length from the Distribution Board/Panel Board up to the first switch box on that circuit only; from this point onwards, all looping will be measured under point wiring.

**General**
Point wiring and circuit wiring should be done in independent conduits and should not be taken through one conduit.

Fan regulator box, fans, light fittings, calling bells are to be properly earthed. In respect of 5 Amps conventional plug point, the third pin should be earthed with 2.5 Sq.mm green FRLS insulated copper wire.

All flush type switches and accessories will be used with 3-mm thick hylam sheet in MS box.

For the purpose of determining the load per circuit, the following electric rating of points shall be assumed.

- **Light point**: 60 watts
Conventional plug point : 100 watts
(Plug point in light switch box or independent)
Fan points : 60 watts
Exhaust fan points : 40 watts or as specified

Lights, fans and 5 A points shall be wired on a common circuit. Each circuit shall not have more than a total of ten points of lights, fans and 5 A socket outlets or a load of 800 watts whichever is less. The ceiling fan point shall be complete with special outlet box including fixing and connection of regulator. Supply and fixing of 5A switch for each ceiling fan is included in scope of Contractor.

For 15A Power Plug Points
In one circuit, there shall not be more than two 15A power plug points and 2 x 4 Sq.mm copper conductor wires shall connect circuit.

One flush type plug socket outlet and switch shall be fixed for each power point on 3 mm thick hylam sheet cover. Plug socket can be standard type or 15/5 A universal type as shown in the diagram. The circuit main would commence from DB and end up to the switch box. Looping of circuit would be done to second 15A power point from first 15A power point and shall be counted as power point wiring.

Each circuit would have its own 2.5 Sq.mm green FRLS insulated copper wire from DB to switch box and would be connected to third pin of socket outlet.

Electrical load for each 15A power point would be considered as 1000 watts.

Group Wiring
The following specification is applicable only when three or more lights (or) more than 500 watts of lighting load are controlled by one MCB.

Lights would be controlled by rated capacity MCB and connected by wire size, as specified in schedule of quantities. However, it shall not be less than 5A and 2.5 sq mm respectively. Light points controlled by one MCB would be in parallel.

MCB for these lights should be installed in a suitable MS box with hylam sheet cover. Total electric load is to be controlled from this. “Group lighting board” would not exceed 3000 watts or six groups of lights or as specified in the approved drawings. Circuits with earthing for this Group Lighting Board would always be from DB of size as specified in schedule of quantities.

“Group lights” points would commence from DB including circuits, surface/concealed conduit system, necessary wiring, MS switch box, M.C.B, hylam sheet cover and outlet box up to last light of the group.
12. LIGHT FITTINGS AND ACCESSORIES

1.0 **SCOPE:**

This Specification also covers the design, material specification, manufacture, testing at works, inspection and delivery at site of light fittings and their associated accessories.

2.0 **STANDARDS:**

The light fittings and their associated accessories such as lamps/tubes, reflector, housings, ballasts etc. shall comply with the latest applicable standards. All luminaries, lamps and accessories shall be of same make.

3.0 **GENERAL REQUIREMENTS:**

Fittings shall be designed for continuous trouble-free operation under hot humid atmospheric conditions, at an ambient of 45°C without reduction in lamp lift or without deterioration of materials and internal wiring. Outdoor fittings shall be weatherproof and waterproof type.

The fittings shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps / starters etc.

Connectors between different components shall be made in such a way that they will not work loose by small vibration.

For each type of light fitting, the Manufacturer / Vendor shall supply the utilisation factor to indicate the proportion of the light emitted by the bare lamp, which falls on the working plane.

The fittings shall be supplied complete with lamps.

The fittings and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.

All Direct-Indirect, CFL, & T5 light fittings shall be completed with accessories like lamps, ballasts, power factor improvement capacitors, starters / igniters wherever applicable etc. These shall be mounted as far as possible in the fitting assembly only.

Outdoor type fittings shall be provided with outdoor type Control gear box. The fittings shall be power factor corrected to 0.95 (maximum)

Each fitting shall have a terminal block suitable for loop-in, loop-out T-off connection. The internal wiring shall be completed by the manufacturer by means of stranded Copper wire and terminated on the terminal block.

All hardware used in the luminaries, shall be Cadmium plated.
4.0 **EARTHING:**

Each light fitting shall be provided with an earthing terminal suitable for connection to the earthing conductor.
All metal or metal-enclosed parts of the housing shall be bonded to the earthing terminal so as to ensure satisfactory earth continuity throughout the fixture.

5.0 **PAINTING / FINISH:**

All surfaces of the fittings shall be thoroughly cleaned and de-greased. The fittings shall be free from scale, sharp edges and burns.
The housing shall be stove-enameded / epoxy stove-enameded / vitreous enameded powder-coated of anodised as indicated as indicated under various types of fitting.
The finish of the fitting shall be such that no bright spots are produced either by direct light source or by reflection.

6.0 **ACCESSORIES FOR LIGHT FITTINGS:**

6.1 **REFLECTORS:**

The reflectors shall be made of CRCA sheet steel. Aluminum / Silvered glass as indicated, for the above mentioned fittings.
The thickness of Steel/Aluminium, shall comply with relevant Standards. Reflectors made of Steel, shall have stove-enameded / Vitreous-enameded / Epoxy-coating finish.
Aluminium used for reflectors, shall be anodized / Epoxy Stove-enameded / Mirror polished.
Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting co-efficient such as to ensure the overall light output specified by the manufacturer.
Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools, they shall be securely fixed to the housing by means of positive fastening device of captive type.

6.2 **LAMP / STARTER HOLDERS:**

Lamp Holders shall comply with relevant Standards. They shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met within normal installation and use.
Lamp Holder for the fluorescent lamps shall be of the spring loaded bi-pin rotor type.
Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pings when in working position. Starter holders for fluorescent lamps shall conform to the relevant Standards. All material used in the construction of the holder shall be suitable for tropical use. The Starter Holder shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

6.3 **BALLASTS:**

The ballasts shall be designed, manufactured and supplied in accordance with the relevant Standards. The ballasts shall be designed to have a long service life and low power loss. Ballasts shall be mounted using sell locking, anti vibration fixings and shall be easy to remove without de-mounting the fittings. They shall be in dust-tight, non-combustible enclosures. The ballasts shall be of the inductive, heavy-duty type, filled with thermosetting insulating, moisture-repellant, Polyester compound filled under vacuum. Ballasts shall be provided with tapping to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure. The ballast wiring shall be of Copper wire that shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Vendor. Low loss Silicon steel lamination, shall be wounded with super enameled Copper wire with Class "F" insulation on glass filled Nylon bobbin. High temperature-resistant interlayer Polyester film shall be used for inter layer insulator glass-filled Polyester connector should withstand high voltage upto 5 KV. Separate ballast for each lamp shall be provided in case of multi lamp fittings. The ballast for each lamp shall be provided in case of multi lamp fittings. The ballasts for Metal Halide lamps shall not be constant wattage type.

6.4 **STARTERS:**

Starters shall have bi-metal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference capacitor. The starters shall generally conform to the relevant Standards.

6.5 **CAPACITORS:**

The Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.
The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.95 lag. The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.

6.6 **LAMPS:**

Incandescent (GLS) lamps shall be of "Clear" type unless otherwise specified. The fluorescent lamps shall be "Cool Day Light" type unless otherwise specified and shall be provided with features to avoid blackening of lamp ends. The fluorescent lamps shall have a high lumen output of 3250 lumens. The lamp shall have triple coil electrode with an anode ring and a triband Phospher coating.

Direct- Indirect Recess mounted light with a luminous efficiency of 70 lumen / watt. The average lumen output shall be 5800 lumen for 2x36w light fitting and lamp voltage shall not exceed 100V.

The lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments / electrodes, shall not break under such circumstances. Lamps / Tubes shall conform to relevant Standards and shall be suitable for supply voltage and frequency specified.
13. CABLE TRAYS

1.0 **SCOPE:**

1.1 **TRAYS MADE OUT OF MS ANGLES, FLATS ETC.**

This specification covers the design, supply, fabrication fixing, aligning, and painting of cable trays and other steel frame works at site as required.

The cable trays shall be designed and fabricated out of various sections such as M.S angles, flats, channels etc. and got approved by Consultants.

Before fabrication the MS sections shall be properly straightened, aligned, cleaned properly to remove rust if any. All materials used for fabrication of cable trays shall conform to IS 226 and fabrication shall be as per IS : 800.

After fabrication the cable trays, and accessories shall be free from sharp edges, corners, burrs and unevenness, and a coat of cold phosphate chemical shall be applied followed by a coat of red oxide primer.

The cable trays shall be welded to the mounting supports which in turn are either welded to plate inserts or grouted to structural members.

Plate inserts for cable tray mounting supports shall be provided by Civil Contractor. Cable trays shall either run in cable trenches or run overhead and supported from available structure.

Minimum clearance between the top most tray tier and structural member shall be 300 mm. The type and size of tray to be used shall be as required. Each continuous length of cable tray shall be earthed at minimum two places.

All hardware’s such as passivized bolts, nuts, washers, and other consumable required for the fabrication and erection shall be included in the rate quoted by contractor. However, if any grip / Anchor bolts or fasteners are required, the same shall be paid extra.

The cable trays, accessories, covers etc. shall be painted with two coats of red oxide primer followed by two finishing synthetic enamel paint of approved shade. Where any cuts or holes are made or welding is done on finished steel work, the same shall be sealed against oxidation by
red oxide primer followed by finished paint.

1.2 TRAYS MADE OUT OF GI SHEET.

Cable trays shall be made of 2mm thick, perforated, galvanized sheet steel. Sizes shall be 300mm or 150mm wide as applicable and 75mm high.

Trays shall be supported at every 1500mm intervals when run under slung from slab / beam or run along wall / structure.
Supports shall comprise of M.S angles of sizes denoted in the relevant layout drawings. The support steel sections shall be applied one coat of red oxide primer and two coats of finish paint of approved color.
Cable trays shall be earthed at every 15-meter intervals or through an earthing conductor run along its route length, as shown in the layout drawings.

Trays shall be bolted to the support steel members. Supports shall be derived from building structure by anchor fasteners,
14. DISTRIBUTION BOARDS

SCOPE
Supply, erection, testing and commissioning of standard make distribution boards conforming to relevant Indian standards (IS 8623) and specifications given below.

GENERAL
Distribution Boards Shall Consist Of Following.

MCBs and ELCBs of reputed make and designed capacity, which shall conform to IS 8878 latest.

Neutral strip/earth strip for connecting all distribution point neutral/earth wires of guest room.

Two numbers brass bolts and nuts on DB base for its earthing. Cable conduit entry boxes on top and bottom as per design drawing.

However the specifications herein after described shall take precedence over the above wherever this specifications call for a higher standard of material or workmanship. The distribution boxes shall be of standard factory make and flexibility shall be given to mount MCBs and ELCBs of any make.

CABINET DESIGN

Distribution boards shall be of totally enclosed type with dust and vermin proof construction. The enclosure shall be made of steel sheet of 18G. The steel sheet shall be treated with a rigorous rust inhibition process before fabrication. The distribution boards shall consist of Earth Leakage/Miniature Circuit Breaker as in-comer and required number of miniature Circuit Breakers as outgoing. The distribution boards shall be with top and bottom cable/conduit entry. The incoming and outgoing shall be rated as specified on the drawings and schedule; and both shall be totally isolated from one another. The cabinet shall be spray enameled to required colour shade finish. The interior components of the DB shall be mounted on Din Rails, mounted on the studs provided inside the cabinet. Covers made of hylam sheet, or spray enameled 16 G steel sheets, shall be provided over the cabinet, with slots for operating knobs or breakers.

The cabinet shall be equipped with 16/18G inside hinged front door having a spring latch and lock over flanged door. Cabinets shall have detachable gland plates at both top and bottom made out of 16/18G. The hinged type door shall be with ‘U’ shape edge to provide square type compressed rubber gasket.

The construction of the hinges shall be to enable the door to swing open by not less than 150°. In addition to this, the hinged design shall permit doors being completely removed whenever
MINIATURE CIRCUIT BREAKERS (MCB)

Miniature Circuit Breakers shall be quick Make and Break type, and shall conform to relevant Indian Standards. The housing shall be heat resistant and shall have high impact strength. MCBs shall be flush mounted and shall be provided with trip free manual operating lever and ‘ON’ and ‘OFF’ indications. The contacts shall be provided with magnetic and thermal releases for short circuit and over current. The device shall have a common trip bar in the case of DP and TPN Miniature Circuit Breakers.

MCB for ratings upto 125 Amps shall be available in 1, 2, 3 or 4 pole versions. MCB casing shall be made of self-extinguishing material tropicalised treatment 2 (relative humidity) 95% at 55°C. MCB shall comply with IS 8828-1996/IEC 898— 1995.

It shall be suitable for use in frequency range 40Hz to 60Hz and shall accommodate AC/DC supply according to requirements.

Arc chutes should be provided for effective quenching of arc during operations and fault conditions.

It shall have trip free mechanism and toggle shall give positive contact indication.

It shall have trip free mechanism ad toggle shall give positive contact indication.

It shall be suitable for mounting on 35mm DIN rail/surface mounting.

Line supply may be connected to either top or bottom terminals i.e. there shall be no line load restriction.

Degree of protection, when the MCB is flush mounted, shall be 1P40. MCB & shall be supplied with clamping terminals fully open.

Contact closing shall be independent of the speed of the operator.

MCB’s operating temperature range shall be —20 deg C to + 60 deg C.

The characteristics should be in accordance with IS 8828 —1996. The breaking capacity of the MCB shall be 10kA and energy limiting class3.

The rated impulse voltage of the MCB shall be greater than 4kv.

The MCB shall be capable of being used as Incomer circuit breaker and shall be suitable for use as an isolator.

Contact closing shall be independent of the speed of the operator.

Electrical endurance of the MCB shall be greater than 4kV.

Power loss per pole shall be in accordance with IS 8828-1996 and the manufacturer shall furnish the same.

In case of multipole MCBs in a single location (DB), it shall be possible to remove MCB without having to disturb other MCB’s in the vicinity.

‘B’ curve type MCB should be used for lighting loads, ‘C’ curve type for motor loads and ‘D’ curve
type for UPS circuits.

**INDICATING LAMPS**

<table>
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<tr>
<th>Type</th>
<th>Panel mounting “Protected LED” types. (I.e. protection is provided against Electromagnetic interference &amp; over Voltage)</th>
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<tr>
<td>Standard applicable</td>
<td>IEC 947-5-1</td>
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<tr>
<td>Electric shock protection</td>
<td>class 2 (IEC 536)</td>
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**PUSH BUTTONS**

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<td>Degree of protection</td>
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<td>Reset PB Yellow</td>
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<tr>
<td>Contact rating</td>
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</tbody>
</table>

**TERMINALS**

Distribution Boards shall be provided with a terminal block for neutral and earth terminations of adequate size. The terminal block shall be so located as to prevent crowding of wires in the proximity of live parts.

**DIRECTORY**

Distribution Boards shall be provided with a directory indicating the areas of loads served by each Circuit Breaker, the rating of breakers, size of conductors, etc. The directory shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door. A suitable size “Danger”
plate indicating voltage grade shall also be fixed inside the DB front cover.

**INSTALLATION**

Distribution Boards shall be wall surface mounted or recess mounted as required and at the locations shown on the drawings. The Boards shall be fixed on 30 x 40 x 6mm angle iron framework and bolts for surface installation. All the cables/conduits shall be properly terminated using glands/grips/check nuts, etc. Wiring shall be terminated properly, using crimping lugs/sockets and PVC identification ferrules. No bare conductor shall be provided inside the board.

Distribution boards shall be bonded to the earthing system at least at two points using brass bolts and lugs.
15. TRANSFORMER

TECHNICAL SPECIFICATION FOR TRANSFORMER WITH OLTC

The transformer cubicle will be fitted with oil filled as per the technical specification detailed below

General

The Transformer shall be of oil filled type, generally in accordance with is:2026 as applicable unless specified otherwise should be ISO 9001 certified company manufacturing Transformer and also in accordance with the following requirement.

The transformers shall be designed and suitably insulated for continuous operation at the rated KVA, under the prevailing site conditions at the rated voltage, frequency and temperature rise stipulated hereinafter.

VARIATION IN VOLTAGE & FREQUENCY.

The rated no load voltage shall be as under:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV</td>
<td>11,000 Volts</td>
</tr>
<tr>
<td>LV</td>
<td>433 Volts</td>
</tr>
</tbody>
</table>

The rated frequency shall be 50 Hz.

The transformers shall be designed for satisfactory operation of any supply voltage with +5% to −15% in step of 125% of rated voltage of 11,000 volts Fault level at 11 kV systems is 350 MVA

Nature of the Load

The Transformer will be commissioned to provide electrical supply to a commercial complex.

Winding

The HV & LV winding shall be of copper and shall be circular. The arrangement of the windings shall be such that there is no magnetic imbalance under all conditions of operation.

The Design and construction of the core coil assembly shall feature the following:
Inner turn short circuit around the core is avoided.

Windings are totally impervious to moisture and designed for operation of 50 degree “C” ambient temperature.

No creep age path can form under dusty & humid atmosphere condition.

The coils are noninflammable and self-extinguishing.

The design, treatment, and construction of the transformer and bracings of the windings shall be such as to withstand the heavy mechanical & thermal stresses, which may be experienced under the normal conditions of daily cycles of heating and cooling due to fluctuations in load and of dead short circuits on either side of the transformers due to fault conditions. The windings shall be capable of withstanding a fault of the level of 15 KVA for 1 second without any permanent damage to insulation.

All clearances of windings and other live parts shall be adequate for maximum voltage of operations of 11,000 volts plus 10% for these transformers.

**Connections**

The windings shall be connected delta on the primary and star on the secondary with neutral brought out to an insulated terminal for direct earthing the connections shall be made in accordance to the vector symbol Dyn 11.

**Insulation**

The primary windings of the transformers shall be suitable for highest system voltage of 12KV for 11KV primary voltage and shall withstand power frequency test voltage as per table 2 of IS 2026/ (III). The power frequency test voltage for the primary & secondary windings shall be 25 KV RMS. The tendered must clearly state in his tender the value of the power frequency test voltage for which the primary and secondary windings of the transformers are designed. Minimum insulation level for primary shall be 75 KV impulse and 28KV power frequency and secondary and 25 KV power frequency.

The inter turns and end turns of the HV & LV windings shall be insulated for protection against surges and transients.

**Temperature Rise**

The temperature rise of the transformer above the cooling air temperature when tested at the rated
KVA shall not exceed the limit in table 4 of IS 11171/1985 reaffirmed in 1991 for ‘F’ temperature class of insulation when tested in accordance with Clause No17 of IS 11171/1985 reaffirmed in 1991 i.e. winding rise by resistance method should be less than 90 degree C.

**Overload Capacity**

The permissible overloading of the transformer under the following operation conditions shall be clearly stated by the tendered.

However the minimum requirement of the overload capacity is 110% for one hour operation.

**Radio interference and Noise level:**

The transformer shall be designed with particular attention to the suppression of maximum harmonic voltages, especially the third and fifth, so as to minimize interference with communication circuits.

The Noise level, when energized at normal voltage and frequency, shall not exceed, when measured under standard conditions the value specified by IS standard.

The maximum flux density in any part of the core and yokes at normal voltage and frequency shall be such that the flux density under over voltage conditions shall not exceed the maximum permissible values for the type of core and yoke material used. The type of material and values of flux density in the core/yoke for the 100%, 110%, 125% and 140% and the hysteretic characteristic curves shall be included in the bid and shall be subject to the purchaser’s approval.

The transformers shall be designed for the following over fluxing withstand capability:

- 110% : Continuous
- 125% : for 1 minute
- 140% : for 5 seconds

Transformers shall be capable of operating under natural air cooled condition to the specified capacity. Transformers shall be capable of operating continuously in accordance with the application standard loading guide at their rated KVA and at any of the specified voltage ratios.

**IMPEDANCES**

The percentage impedance voltage at principal tapping on the ratio primary/secondary KVA base shall be as per IS 2026 the permitted tolerance on this value is as specified in IS 2026.

**LOSSES**
Transformers with lower losses are preferred.

PLEASE INDICATE THE LOSSES AS PER IS 2026 PART1 TABLE7

NOLOAD LOSS =

FULL LOAD LOSS =

TOTAL LOSS =

IMPEDANCE =

Permissible tolerance = 10% of the Total Loss

Positive tolerance is not permitted.

If the test figures exceed the quoted values, the transformer will be rejected/capitalized.

Core
The core shall have inter layered yoke which shall be well clamped to minimize humming as far as possible when the transformer is on load.

The core shall be constructed from non-ageing low loss silicon steel laminations of the cold rolled grain oriented type, treated with an oxide insulating material on both sides of each lamination. The outside of the core is protected against corrosion by an epoxy resin finish. The insulating materials shall be of such composition that there is no possibility of moisture being absorbed by it due to the varying seasonal and daily temperature cycle in a humid atmosphere.

The core shall be provided with suitable lifting lugs to enable the complete core and coil assembly to be lifted for transportation.

FITTINGS

The transformer shall be provided with the following fittings as per IS 2026/1977 (I).

Rating & Diagram Plate : 1 No
Earthing Terminals : 2 Nos
Lifting Lugs : 2 Nos
Terminal Board : 1 No
Base Channel & Bi Directional Rollers : 1 No
Set Metal Enclosure IP : 2 Nos
Set On Load Tap Changer + : AVR 1
Digital Temperature Scanner : 1 No
off load tap changer 11 kv 1 no (suitable for 415v, 3 ph, 50 hz operation) -

Rollers

The bidirectional rollers shall enable the transformer to roll in planes at right angles to the vertical plane containing the centerlines of the HV & LV termination, as the case may be.

Terminals

The primary of the Transformer should have a Cable box for terminating suitable upto 11KV 3C 95 Sq mm XLPE Cable and the secondary of the Transformer should be suitable for terminating with L.T AYFY Cable. The neutral bushing should be brought out for earthing the neutral of Transformer.

The minimum height of the cable gland from ground level shall not be less than 750mm.

The high & low voltage phase terminals shall be mounted with enclosure red, yellow, and blue, the neutral point terminal being indicated by letter ‘N’.

Taps

Tapping shall be provided on the higher voltage winding for variation of HV voltage as per IS 2026

Terminal marking plate & rating plate

Each transformer shall be fitted with a terminal marking plate and rating plate. These shall be engraved metal plates giving clearly the connections for the transformer, the terminal marking and all other information as specified in clause 8 of IS 11171/85 reaffirmed in 1991.

Housing

The transformer shall be totally enclosed type as per clause (No222 of IS 11171/85 reaffirmed in 1991 the housing (enclosure) shall be IP23 class as per IS 2147.

Testing and Inspection Tests: The transformer shall be subjected to the following tests at the manufacturer’s works as specified in section 5 of IS 11171/85 reaffirmed in 1991.

Routine tests: Measurement of winding resistance
Ratio, Polarity, and phase relationship
Measurement of Impedance Voltage
Load losses at 50%, 75% and 100% load at unity and 08 (lag) PF
No load losses and no load current
Induced over voltage withstand
Separate source voltage withstand
Partial discharge for applied voltage up to 13 times of rated voltage
Voltage regulation

The tolerance on the above performance test values shall be as specified in IS 2026 / 1981.

The tenderer shall supply three certified copies of the test certificates in respect of each test carried out on the transformers.
The transformer along with the enclosures shall be offered for inspection and witnessing the tests referred above by our representative at the manufacturer’s works before dispatch.

FOR 11KV /433V OUTDOOR TYPE DISTRIBUTION TRANSFORMER

Transformer rating (continuous) KVA : 750kVA
Quantity : As per BOQ
Duty/Application : continuous/Power Distribution
Service : OUTDOOR
Type of Winding/Core : Double wound/Core type
Type of cooling : ON-AN
Winding type : Electrolytic grade Copper
No of Phases : Three, HV, LV 4 Wire
Supply Frequency : 50Hz
Primary winding (HV/Incoming Side) : Delta
Secondary winding (LV/Outgoing side) : Star
Vector group Symbol (as per IS 2026) : Dyn11
Ambient conditions (as per IS 2026) : Suitable for CHENNAI, India
Max ambient air temperature : 50deg C
Max daily average temperature : 40deg C
Max yearly weighted average temperature : 32deg C
Min ambient air temperature : 5deg C
Min Altitude (above MSL) : <= 10M

Guaranteed Temperature rise over above ambient conditions:

By thermometer : 32 C
By winding resistance method : 55 C

Nominal primary voltage (No Load) : 11KV
Nominal secondary voltage (No Load) : 433V
Tapping on HV side : Provided for variation of Incoming Voltage
Tapping Range : +2.5+5 %-2.5-5%m each slip
The Transformer shall conform to IS 2026 (parts HV) and CBIP Manual on power transformers, and standard manufacturing practice

NOTE: THE TRANSFORMER ENCLOSURE SHALL BE DESIGNED FOR EMI INTERFERENCE FREE

GUARANTEED TECHNICAL PARTICULARS FOR TRANSFORMERS
(TO BE FILLED IN BY THE TENDERER)

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description</th>
<th>Units</th>
<th>To be filled by the bidders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Name of the manufacture or type of transformer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Out door</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Rating</td>
<td></td>
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<tr>
<td></td>
<td>Air cooled</td>
<td>KVA</td>
<td></td>
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<tr>
<td>4</td>
<td>Rated Frequency</td>
<td>HZ</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Number of phases</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>Rated Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. HV Winding</td>
<td>KV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. LV Winding</td>
<td>KV</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Vector group symbol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Type of cooling</td>
<td>(Air cooled)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Tapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a Range</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>b Number of Steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c Tapping provided on HV Side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Losses (at 75 Deg Centigrade and principal tapping)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a No load loss at rated voltage and frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b Load loss at rated current Subject to IS Tol</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c Total loss at maximum rated power</td>
<td></td>
<td></td>
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<tr>
<td>11</td>
<td>Impedance voltage at 75 deg Centigrade</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a At principal tapping</td>
<td>%</td>
<td></td>
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<tr>
<td></td>
<td>b At maximum tapping</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c At minimum tapping</td>
<td>ORDER</td>
<td></td>
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<tr>
<td></td>
<td>Reactance at rated current and frequency</td>
<td>%</td>
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<td>----------------------------------------</td>
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<tr>
<td>13</td>
<td>Resistance at rated current and 75 deg Centigrade</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a HV</td>
<td>OHMS/PHASE</td>
<td></td>
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<tr>
<td></td>
<td>b LV</td>
<td>OHMS/PHASE</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Zero sequence impedance</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Zero sequence capacitance of HV winding</td>
<td>MICRO FARAD</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Temperature rise 45 deg Centigrade above ambient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Hottest spot temperature in winding limit to over an maximum yearly weighted average ambient temperature of 32 deg Centigrade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Efficiency at 75 deg Centigrade and 0.9 PF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a At full load</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b At 75% load</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c At 50% load</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Load and Power Factor at which maximum efficiency occurs % full load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Maximum efficiency</td>
<td></td>
<td></td>
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<tr>
<td>21</td>
<td>Regulation at full load and at 75 deg Centigrade</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a At unit PF</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b At 0.8 PF lagging</td>
<td>%</td>
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<td>22</td>
<td>No Load current referred to 0 HV and 50 HZ (apprx)</td>
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</tr>
<tr>
<td></td>
<td>a At 90% rated voltage</td>
<td>A</td>
<td></td>
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<tr>
<td></td>
<td>b At 100% rated voltage</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c At 110% rated voltage</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Maximum current density at rated power</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a HV winding</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b LV Winding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Maximum Flux density in iron at rated voltage ratio and at rated frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a At 100% rated voltage</td>
<td>TESLA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b At 110% rated voltage</td>
<td>TESLA</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Maximum clearance in air</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>a Between phases (HV/LV)</td>
<td>MM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b Between Phases &amp; Ground</td>
<td>MM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Insulation Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a Impulse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I HV</td>
<td>KV(PEAK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii LV</td>
<td>KV(PEAK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Power Frequency</td>
<td></td>
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</tr>
<tr>
<td>HV</td>
<td>KV (rms)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV</td>
<td>KV (rms)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Winding Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>29</td>
<td>Insulation Material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HV</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LV</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tapping leads</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Core to LV</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HV to LV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Details of Core</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a Core Lamination Materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of laminations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation of lamination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (Shell or Core)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific loss of Core steel at 15 tesla</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Details of tank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>: Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of side</td>
<td>mm</td>
<td></td>
<td></td>
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<tr>
<td>Thickness of bottom</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of cover</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of Tube</td>
<td>mm</td>
<td></td>
<td></td>
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<tr>
<td>Maximum internal pressure the tank is capable of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No of Limbs(core type)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Maximum Noise Level</td>
<td>db</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Approximate Maximum overall dimensions including fittings</td>
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<td></td>
</tr>
<tr>
<td>34</td>
<td>Height</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Breadth</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>mm</td>
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<tr>
<td></td>
<td>Shipping Dimensions</td>
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<td></td>
</tr>
<tr>
<td>35</td>
<td>A Height</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B Breadth</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C Length</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Core winding</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shipping weight</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Reference Standard</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
16. DIESEL GENERATOR

1. A DG set of suitable capacity shall provide the backup power to Emergency & Essential categories of loads as well as to the UPS. While working out capacity of DG set; provision shall be made for soft start of heavy loads such as firefighting pumps for clipping the maximum demand during starting and running of such load.

2. The DG set shall also be located as close to the auxiliary substation and the fire pump room possible. Starting of DG set shall be controlled through automatic mains failure panel (AMF). The supply from the DG set shall be received at LV switch board provided in ASS and DG set supply shall be extended to LV MBD through a bus coupler arrangement suitably interlocked to open whenever the income supply resumes after a failure. A direct feeder will go from DG set to pump room for fire pumps.

3. The DG set shall be able to start automatically even in cold conditions to take full load within 10 seconds (Wake up time) of failure of normal supply. The AMF panel shall be connected & provided with suitable interlocking arrangements to ensure automatic starting of the DG set on the failure of supply from both the feeders and interlocking arrangement to avoid any incident of parallel of normal power supply to DG set supply. The equipment shall be designed, to the international standards like BS4999, BS5000, BS5514, IEC34, or equivalent, to the latest changes and tested as per these standards and designed for low specific fuel consumption, low weight (KG) to KVA capacity ratio & less space (SQM) to KVA capacity ratio.

4. The design shall include following but not limited to diesel Engine, alternator, cooling system, filtration system, starting system, automatic idle run, battery charging system, exhaust silencer system, coupling arrangement, mounting arrangement, lifting arrangement, Smoke exhaust & ventilation, auto start, foundation, power factor correction, testing & commissioning.

5. Protection and annunciation system confirming to latest standards like BS/IEC or IS with soft control and touch resets shall be designed and provided comprising of overload, short circuit trip, High temperature for cooling water trip, Alarm in case the DG set is not run for one week at a stretch, Earth fault, Reverse power relay, Low battery voltage, fault indication alarm through suitably designed hooter. Self-diagnostic annunciation system.

6. The Engine will be provided with safely protection against low lubricating oil pressure, High engine – Temperature. Fail to start, safety control trip for the DG set. Safety control trip for Engine over-speed. Each safety device shall include LED indication, annunciation, alarm and
tripping arrangement. Alarm and operation status shall be available on auxiliary terminal board so as to enable extended alarm and operation status to operation control center & station control center. The metering system shall be based on digital indication with status on auxiliary contracts. The control system and metering panel shall include all above parameters to be monitored.

1.0 SCOPE

This specification defines the minimum requirements for supply of a diesel engine generator set to be installed. The Vendor shall be responsible for all design, fabrication, assembly, painting and testing necessary to provide a complete and operable unit in accordance with this specification and all attachments listed herein.

2.0 GENERAL

2.1 Purpose

The emergency generator set will be used for power generation and will supply power to motors, communication equipment, lighting, and utility loads on the platform during periods when the main generating sets are shutdown and during the platform start-up.

2.2 Codes and Standards

The following codes and standards are referred to and made a part of this specification.

ISO 3046
International Standards Organizations, Standard for Reciprocating IC Engines, Parts I to VI.

NEC

IEC

2.3 Included Equipment

2.3.1 The Vendor shall furnish all components and ancillary equipment to make a complete, operating diesel engine, generator system. The system shall include, but not be limited to the following equipment.

- Diesel Engine and Generator with Coupling
• Engine Starting System (For black start and subsequent start).
• Lube Oil System
• Fuel System
• Engine Cooling System
• Governing System
• Engine Control System
• Remote Control panel (if specified on data, sheet).
• Generator Breaker (if specified on data sheet).

2.3.2 Some of equipments shall be supplied to the Switchgear Vendor by the Generator well in time. Such equipments are listed in enclosed emergency generator incomer equipment data sheet.

2.3.3 Vendor shall provide one skid-mounted local engine control panel with manual start/stop and facility for remote automatic start/stop and manual emergency stop.

2.3.4 Excluded are electrical power feeders and cables, motor starters and interconnection cables, inter-connecting cables from generator to remote control panel / switchgear and local control panel to remote control panel / switchgear.

2.3.5 Vendor shall provide interface for all utilities required at the skid edge and on the local control panel.

2.4 Safety

2.4.2 All Controls shall operate in a fail safe-mode.

2.4.3 All couplings and gears shall be provided with adequate guards of non-sparking type. Drive belts, if used, shall be anti-static type.

2.4.4 Piping shall be arranged to minimize tripping or head room problems. Piping or tubing of insufficient mechanical strength for standing or hanging shall be protected from personnel traffic.

2.4.5 Equipment shall have noise attenuating characteristics to reduce noise in accordance with “Equipment Noise Limits”.

2.5 Conflict
In the event of conflict between this specification and other documents listed herein, the following priority shall govern.

i) Data Sheets
ii) This Specification
iii) General Specifications
iv) Codes and standards.

### 3.0 DESIGN CRITERIA

#### 3.1 Generator

3.1.1 Continuous rating of the generator will be as mentioned in attached data sheet at the site conditions and at rated rpm, when equipped with all necessary operating accessories such as exciter, radiator, fan, etc. described elsewhere in this document.

3.1.2 Voltage regulator shall be employing Zener references and arranged for single phase sensing. Regulator shall be arranged for automatic control and shall include frequency sensing circulatory to limit ceiling voltage and prevent damage to components when the generator is driven at reduced speeds such as when starting or idling the prime mover. Regulator shall also include current – boost, circuitry to furnish excitation and sustain voltage under short-circuit conditions and rheostats to control terminal voltage.

3.1.3 The steady-state frequency shall remain within $\pm \frac{1}{2}\%$ of the rated frequency.

3.1.4 Provisions shall be made for termination of cables / bus duct from switchgear.

3.1.5 Neutral of generator shall be solidly grounded and facility for neutral isolation shall be provided. Neutral CT shall be mounted in the neutral terminal box.

#### 3.2 Diesel Engine

3.2.1 The design, construction, and rating of the diesel engine shall fully meet the requirements of the electric power generator and the Vendor shall be responsible for safe and satisfactory operation of the D.G. set as a whole.

3.2.2 The offered diesel engine shall be one of the regular production models of the manufacturer for industrial applications and already type tested. The type test report shall be furnished to the company for review, if so desired. In case the proposed engine model has not been type tested, vendor shall furnish a
reference list of its existing installations and at least three of these engines should have completed 5000 hrs. (each) of continuous running at site.

3.2.3 Unless otherwise specified, the site rating of the engine shall be worked out considering denoting in accordance with ISO 3046.

3.2.4 The Engine shall be capable of satisfactorily providing an output 10% in excess of the continuous rating specified in the data sheet, at the same speed, for two hours in any period of 12 hours consecutive running.

3.2.5 The Engine shall be water cooled, naturally aspirated or turbo charged engine. The engine shall use ‘diesel’ as fuel.

3.2.6 The Power requirement of the engine / motor driven radiator or the coolant pump and other auxiliaries shall be clearly stated.

3.2.7 Diesel Engine shall be capable of starting without the use of cold starting aids.

3.2.8 A diesel day tank with a minimum capacity as defined in the data sheet for the full load shall be supplied along the interconnected piping, valves, air breathers, level gauge, strainer a hand hole of not less than 150mm dia besides the required connections, and a drain plug.

3.2.9 The inside surfaces of the day tank shall be coated with Enamel red or black or its equivalent.

3.2.10 Fuel System:

a) The Engine shall be capable of satisfactory performance on diesel fuel.

b) The Engine shall have individual mechanical fuel injector for each cylinder.

c) The fuel system shall have built-in gear type engine-driven fuel transfer pump to supply, at constant pressure, fuel through filter to the injection pump.

d) The diesel to the engine-driven transfer pumps shall be supplied from the day tank mounted integrally as part of the engine skid. With a low level switch with DPDT contacts and self-actuated full float level controller in the fuel oil inlet line to day tank.
e) Excess fuel to the engine shall be returned back to the day tank

### 3.2.11 Performance Data

The Vendor shall furnish fuel and lubricating oil consumption estimates under different load conditions of engine-generator and also given an estimate or requirements of combustion air in the proposal. Vendor shall also indicates in his proposal the rate of heat radiation from the Generator set to enable the company to size the ventilation system for the generator room.

### 3.2.12 Lubrication

The Engine shall have positive displacement, gear type lubrication oil pump for supplying oil under pressure to main bearing, crank pin bearing, piston pins, timing gears, crankshaft bearings, and valve rocker mechanism, etc. Effective full flow duplex type lubricating oil filters shall be provided and so located and connected that lubricating oil is continuously filtered and cleaned. Filters shall be accessible and suitable for easy replacement. This system shall have a lube oil cooler with thermostat.

### 3.2.13 Intake Air-filters

The Engine shall be provided with dry type air cleaners of sufficient capacity for the intake air.

### 3.2.14 Exhaust System

The exhaust system shall be furnished with spark arresting type silencer with flexible connector. Exhaust piping in the enclosure shall be supplied with calcium silicate insulation. A flexible connection for the exhaust on the engine shall be supplied (Exhaust ducting to safe location by Contractor).

### 3.2.15 Cooling:

The engine shall be cooled by means of a radiator type cooling system composed of an engine shaft or motor driven radiator fan as per data sheet and a water pump controlled with full-flow bypass.

### 3.2.16 Governor
The governor for the engine shall be electromechanical Woodward 2301. or equal, with matching actuator. The mechanical operation shall be used during operation of engine generator under ‘black start’.

3.2.17 Instruments and Controls

The engine shall be equipped with instruments, gauges and controls as per the Diesel Engine / Instrument data sheets attached. Vendors shall also include any other safety devices which are considered necessary for the protection of equipment supplied by them.

3.3 Engine Control Panel

3.3.1 The engine controls supplied by the Vendor, completely wired, mounted on a panel and the panel installed in a corrosion-proof enclosure.

3.3.2 Wiring of the panel shall be complete and shall include a terminal block for termination of all points external to the panel. All relays shall be plug-in type and hermetically sealed with spoiling clips.

3.3.3 The controls shall include a local on / off / remote switch for energizing the controls. The ‘on’ mode shall open a solenoid valve in the fuel line to the engine. System shut-down /s top (off) shall de-energize a solenoid valve to shut off the fuel supply to the engine. The remote model shall allow starting and stopping from a remote location. Automatic starting shall be provided with lockout after three starts. Engine shutdown shall cut-off air supply to the Engine.

3.3.4 The Engine shall shut-down on low oil pressure, excessive vibration, high water temperature, and over speed. Alarm shall be provided for excessive vibration, low radiator water level, oil pressure-low, Jacket water temp. High, over speed, low diesel fuel level and high oil temperature. Under any of these abnormal conditions, a visual local indication on the control panel shall be given and an auxiliary contact, which is closed in healthy condition, shall open to activate a remote annunciation. In addition, a dry contact will be provided that opens on the successful starting and running of the engine (to provide remote status indication).

3.3.5 The controls shall prevent cranking of the engine if a shutdown condition exists.
3.3.6 The Engine control circuit shall provide terminal contacts for ‘permissive’ signal to run / stop from an external relay contact (by others) that will close, shorting the terminals, and allowing the engine to start/run. This system will be used for fire detection. Shutdown (furnished by others), lockout on an electrical fault in the switchgear, and start signal from the main generators control panels on lockout and / or shutdown of main generator sets.

3.3.7 Engine control panel shall consists of following in addition to those specified on diesel engine data sheet.

- Hour Meter
- Start/Stop Push Buttons
- Remote / Local Selector Switch
- Running Indication
- Trip / Alarm indicators (visual only)

4.0 TELEMETRY

As the generator set will be monitored from a remote location at a later date, it is necessary that provisions for telemetry inputs and outputs be provided. Any other parameter considered essential for monitoring the performance of these units, shall be included by Vendor for remote telemetry. On the basis of these parameters, the vendor shall include necessary transducers, auxillary relays, and wired output contacts in a separate junction box on each skid. Contacts, where furnished, shall be volt-free. Supervisory system for telemetry shall be provided by the Company. The analog signal output for telemetry shall be two wire, total isolated and powered, 4-20ma D.C. The Company shall pick off these output points for remote analog telemetry, and other volt-free contacts wired for remote indication / alarm and remote start and stop actuation, from each junction box which shall be considered as the interface between vendor equipment and Company’s supervisory telemetry system. Control supply of 240V, single phase A.C. from U.P.S. source can be furnished. The Vendor shall furnish power requirements, if any, for this equipment in this regard. deviations, if any, shall be clearly brought out for Company’s consideration.

4.1 The control Panel shall have

- Auto Start / Stop with safety shutdowns
- LCD readouts for
  - Engine Oil pressure
  - Engine water temperature
  - Engine speed
  - Engine hours of operation
  - DC voltage
• Generator AV volts and AC amps for all the three phase
• Frequency

• LED indications for the following
  o Low oil pressure
  o High coolant temperature
  o Engine over speed
  o Over crank
  o Emergency stop
  o Fault
  o Alarm
  o Spare

• Power metering options
  o Kilowatts kW (total and per phase)
  o Kilovars kVAR (total)
  o Kilovolt-amps kVA (total)
  o Kilowatt-hours kWhr (total)
  o Kilovar-hours kVARHr (total)
  o Percent of rated power (total)
  o Power factor (average total and per phase)

• Expanded AC metering
  o Voltage per phase (L-N)
  o Current in Amps for all the three phases

• Protective relaying (programmable trip point and time delay)
  o Over-voltage (Alarm and shutdown)
  o Under-voltage (Alarm)
  o Over-frequency (Alarm and shutdown)
  o Under-frequency (Alarm)
  o Over-current (Alarm and shutdown)
  o Reverse power (Shutdown)
  o Load demand relay (Shutdown)
  o Spare relay
  o Spare inputs

5.0 TESTING AND INSPECTION

5.1 The Company or its representative certification agency reserves the right to inspect equipment at any time during fabrication and witness testing.

5.2 Vendor tests shall include the following as a minimum

  a) Engine shall be separately tested at Engine manufacturer’s shop. As a minimum, tests as indicated in Diesel Engine Data Sheet shall be performed.
b) The Engine generator set shall be run at synchronous speed, non-stop for two (2) hours, at its rated capacity. Each half-hour the following data shall be recorded.

- Ampere
- Voltage
- Frequency
- Power Factor
- Water Temperature
- Oil pressure
- Vibrations
- Noise

c) The operation of protective / safety devices shall be checked for operation during this test.

d) The generator will be run at 10% above rated capacity for 30 minutes. Every 10 minutes the same data as listed in paragraph (b) shall be recorded.

e) The required load bank and all interconnecting wiring / cabling required for testing shall be arranged by the Vendor at his own cost.

f) Sudden application of full load drop and recovery time.

g) Automatic start of this unit with loss of the primer power.

h) Insulation of the generator.

i) High Voltage test on the generator.

j) Generator shall be loaded to ¼, ½, ¾ and full load with temperature rise recorded under this sustained load conditions. These loads will be applied in the blocks of ¼, ½, ¾ and full load to test voltage regulator and governor response to step load.

5.3 No slave or temporary installed wiring, etc. shall be used on the set during testing.

5.4 A detailed schedule of testing along with test procedures shall be furnished for approval two months prior to testing.
5.5 Local control panel and remote control panel shall be functionally tested to check all safety system and control instruments. Company reserves the right to witness the test.

5.6 In addition to the tests mentioned above, the tests specified in the codes pertaining to engine and generator shall be performed.

Vendor shall notify company or its representative minimum 15 days prior to any tests.

Vendor shall supply list of tests to be performed, including those listed above, with the proposal.

The above tests shall be performed at the Vendor’s facility. However Vendor must depute representatives for performing complete operational tests after installation.

6.0 WARRANTY

Vendor shall have final and total responsibility for the design and performance of all equipment supplied under this specification. Vendor shall warrant the equipment furnished by him and the performance of the said equipment.

7.0 VENDOR DATA REQUIREMENTS

The Vendor must completely fill-in the attached engine and generator data sheets.

Data to be submitted for Diesel / Engine / Generator along with proposal, after order placement and with Equipment data Book shall be as per attached Vendor data for approval sheet.

8.0 SPARE PARTS

The Vendor shall furnish all spares as required

8.1 Parts

Vendor shall furnish, along with bid a list of placed recommended parts of two (2) years operation and for start-up and commissioning. Recommended spares should take into account related factors of equipment reliability, cost of parts, and availability of equipment service faculties.
### 8.2 Packaging

All spare parts furnished by Vendor shall be wrapped and packaged so that they will be preserved in original as new condition under the normal conditions of storage to be anticipated in India and shall be properly tagged and coded so that later identification as to intended equipment usage will be facilitated. They shall be packaged separately, clearly marked as ‘Spare Parts’, and shipped at the same time as the main equipment. Packing lists shall be furnished so that the parts can be handled without uncrating, if desired.

### ELECTRICAL CHARACTERISTICS:

1. Type - Synchronous

2. Rating: As per BOQ (The emergency generator shall be sized for the loads connected to utility. Generator shall be able to feed maximum running load of PCC. A margin of ten percent over that shall be kept for sizing. Exact rating of gen. to be decided by Contractor and furnished to Vendor).

3. Output 415 V, 3-Phase, 4-wire, 50 Hz, Wye connection. All six leads brought out for phases. Neutral solidly grounded with the provision for neutral isolation.

4. Temperature Rise Stator – 80°C above 40°C  
   Rotor - 80°C above 40°C

5. Insulation Class Stator – ‘F’ – Temperature rise limited to  
   Rotor – ‘F’ – Class ‘B’.

6. Wave Form Dev. 10% Max – sinusoidal  
   RMS Harmonic 5% Max.

7. Sub Transient Reactance 10% Minimum

8. Exciter Static, Brushless
9. Neutral C.T. Suitable, 15VA Class 1
10. No. of Poles Vendor to decide
11. Overload Capacity 10% for 2 hours at rated p.f. and 50% for 1 minute at normal rated load excitation.
12. Short circuit Regulator and exciter should sustain 300% of FLC for 10 seconds.
13. Space heaters (with thermostat) Required: 240V, 1 Phase, 50HZ (Power supply by others.)
14. R.T.Ds Required
15. Voltage regulator Solid state, adjustable within +10%
16. Steady state error of Voltage regulator +1%
17. Voltage excursion (F.L. transient) +15% (Recovery to +5% in 1 second, maximum two over shoots)
18. Steady state frequency error +1/2 %
19. Governor transient response
   Frequency variation under step change of rated load +2%
   Recovery time (to normal tolerance limits) 2 seconds

CONSTRUCTION

1. Mounting Skid
2. Enclosure TEFC, IP-55
3. Ventilation : Self
4. Bearings : One
5. Lubrication : Standard
6. Terminal box : Required for power cables, space heater circuits, RND and neutral C.T. separately.
8. Tropicalisation : Yes
9. Tests : See main specification

ACCESSORIES

1. Vibration sensors : Required
2. Auto / Manual Controls : Required
3. Remote control panel : Required
4. Generator Breaker : Not required (By others)
5. Space Heater (240 V AC) : As required

UTILITY

1. Fuel : Diesel Oil
2. Electric Power : 24V ±5 DC (Control) and 240 V, ±5%, 1 Phase, 50 Hz ±3% (for space heaters only.

ATA TO BE FURNISHED BY VENDOR (WITH BID)

1. Unsaturated Synchronous reactance
2. Sub transient reactance : 

3. Transient reactance : 

4. Zero seq. Reactance : 

5. Negative Seq. reactance : 

6. Temperature rises and test procedure adopted
   
   Stator Winding : 
   
   Stator Core : 
   
   Rotor Winding : 

7. Coupling type (with engine) : 

8. Type of cooling : 

9. Speed : 

10. % Efficiency : 

<table>
<thead>
<tr>
<th>Output</th>
<th>100%</th>
<th>75%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.F.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. Critical speed : 

12. Direction of rotation : 

13. Moment of inertia : 

14. Type of cooling : 

15. Bearing Type : 

16. Lubrication : 

383/498
17 Exciter
   Type :
   Rated Current :
   Rated output :
   Ceiling voltage :
   Accuracy :
   Type of Regulator :
   Rated Voltage
   Type of Manual Regulation

18 Cable Glands :
   Type and Make :
   Size :

19 Cable Lugs
   Type and Make :
   Size :

20 Bus Duct
   Make :
   Size of Busbars
      Phase :
      Neutral :
Generator Neutral CT

Type and Make : 

VA Capacity : 

Class : 

Ratio : 


17. PVC CONDUITS

The conduits shall be of rigid PVC FRLS conduit of size 19/25/32 mm in diameter. The inside and outside surfaces of conduit shall be reasonably smooth & free from burrs, flash & similar defects, in addition, the edges over which the conductors or cables are likely to be drawn shall not damage the cable or conductors.

Installation:
The conduits shall be joined by means of plain couplers with suitable adhesive. The conduit pipe shall be fixed by means of saddles placed at regular interval of 600mm and on either side of the bends and couplers.
The suitable inspection boxes which is of GI duly painted should be used at a regular interval of not more than 10mtrs of length and after not more than 3 bends in a length.
The suitable Metal Junction boxes duly painted should be for the light points.

Insulation resistance:
The insulation resistance measured shall not be less than 100 meg ohms when the sample of conduit subjected for measurement of insulation resistance on application of 500 V DC between the electrodes for 1 minute

Electrical Strength:
There shall be no breakdown or flashover occurs when the sample of conduit was subjected for high voltage test by applying 2000 V AC for 15 l', minutes between the electrodes.

Test Certificate:
The supplier should provide the following test certificates
Oxygen index test
Temperature index test
Halogen acid
Smoke index test
Flammability test

Conduit of Insulating material shall be marked with the following information’s:
Name of the manufacturer, trade-mark or identification mark
Nominal size of the conduits
Information relating to classification
BIS certification mark
18. SOLAR PHOTO VOLTAIC SYSTEM

INDEX

A) 70 kWp SOLAR SYSTEM

1.0 SCOPE OF WORK

2.0 SPECIFICATIONS OF THE SOLAR SYSTEM

2.1 SOLAR PV ARRAY – 70 kWp
2.2 CHARGE CONTROLLER & MPPT
2.3 INVERTER (70 KW INVERTER)
   2.3.1 ELECTRONIC PROTECTION
2.4 STRUCTURES
2.5 PV MODULE
2.6 JUNCTION BOXES
2.7 INSTALLATION & SAFETY STANDARDS
2.8 CABLES & CONTROL COMPONENTS
2.9 MOULDED CASE CIRCUIT BREAKERS (MCCB)
2.10 RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)
2.11 INDICATING LAMPS
2.12 PUSH BUTTONS
2.13 TERMINALS

3. DATA TO BE FURNISHED BY BIDDER

3.1 SOLAR PV ARRAY – 70 kWp
3.2 INVERTER (70KW INVERTER)
3.3 STRUCTURES
3.4 PV MODULE

4. LIST OF APPROVED MAKES

A) 70 kWp SOLAR SYSTEM

1.0 SCOPE OF WORK:

Scope should cover the supply, installation and commissioning of roof mounted PV Solar systems consisting of 70kWp solar systems. The scope also include supply of inverters, power conditioner
units, cable, and junction boxes, control components including Installation and commissioning.

2.0 SPECIFICATIONS OF THE SOLAR SYSTEM:

PV arrays should consist of PV modules Connected in series and parallel to provide the required voltage and current thus making required wattage.

The modules supplied should confirm to IEC 61215 revised standard (2005) for the Design and so IEC 61730-2 for safety qualification requirements.

All the modules supplied are required to be tested for their STC Performance, and the copy of the same should be supplied with the modules.

The detail specification of the individual module given below:

2.1 SOLAR PV ARRAY – 70 kWp

The details of the 70 kWp Solar PV array System as given in the below table:

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Semiconductor type</td>
<td>Mono / Poly Crystalline</td>
</tr>
<tr>
<td>2</td>
<td>Array Capacity</td>
<td>41125 Wp</td>
</tr>
<tr>
<td>3</td>
<td>No. of PV modules</td>
<td>249</td>
</tr>
<tr>
<td>4</td>
<td>Type of PV module</td>
<td>280 Wp</td>
</tr>
<tr>
<td>5</td>
<td>Configuration</td>
<td>500 V (max)</td>
</tr>
<tr>
<td>6</td>
<td>System nominal Voltage</td>
<td>391V</td>
</tr>
<tr>
<td>7</td>
<td>Weight of each module</td>
<td>24.60 Kgs</td>
</tr>
<tr>
<td>8</td>
<td>Total weight of PV array</td>
<td>6125 Kgs.</td>
</tr>
<tr>
<td>9</td>
<td>Area Covered by PV array</td>
<td>7573 sq.ft</td>
</tr>
</tbody>
</table>
PV arrays of 280Wp should consist of PV modules Connected in series and parallel to provide the required voltage and current thus making required wattage.

The modules supplied should confirm to IEC 61215 revised standard (2005) for the Design and ISO IEC 61730 - 2 for safety qualification requirements.

All the modules supplied are required to be tested for their STC Performance, and the copy of the same should be supplied with the modules.

The following minimum data should be available in the module report:

- Open circuit voltage
- Short circuit current
- Power at STC
- NOCT
- Power at NOCT
- Max.System voltage

2.2 70 kW CHARGE CONTROLLER & MPPT:

The charge controller and MPPT should preferably confirm to IEC 62109-3, IEC 62093 and IEC 62509 standards.

- Operational Voltage Range: 150V to 750V (for 415V)
- Controlling element IGBT’s

2.3 INVERTER (70 kW INVERTER/POWER CONDITIONER UNIT):

The Details of the Inverter which is required for the System as given in the below table:

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DC Input data :</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Nominal DC input</td>
<td>Max. 530V DC</td>
</tr>
<tr>
<td>1.2</td>
<td>MPPT Range</td>
<td>400V AC, 50Hz, 3 phase</td>
</tr>
<tr>
<td>2</td>
<td>AC Output data :</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Nominal AC output</td>
<td>415V A/C 50 Hz – 3 ph</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>2.2</td>
<td>Output Regulation</td>
<td>A/C voltage +/- 5%, Frequency +/- 0.2%</td>
</tr>
<tr>
<td>3</td>
<td>Control method</td>
<td>Microprocessor assisted regulation</td>
</tr>
<tr>
<td>4</td>
<td>DC input voltage</td>
<td>300-750V or 125-540V</td>
</tr>
<tr>
<td>5</td>
<td>THD</td>
<td>3%</td>
</tr>
<tr>
<td>6</td>
<td>Cooling</td>
<td>Fan forced</td>
</tr>
<tr>
<td>7</td>
<td>Current protection</td>
<td>Peak over load detection and in-line fuse</td>
</tr>
<tr>
<td>8</td>
<td>Thermal protection</td>
<td>At 70 deg.c.</td>
</tr>
<tr>
<td>9</td>
<td>Operating Frequency Grid</td>
<td>47.5-50.2 Hz</td>
</tr>
<tr>
<td>10</td>
<td>Operating Voltage Grid</td>
<td>196-253V</td>
</tr>
<tr>
<td>11</td>
<td>Data logging</td>
<td>Should be Available</td>
</tr>
<tr>
<td>12</td>
<td>LAN / Web access - monitoring</td>
<td>Should be Available</td>
</tr>
</tbody>
</table>

Preference should be given to the model saving qualification as per IEC 61683, IEC 62109-2 & IEC 62093.

The inverters supplied should be preferably from an Indian manufacturer.

### 2.3.1 ELECTRONIC PROTECTION

The Inverter should be protected against:

- A.C. Short circuit protection.
- Over load protection.
- Under voltage & Over voltage of battery
- Auto/ Manual re-connect provision.
## 2.4 STRUCTURES:

The details of Structures as given in the below table:

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mounting structure</td>
<td>Roof</td>
</tr>
<tr>
<td>2</td>
<td>Material</td>
<td>Mild steel (as per IS)</td>
</tr>
<tr>
<td>3</td>
<td>Tilt provided</td>
<td>Fixed tilt</td>
</tr>
<tr>
<td>4</td>
<td>Environmental protection</td>
<td>Hot dip galvanization / Power coating</td>
</tr>
<tr>
<td>5</td>
<td>Design wind speed</td>
<td>Can withstand horizontal wind speed&lt;= 150 kmph</td>
</tr>
<tr>
<td>6</td>
<td>Structure Grouting</td>
<td>Concrete base / bolt and nut</td>
</tr>
<tr>
<td>7</td>
<td>Hardware</td>
<td>Stainless steel SS – 304</td>
</tr>
</tbody>
</table>

## 2.5 PV MODULE:

The details of 280PV Module as given in the below table:

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Parameter</th>
<th>Units</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$P_{max}$</td>
<td>Wp</td>
<td>280</td>
</tr>
<tr>
<td>2</td>
<td>$V_{oc}$</td>
<td>V</td>
<td>44.50</td>
</tr>
<tr>
<td>3</td>
<td>$I_{sc}$</td>
<td>A</td>
<td>8.30</td>
</tr>
<tr>
<td>4</td>
<td>$V_{mp}$</td>
<td>V</td>
<td>35.5</td>
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<td>5</td>
<td>$I_{mp}$</td>
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<td>7.90</td>
</tr>
<tr>
<td></td>
<td>Nos.</td>
<td></td>
<td>249</td>
</tr>
</tbody>
</table>
2.6 JUNCTION BOXES:

Junction Boxes, AC/DC Distribution boxes as per IP 61 specifications

2.7 INSTALLATION:

Installation and safety requirements should be as per IEC 62548.

2.8 CABLES:

Cables and other control components such as cut outs, fuses and varriesters to suppress the high voltages and current surges.

- Lightning arresters and proper grounding of array structures, Junction Boxes, inverters, Charge controllers, wherever necessary. All the supervisions should be as prescribed in the Indian National Electrical Code.

- Necessary cabling and wiring to connect the system with mains and loads.

- Energy meters at the mains input of inverter and output of inverters to monitor the energy generated by the PV array.

- All the Above Equipments should have IP-54 Protection

2.9 MOULDED CASE CIRCUIT BREAKERS (MCCB)

Miniature Circuit Breakers shall be quick Make and Break type, and shall conform to relevant Indian Standards. The housing shall be heat resistant and shall have high impact strength. MCBs shall be flush mounted and shall be provided with trip free manual operating lever and ‘ON’ and ‘OFF’ indications. The contacts shall be provided with magnetic and thermal releases for short circuit and over current. The device shall have a common trip bar in the case of DP and TPN Miniature Circuit Breakers.

MCB for ratings up to 125 Amps shall be available in 1, 2, 3 or 4 pole versions. MCB casing shall be made of self-extinguishing material tropicalised treatment 2 (relative humidity) 95% at 55°C.

It shall be suitable for use in frequency range 40Hz to 60Hz and shall accommodate AC/DC supply according to requirements.
Arc chutes should be provided for effective quenching of arc during operations and fault conditions.
It shall have trip free mechanism and toggle shall given positive contact indication.
It shall have trip free mechanism ad toggle shall given positive contact indication.
It shall be suitable for mounting on 35mm DIN rail/surface mounting.
Line supply may be connected to either top or bottom terminals i.e. there shall be no line load restriction.
Degree of protection, when the MCB is flush mounted, shall be 1P40. MCB & shall be supplied with clamping terminals fully open.
Contact closing shall be independent of the speed of the operator.
MCB’s operating temperature range shall be —20 deg C to + 60 deg C.
The characteristics should be in accordance with IS 8828 —1996. The breaking capacity of the MCB shall be 10kA and energy limiting class3.
The rated impulse voltage of the MCB shall be greater than 4kv.
The MCB shall be capable of being used as Incomer circuit breaker and shall be suitable for use as an isolator.
Contact closing shall be independent of the speed of the operator.
Electrical endurance of the MCB shall be greater than 4kV.
Power loss per pole shall be in accordance with IS 8828-1996 and the manufacturer shall furnish the same.
In case of multipole MCBs in a single location (DB), it shall be possible to remove MCB without having to disturb other MCB’s in the vicinity.
‘B’ curve type MCB should be used for lighting loads, ‘C’ curve type for motor loads and ‘D’ curve type for UPS circuits.

2.10 RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)

RCCB shall comply with IS 12640-1988 /IEC1008. It shall be available in 2 pole and 4 pole versions and threshold sensitivities (non-user adjustable) of 30mA, 100m A 300mA & 300mA with inbuilt time delay of 200ms for discrimination with downstream ELCB, if specified in schedule of quantities.
Tropicalisation: treatment 2 (relative humidity 95% at 55°C).
The current rating shall be from 25A to 125A. Ratings ad sensitivities shall be as specified in schedule of quantities.
It shall be operationally independent of line voltage.
There shall be clear identification of earth fault or overload/short circuit fault on the RCCB.
The RCCB shall not be given nuisance tripping due to transient over voltages (lightening, line disturbances or other equipment).

The RCCB should preferably be ‘IS’ class type (should be suitable for SMPS loads i.e. unaffected by the D.C pulsated components present if any in the circuit), and should not give nuisance ripping. Details to be furnished confirming suitability.

The short circuit withstands capacity of the RCCB without the associated short circuit/overload protection should preferably be 6kA.

A test device should be incorporated to check the integrity of the system and tripping mechanism.

Terminals should ensure easy termination of cables and should provide covers to shield incoming and outgoing terminals with 1P20 degree of protection.

The RCCB should be suitable for DIN rail mounting.

### 2.11 INDICATING LAMPS

| Type | Panel mounting “Protected LED” types.  
| (I.e. protection is provided against  
| Electromagnetic interference & over  
| Voltage) |
| Standard applicable | IEC 947-5-1 |
| Electric shock protection | class 2 (IEC 536) |
| Degree of protection | IP 65 9 (IEC 529) |
| Diameter | 22mm |
| Voltage | 230VAC |

### 2.12 PUSH BUTTONS:

| Type | Manually operated Spring return type |
| Standard applicable | IEC 947-5-1 |
| Electric shock protection | Class 2 (IEC 536) |
| Degree of protection | IP 65 9 (IEC 529 Type) |
| Rated Impulse voltage | 6kV 600V |
| Diameter | 22mm |
| Type of mounting | snap type |
| Color of actuator | Start PB Green  
| Stop PB Red  
| Test PB Black  
| Reset PB Yellow |
| Contact configuration | I NO or I NC |
Contact rating : AC-15, 3A, 240V

2.13 TERMINALS

Distribution shall be provided with a terminal block for neutral and earth terminations of adequate size. The terminal block shall be so located as to prevent crowding of wires in the proximity of live parts.

3. DATA TO BE FURNISHED BY THE BIDDER:

3.1 SOLAR PV ARRAY (70kWp):

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Array Capacity</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>No of PV modules</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Type of PV module</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Configuration</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>System nominal Voltage</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Weight of each module</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Total weight of PV array</td>
<td></td>
</tr>
</tbody>
</table>

3.2 INVERTER (70 kWp INVERTER/POWER CONDITIONER UNIT):

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>Nominal AC output</td>
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### Output Regulation

<table>
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<th>Description</th>
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<td>Output Regulation</td>
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</tr>
<tr>
<td>4</td>
<td>Control method</td>
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</tr>
<tr>
<td>5</td>
<td>Rating of inverter</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Rating of Charge controller</td>
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<tr>
<td>7</td>
<td>DC input voltage</td>
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<td>8</td>
<td>Peak efficiency</td>
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<td>9</td>
<td>THD</td>
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<td>Inversion method</td>
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<td>Operating Frequency Grid</td>
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<td>15</td>
<td>Operating Voltage Grid</td>
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<tr>
<td>16</td>
<td>Data logging</td>
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<td>17</td>
<td>LAN / Web access - monitoring</td>
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#### 3.3 STRUCTURE :

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<td>Wp</td>
</tr>
<tr>
<td>2</td>
<td>Voc</td>
<td>V</td>
</tr>
<tr>
<td>3</td>
<td>Isc</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>Vmp</td>
<td>V</td>
</tr>
<tr>
<td>5</td>
<td>Imp</td>
<td>A</td>
</tr>
<tr>
<td>6</td>
<td>Total no. of modules in series</td>
<td>No.s.</td>
</tr>
<tr>
<td>7</td>
<td>Total string Voltage</td>
<td>Vmax</td>
</tr>
<tr>
<td>8</td>
<td>Average Vmp</td>
<td>Vav</td>
</tr>
<tr>
<td>9</td>
<td>Total no of parallel strings</td>
<td>No.s.</td>
</tr>
</tbody>
</table>
4. LIST OF APPROVED MAKES:

1. PV MODULES : KOTAK URJA/ORB ENERGY/HHV/EMMVEE SOLAR/TATA BP/NUMERIC

2. INVERTERS : SINE WAVE/XANTREX/APC/SUKAM/NUMERIC

3. MCCB/RCCB : ABB/L&T/SIEMENS/LEGRAND/HPL Molar

4. CONTACTORS: ABB/L&T/SIEMENS/M&G

5. LT CABLES : FINOLEX, RR KABEL, UNISTAR, NICCO, HAVELLS, POLYcab

6. LT CABLE TERMINATION: M-SEAL, REPL, BIRLA 3M

7. JUNCTION BOXES: ANCHOR-Woods, ABB, MK WARAPOUND, LEGRAND – Mosaic

8. PUSH BUTTONS/INDICATION LAMPS: LEGRAND, C&S, TELEMECHANIC

9. MEASURING/INDICATING INSTRUMENTS: L&T MECCO, C&S, TELEMECHANIC, LEGRAND

10. BATTERIES: EXIDE, AMRON, PRESTOLITE, PANASONIC, AMCO

11. UPS: APC, COSMIC, SIEMENS, MERLIN-GERIN/NUMERIC
### 19. **List of Approved Make of Materials & Equipments**

The materials/equipments to be incorporated in the works shall conform to any of the following approved makes:

1. **HT Switchgear** : ABB / Siemens / Schneider (Enclosure Panels by the respective system vendor)
2. **LV Switchgear** : Larsen & Toubro/ Siemens/ ABB / Schneider
3. **Transformer** : EMCO / Voltamp / Universal / KEC
4. **Instrumentation Transformers** : Kalpa / Kappa / Instrans / Voltamp
5. **Lighting Arrestors** : GEC/ W.S.Insulators/ KEL
6. **Moulded Case Circuit Breakers (MCCB)** : Larsen & Toubro/ Siemens/ ABB
7. **Lighting Fixtures & Lamps** : Philips/ Crompton / Bajaj/Wipro/Havells
8. **Switch fuse units and Isolators** : Siemens/ Larsen & Toubro /ABB
9. **Plastic Moulded Plug & Socket** : ABB / Siemens / L&T
10. **PVC Wires** : Power flex/ Esbee cables/ Polycab / Finolex / Ravincab
11. **MCB & DB’s** : Siemens/ Larsen & Toubro /ABB / Schneider / Legrand
12. **Cables** : Unistar /Polycab / Esbee cables / Finolex / Ravincab
13. Telecommunication Cables : HCL/ DELTON/ Ravin cables

14. Exhaust Fans : Crompton/ Khaitan/ Almonard

15. PVC Conduits : Precision / Universal/ Nelco/Aeroplast

16. Modular switches sockets combined switch plug etc. : Anchor Roma / Crabtree / MK electric-India / Legrand

17. Meters(Static) : Electrex/ Conzerve / L&T / ABB / Siemens

18. Relays(Static) : Easun-Reyrolle/ L & T / ABB / Siemens

19. Ammeter and Voltmeter (Digital only) : A.E/ MECO/ Conzerve / Electrex

20. Capacitors / APFCR : L&T/Siemens/ Epcos / ABB / Schneider

21. ELCB : Siemens/ Larsen & Toubro /ABB / Schneider / Legrand

22. PANEL FABRICATION : Elins / Pace switchgear / Lotus switchgear / Load controls / Pragathi controls / Prakash Power Products

23. Cable glands / lugs (tinned copper) (Heavy duty) : Dowells / Jainson/HMI


25. DG Set : Powerica (Cummins-Stamford) / Gmmco (Caterpillar-Stamford) / Sterling Generators (perkins, Leroy Somer)

26. UPS : Numeric/ Emerson /APC-schneider
27. Batteries : Amaron / Exide / Panasonic

28. HT termination KIT : Raychem/3M/

29. Cable trays & supports : Profab (GI) / Patny /Indiana/Elcon

30. MS pipe : AKG/Bharath/Gupta

31. Ceiling Fans : Anchor/Orient/Bajaj

NOTE:
In case the approved make of materials/ equipments are not available due to some reason, the contractor can supply other makes of materials/ equipments which are approved by ISI or other relevant standards after obtaining the prior approval from the Consultants.

The tenderer shall procure all the required materials directly from the approved manufacturer or their authorised agency only for which they will have to furnish the delivery note/ purchase bill along with test certificates while delivering the materials at site, after consultants approval.

The successful tenderer shall order all the required materials on the approved manufacturer or their authorised agency within 15 days from the date of receipt of acceptance letter and the copy of the same shall be furnished to the Engineer-in-charge, after consultants approval.

Clients / Consultants reserves the right to select any of the make of material for supply by contractor, listed above.
## LIST OF DRAWINGS:

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<th>SL.NO</th>
<th>DRAWING NO.</th>
<th>DRAWING TITLE</th>
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<tr>
<td>01</td>
<td>E-101</td>
<td>GENERAL NOTES, LEGENDS, ABBREVIATIONS AND LIST OF DRAWINGS.</td>
</tr>
<tr>
<td>02</td>
<td>E-102</td>
<td>MAIN SINGLE LINE DIAGRAM</td>
</tr>
<tr>
<td>03</td>
<td>E-103</td>
<td>GROUND FLOOR LIGHTING LAYOUT.</td>
</tr>
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<td>E-103A</td>
<td>GROUND FLOOR POWER LAYOUT.</td>
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<td>05</td>
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<td>FIRST FLOOR LIGHTING LAYOUT</td>
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<td>E-104A</td>
<td>FIRST FLOOR POWER LAYOUT</td>
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<td>E-105</td>
<td>SECOND FLOOR LIGHTING LAYOUT</td>
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<td>E-105A</td>
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<td>THIRD FLOOR LIGHTING LAYOUT</td>
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<td>TERRACE FLOOR LIGHTING LAYOUT</td>
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<td>12</td>
<td>E-108</td>
<td>STANDARD FIXING DETAILS</td>
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D. Soil report –

Note:

- Page numbers not continuous from subsequent pages for Soil Report.
- It consists of Pages 1 to 61 & Pages 1 to 28.
- Total no of Pages in Volume 2 document is 498.
SOIL INVESTIGATION FOR CONSTRUCTION OF BUILDING AT ANNA UNIVERSITY CAMPUS, CHENNAI

SOIL EXPLORATION REPORT

«« Prepared for »»

M/s. NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI

«« Prepared by »»

VELCITI CONSULTING ENGINEERS PVT. LTD.
4A, 4th Cross Street,
Dhandeeswaram Nagar,
Velachery, Chennai - 600 042.
Ph. Nos. 91- 44 - 2243 5659 / 2243 2659
E-mail: velciti@gmail.com
SOIL EXPLORATION REPORT

CLIENT M/s. NCSCM, Chennai

PROJECT : Construction of Building

LOCATION : NCSCM, Chennai

TOTAL NUMBER OF LOCATIONS : 12 Nos.

VELCITI CONSULTING ENGINEERS PVT. LTD.
4A, 4th Cross Street,
Dhandeeswaram Nagar,
Velachery, Chennai - 600 042.
Ph. Nos. 91- 44 - 2243 5659 / 2243 2659
E-mail: velciti@gmail.com
<table>
<thead>
<tr>
<th>INDEX</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GENERAL</td>
<td>1</td>
</tr>
<tr>
<td>2. OBJECTIVE</td>
<td>2</td>
</tr>
<tr>
<td>3. FIELD INVESTIGATION</td>
<td>3 to 5</td>
</tr>
<tr>
<td>3.1 Rotary Boring</td>
<td></td>
</tr>
<tr>
<td>3.2 Standard Penetration Test</td>
<td></td>
</tr>
<tr>
<td>3.3 Sampling</td>
<td></td>
</tr>
<tr>
<td>4. LABORATORY INVESTIGATION</td>
<td>6</td>
</tr>
<tr>
<td>5. FOUNDATION ANALYSIS</td>
<td>7</td>
</tr>
<tr>
<td>5.1 Soil Profile</td>
<td></td>
</tr>
<tr>
<td>5.2 Safe Bearing Capacity</td>
<td></td>
</tr>
<tr>
<td>6. SBC CALCULATION</td>
<td>8 to 11</td>
</tr>
<tr>
<td>6.1 to 6.5 SBC calculation based on Shear Criteria</td>
<td></td>
</tr>
<tr>
<td>6.6 SBC calculation based on Settlement Analysis</td>
<td></td>
</tr>
<tr>
<td>7. ANNEXURE</td>
<td>12</td>
</tr>
<tr>
<td>7.1 Log of Boring</td>
<td>13 to 25</td>
</tr>
<tr>
<td>7.2 Laboratory Test Results</td>
<td>26 to 48</td>
</tr>
<tr>
<td>7.3 Gradation</td>
<td>49 to 60</td>
</tr>
<tr>
<td>8. REFERENCES</td>
<td>61</td>
</tr>
</tbody>
</table>
1. GENERAL

- The proposed site is located at anna university campus.

- The surface of the earth is Greyish Brown.

- The field investigation was carried out during the month of December 2012 and January 2013.

- The laboratory investigation was done during the month of January 2013.

- Geotechnical investigation consists of twelve boreholes in twelve locations tested up to hard strata from the natural ground level.
2. OBJECTIVE

VELCITI CONSULTING ENGINEERS PVT LTD., performed a Geotechnical site investigation for the construction of Building at chennai. This work was referred to us by THE Director NCSCM, AN NA U NIVERSITY CAMPUS. The primary purpose of this investigation was to obtain data to ascertain sub-surface soil stratigraphy for the purpose of foundation design.

The location of borings were selected by client's representatives. To accomplish these purposes, the following tasks were performed:

1. Detailed twelve number of soil borings were done up to hard strata to explore the subsurface stratigraphy and obtain soil samples for laboratory testing;

2. Field and laboratory tests were conducted to evaluate the index and engineering properties of the soils.

3. Engineering analyses were performed to develop foundation design information for the proposed structure.
3. FIELD INVESTIGATIONS

Rotary Boring:

Rotary boring was performed at twelve locations in accordance with IS: 1890. In this method, boring is effected by the cutting action of a rotating bit which is kept in firm contact with the bottom of the hole. The bit is attached to the lower end of a hollow drill rod which is rotated by a suitable chuck. Drilling mud [usually Bentonite] is continuously forced down the hollow drill rods. The mud returning upwards through the annular space between the drill rods and the side of the hole brings the cuttings to the surface.

Boring was advanced in weathered rock stratum using TC bit attached to the lower end of the hollow drill rod. While boring in soft rock / hard rock stratum, NX size diamond bit was used.

Standard Penetration Test:

Standard Penetration Test was performed in twelve locations in accordance with IS: 2131 - 1981.
It is now the most commonly used in situ test. The test measures the penetration resistance of the split-spoon sampler, when it is driven into the soil, at the bottom of a bore hole in a standard manner. The N-value, which is the number of blows required to achieve 300 mm penetration of the soil, indicates the relative density of a sand or gravel, the consistency of other soils such as silts or clays and the strength of weak rocks. The test is described in IS 2131 - 1981. The split spoon sampler is attached to stiff drill rod and lowered to the bottom of the bore hole. A standard blow consists of dropping a mass of 63.5 kg free fall through 750 mm on to an anvil at the top of the rods and ensuring that this amount of dynamic energy is transferred to the sampler as much as possible.

The number of blows required to achieve each 150 mm penetration is recorded for a full penetration of 450 mm. The initial 150 mm penetration is referred to as seating drive and the blows required for this penetration are not considered as this zone is in disturbed soil. The next 300 mm of penetration is referred to as the test drive and the number of blows required to achieve this fully is termed the penetration resistance or N-value.
**Sampling:**

The soil that is being removed during drilling of boreholes is regularly examined for changes in the soil stratification. At fixed regular intervals and at levels where there is change in soil type samples are collected for closer examination in the laboratory.

The types of samples collected can be grouped under the following two categories.

1. Disturbed samples
2. Undisturbed samples

In disturbed samples there is considerable disturbance in the natural structural arrangement of the soil particles. For meaningful results to be obtained from disturbed samples they must be **representative samples**. That is, the soil sample must contain all the mineral constituents that are present in the soil at the depth from which the sample has been taken and there should not be intermixing of minerals from various depths. Disturbed soil samples can be collected from split spoon sampler used in standard penetration test and also from soil retained in auger.
4. LABORATORY INVESTIGATION

The operations to be performed in the laboratory depend upon the type of the nature of data required for the problem at hand.

In case of cohesion less material, like sand, the laboratory tests are usually minimum and the design parameters are worked out from field test data such as from SPT-N value, core resistance.

For cohesionless soil

a) Specific gravity
b) Sieve analysis
c) Direct shear test

For cohesive soil

a) Specific gravity
b) Natural moisture content
c) Atterberg's limits
d) Sieve Analysis
e) UCC test
5. FOUNDATION ANALYSIS

Soil profile:

In order to obtain the soil profile of the site, twelve locations (one borehole in each location) have been bored. The soil profile reveals that it consists of silty fine medium to coarse sand / silty sand / weathered rock / Soft rock / Hard rock stratum. The detailed borelogs and laboratory test results are enclosed in the annexure.

Safe Bearing Capacity:

The SBC calculations are made based on the information obtained from borehole – 2 from the twelve locations. Extrapolating information from just one borehole may be misleading the designs. However, this may be overlooked by way of conforming the uniformity of soil (with borelog data), during execution of the foundation. And also the Dynamic Analysis for wind load should be considered during Structural Design of the structure.

The bearing capacity of granular soil depends upon the unit weight and angle of internal friction of the soil. These two properties of granular soils are determined by standard penetration tests. The following SBC calculation is made based on Static Analysis.
For the location: - NCSCM

Depth: @ 2.00m. from NGL.

(BH No. 2 Datas are taken for calculation purpose)

6. COMPUTATION OF BEARING CAPACITY (AS PER IS: 6403) BASED ON SHEAR CRITERIA:

6.1 Geometrical Data:
- Type of Foundation System: Open
- R.L. of the top of Borehole (m): 0.00 m
- Depth of Foundation below existing ground level (Deg): 2.00 m
- R.L. of the depth of foundation system (m): -2.00 m
- Effective Depth of Foundation below existing ground level (Df): 2.00 m
- Minimum Design Width of Foundation (B): 1.00 m
- Thickness of Foundation (T): 0.45 m

6.2 Soil Data:
- Type of Bearing Strata: Silty sand
- Design SPT-value of the Bearing Strata: {((21+50)/2) =35
  (Considered based upon the density of the strata)
- Type of Shear Failure: General
- Angle of Shearing Resistance – Limited to a Maximum of: 37.00 Deg.

6.3 Design Parameters:
- Bulk Density of Soil above the foundation depth ($\gamma_{\text{bulk}}$) 18.50 kN/m$^3$
- Effective Overburden pressure at foundation level (q) 17.00 kPa
- Water Table Correction Factor ($w'$) 0.50
6.4 Ultimate Bearing Capacity (Qu):

\[ Q_u = C_u \times N_c \times S_c \times D_c \times I_c + q \times (N_q - 1) \times S_q \times D_q \times I_q + 0.5 \times B \times \gamma \times N_\gamma \times S_\gamma \times D_\gamma \times I_\gamma \times w' \]

\[ = 911.064 + 268.546 \]

\[ Q_u = 1179.610 \text{ kPa} \]

6.5 Safe Bearing Capacity (Qsafe):

Factor of Safety (F.S.): \( 1179.610 / 2.50 \)

\[ Q_{safe} = 471.844 \text{ kPa (or) } 47.184 \text{ t/m}^2 \]
6.2 SBC CALCULATIONS BASED ON SETTLEMENT ANALYSIS:

The allowable bearing pressure based on tolerable settlement has been established empirically by Terzaghi and Peck, 1948 and may be expressed by the equation:

Safe bearing capacity (SBC) = 3.5 \((N-3) \left\{\frac{(B+0.3)}{2B}\right\}^2 \alpha \beta + W\)

Net Safe bearing capacity = SBC - W

Where

\[ N = \text{SPT N. value at the level (corrected)} \]
\[ B = \text{Breadth of foundation} \]
\[ \alpha = 0.5, \text{if this level is submersible} \]
\[ \alpha = 1.0, \text{if water level is always below this level} \]
\[ \beta = \left\{1 + \left(\frac{D}{B}\right)\right\}, \text{but not greater than 2.0} \]
\[ D = \text{Depth below ground level at which SPT is done} \]
\[ W = \text{Wt. of soil above the level in t/m}^2 \text{ (effective over burden pressure)} \]

The above equation was further modified by TENG (1962) as given below:

Net Safe Bearing Pressure \(q_a = 3.5 \left(\frac{N-3}{B+0.3}\right)^2 \left(\frac{B}{2B}\right)^2 \ r_w' C_D\)

\[ r_w' = \text{Water table correction factor} \]
\[ C_D = \text{Depth correction factor} \]
\[ = \left(1 + \frac{D_f}{B}\right) \leq 2 \]
SBC = 3.5 (N-3) \{(B+0.3)/2B\}^2 \ r'_w \ C_D

Observed N = 35 (Average)

D_t = 2.00 m

B = 2.00 m

r'_w = 0.50

C_D = 2.0

q_a = 3.5 (N-3) \{(B+0.3)/2B\}^2 \ r'_w \ C_D

= 3.5 (35-3) * 0.330 * 0.5 * 2.0

q_a = 36.960 \text{ t/m}^2

**Recommended Safe Bearing Capacity: 250.00 kPa (or) 25.0 \text{ t/m}^2**

**Note:**

The above SBC has been worked out with available one borehole data. The foundation should be rested over Sandy / Weathered rock / Soft rock stratum. The site Engineer should verify the layer at founding level while excavation, to confirm the same. If any changes found, please inform to our office.
ANNEXURE

»» LOG OF BORINGS

»» LABORATORY TEST RESULTS

»» GRADATION CURVES
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>1.00</td>
<td>1.50</td>
<td>37 [04/17/20]</td>
<td>Dense</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td>2.00</td>
<td>0.70</td>
<td>&gt;100</td>
<td>Very dense</td>
</tr>
<tr>
<td>2.20 to 3.00</td>
<td></td>
<td>2.20</td>
<td>3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00 to 4.00</td>
<td></td>
<td>3.00</td>
<td>4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.00 to 5.00</td>
<td></td>
<td>4.00</td>
<td>5.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00 to 6.00</td>
<td></td>
<td>5.00</td>
<td>6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td></td>
<td>6.00</td>
<td>7.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00 to 8.00</td>
<td></td>
<td>7.00</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00 to 9.00</td>
<td></td>
<td>8.00</td>
<td>9.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Borehole Terminated @ 9.00M
<table>
<thead>
<tr>
<th>Depth Below G.L. (m)</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of Layer (m)</th>
<th>Depth at which test is conducted</th>
<th>N Value</th>
<th>Relative density/ Consistency</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td>0.00</td>
<td>9 [02/04/05]</td>
<td></td>
<td>Loose</td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>Grey silty fine to medium sand</td>
<td>0.70</td>
<td>1.00</td>
<td>9</td>
<td>Loose</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td>Greyish brown clayey silty sand</td>
<td>2.00</td>
<td>2.00</td>
<td>21</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td></td>
<td>Greyish brown silty sand</td>
<td>3.00</td>
<td>&gt;100 50\text{cm}</td>
<td></td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>4.00</td>
<td></td>
<td>Grey weathered rock</td>
<td>1.80</td>
<td>4.00</td>
<td>&gt;100 50\text{Blows [Rebound]}</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>5.00</td>
<td></td>
<td>Grey weathered rock</td>
<td>5.00</td>
<td>&gt;100 50\text{Blows [Rebound]}</td>
<td></td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>5.60 to 6.00</td>
<td></td>
<td>Soft rock [TCR-10% RQD-NIL]</td>
<td>5.60 to 6.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td></td>
<td>Soft rock [TCR-52% RQD-NIL]</td>
<td>2.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00 to 8.00</td>
<td></td>
<td>Soft rock [TCR-55% RQD-NIL]</td>
<td>7.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00 to 9.00</td>
<td></td>
<td>Hard rock [TCR-59% RQD-NIL]</td>
<td>8.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.00 to 10.00</td>
<td></td>
<td>Hard rock [TCR-62% RQD-NIL]</td>
<td>9.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Borehole Terminated @ 10.00M
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Depth at which test is conducted</td>
<td>N-Value</td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>Weathered rock</td>
<td>1.20</td>
<td>1.00</td>
<td>&gt;100</td>
</tr>
<tr>
<td>1.20 to 2.00</td>
<td></td>
<td>Soft rock [TCR-41% RQD-NIL]</td>
<td>1.20 to 2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00 to 3.00</td>
<td></td>
<td>Soft rock [TCR-46% RQD-NIL]</td>
<td>2.00 to 3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00 to 3.50</td>
<td></td>
<td>Soft rock [TCR-48% RQD-NIL]</td>
<td>3.00 to 3.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Borehole Terminated @ 3.50M
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Depth at which test is conducted</th>
<th>N-Value</th>
<th>Relative density / Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>Brownish grey silty clayey sand</td>
<td>1.60</td>
<td>1.00</td>
<td>11</td>
<td>[03/04/07] Medium</td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td>Brownish grey fine to coarse sand</td>
<td>2.00</td>
<td>2.00</td>
<td>39</td>
<td>[10/16/23] Dense</td>
</tr>
<tr>
<td>3.00</td>
<td></td>
<td>Brownish grey fine to coarse sand</td>
<td>1.80</td>
<td>3.00</td>
<td>&gt;100</td>
<td>50 Blows [Rebound] Very dense</td>
</tr>
<tr>
<td>4.00</td>
<td></td>
<td>Brownish grey medium to coarse sand</td>
<td>1.10</td>
<td>4.00</td>
<td>&gt;100</td>
<td>50 Blows [Rebound] Very dense</td>
</tr>
<tr>
<td>4.50 to 6.00</td>
<td></td>
<td>Soft rock [TCR-32% RQD-NIL]</td>
<td></td>
<td>4.50 to 6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00 to 6.50</td>
<td></td>
<td>Soft rock [TCR-35% RQD-NIL]</td>
<td></td>
<td>6.00 to 6.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.50 to 7.50</td>
<td></td>
<td>Soft rock [TCR-39% RQD-NIL]</td>
<td></td>
<td>6.50 to 7.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.50 to 8.50</td>
<td></td>
<td>Soft rock [TCR-43% RQD-NIL]</td>
<td></td>
<td>7.50 to 8.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graphical Representation of Penetration Resistance

Borehole Terminated @ 8.50M
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>Yellowish grey fine to medium sand</td>
<td>1.20</td>
<td>1.00</td>
<td>&gt;100</td>
</tr>
<tr>
<td>1.20 to 2.00</td>
<td></td>
<td>Soft rock [TCR-10% RQD-NIL]</td>
<td>1.20</td>
<td>2.00</td>
<td>50</td>
</tr>
<tr>
<td>2.00 to 3.00</td>
<td></td>
<td>Soft rock [TCR-15% RQD-NIL]</td>
<td>2.00</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>3.00 to 4.00</td>
<td></td>
<td>Soft rock [TCR-19% RQD-NIL]</td>
<td>3.00</td>
<td>4.00</td>
<td></td>
</tr>
<tr>
<td>4.00 to 5.00</td>
<td></td>
<td>Soft rock [TCR-22% RQD-NIL]</td>
<td>4.00</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td>5.00 to 6.00</td>
<td></td>
<td>Soft rock [TCR-27% RQD-NIL]</td>
<td>5.00</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td></td>
<td>Soft rock [TCR-29% RQD-NIL]</td>
<td>6.00</td>
<td>7.00</td>
<td></td>
</tr>
<tr>
<td>7.00 to 8.00</td>
<td></td>
<td>Soft rock [TCR-31% RQD-NIL]</td>
<td>7.00</td>
<td>8.00</td>
<td></td>
</tr>
<tr>
<td>8.00 to 9.00</td>
<td></td>
<td>Soft rock [TCR-34% RQD-NIL]</td>
<td>8.00</td>
<td>9.00</td>
<td></td>
</tr>
<tr>
<td>Depth Below G.L.</td>
<td>Soil Profile</td>
<td>Description of Soil</td>
<td>Thickness of layer (m)</td>
<td>Depth at which test is conducted</td>
<td>N-Value</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>-------------------------------</td>
<td>------------------------</td>
<td>----------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>9.00 to 10.00</td>
<td></td>
<td>Soft rock [TCR-37% RQD-NIL]</td>
<td>9.00 to 10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00 to 11.00</td>
<td></td>
<td>Soft rock [TCR-39% RQD-NIL]</td>
<td>10.00 to 11.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.00 to 12.00</td>
<td></td>
<td>Soft rock [TCR-42% RQD-NIL]</td>
<td>11.00 to 12.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.00 to 13.00</td>
<td></td>
<td>Soft rock [TCR-45% RQD-NIL]</td>
<td>12.00 to 13.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.00 to 14.00</td>
<td></td>
<td>Soft rock [TCR-47% RQD-NIL]</td>
<td>13.00 to 14.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.00 to 15.00</td>
<td></td>
<td>Soft rock [TCR-49% RQD-NIL]</td>
<td>14.00 to 15.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Borehole Terminated @ 15.00M
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Yellowish grey weathered rock</td>
<td>1.00</td>
<td>0.00</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>1.30 to 2.00</td>
<td>Soft rock [TCR-10% RQD-NIL]</td>
<td>1.30 to 2.00</td>
<td>1.30 to 2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00 to 3.00</td>
<td>Soft rock [TCR-14% RQD-NIL]</td>
<td>2.00 to 3.00</td>
<td>2.00 to 3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00 to 4.00</td>
<td>Soft rock [TCR-17% RQD-NIL]</td>
<td>3.00 to 4.00</td>
<td>3.00 to 4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.00 to 5.00</td>
<td>Soft rock [TCR-19% RQD-NIL]</td>
<td>4.00 to 5.00</td>
<td>4.00 to 5.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00 to 6.00</td>
<td>Soft rock [TCR-22% RQD-NIL]</td>
<td>5.00 to 6.00</td>
<td>5.00 to 6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td>Soft rock [TCR-25% RQD-NIL]</td>
<td>6.00 to 7.00</td>
<td>6.00 to 7.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00 to 8.00</td>
<td>Soft rock [TCR-29% RQD-NIL]</td>
<td>7.00 to 8.00</td>
<td>7.00 to 8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00 to 9.00</td>
<td>Soft rock [TCR-33% RQD-NIL]</td>
<td>8.00 to 9.00</td>
<td>8.00 to 9.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.00 to 10.00</td>
<td>Soft rock [TCR-35% RQD-NIL]</td>
<td>9.00 to 10.00</td>
<td>9.00 to 10.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Borehole Terminated @ 10.00M
## BORE LOG

**Client:** M/s. NCSCM, Chennai  
**Date of Started:** 02-01-2013  
**Project:** Building Construction @ NCSCM  
**Date of Completed:** 03-01-2013  
**Location:** NCSCM  
**Borehole:** 07  
**Ground Water Level:** 0.60M

<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>Greyish brown silty clayey sand</td>
<td>1.70</td>
<td>Depth at which test is conducted: 1.00, N-Value: 35, [09/16/19]</td>
<td>Dense</td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td>Brown fine to medium sand</td>
<td>2.10</td>
<td>Depth at which test is conducted: 2.00, N-Value: &gt;100 50cm@14cm</td>
<td>Very dense</td>
</tr>
<tr>
<td>3.00</td>
<td></td>
<td>Brown fine to medium sand</td>
<td>3.00</td>
<td>Depth at which test is conducted: 3.00, N-Value: &gt;100 50Blows [Rebound]</td>
<td>Very dense</td>
</tr>
<tr>
<td>3.80 to 4.00</td>
<td></td>
<td>Soft rock [TCR-10% RQD-NIL]</td>
<td>3.80 to 4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.00 to 5.00</td>
<td></td>
<td>Soft rock [TCR-15% RQD-NIL]</td>
<td>4.00 to 5.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00 to 6.00</td>
<td></td>
<td>Soft rock [TCR-18% RQD-NIL]</td>
<td>4.50 to 6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td></td>
<td>Soft rock [TCR-23% RQD-NIL]</td>
<td>6.00 to 7.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00 to 8.30</td>
<td></td>
<td>Soft rock [TCR-27% RQD-NIL]</td>
<td>7.00 to 8.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.30 to 8.70</td>
<td></td>
<td>Hard rock [TCR-29% RQD-NIL]</td>
<td>8.30 to 8.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.70 to 9.00</td>
<td></td>
<td>Hard rock [TCR-33% RQD-NIL]</td>
<td>8.70 to 9.00</td>
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</table>

**Borehole Terminated @ 9.00M**
### BORE LOG

**Client:** M/s. NCSCM, Chennai  
**Date of Started:** 03-01-2013  
**Project:** Building Construction @ NCSCM  
**Date of Completed:** 04-01-2013  
**Location:** NCSCM  
**Borehole:** 08  
**Ground Water Level:** 0.98M

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<tr>
<th>Depth Below G.L.</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
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<tr>
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<td>&gt;100</td>
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<td>9.00 to 10.00</td>
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Borehole Terminated @ 10.00M
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<tr>
<th>Depth Below G.L. (m)</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Depth at which test is conducted</th>
<th>N-Value</th>
<th>Relative density / Consistency</th>
<th>Graphical Representation of Penetration Resistance</th>
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Borehole Terminated @ 10.00M
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<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
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<tbody>
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<td>0.00</td>
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<td></td>
<td>0.00</td>
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</tr>
<tr>
<td>1.00</td>
<td>Brown clayey silty sand</td>
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<tr>
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<td>Soft rock  [TCR-13% RQD-NIL]</td>
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<td>4.00</td>
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<td>Soft rock  [TCR-27% RQD-NIL]</td>
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<tr>
<td>8.00 to 9.00</td>
<td>Soft rock  [TCR-31% RQD-NIL]</td>
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Borehole Terminated @ 10.00M
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<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
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<tbody>
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<tr>
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<td>&gt;100 50Blows [Rebound]</td>
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<td>[TCR-34% RQD-NIL]</td>
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Borehole Terminated @ 10.00M
## BORE LOG

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<tr>
<th>Depth Below G.L.</th>
<th>Description of Soil</th>
<th>Soil Profile</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
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<tr>
<td>0.00</td>
<td>Brownish grey clayey silty sand</td>
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<td>&gt;100 50Blows [Rebound] Very dense</td>
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<tr>
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<td>&gt;100 28/5011cm Very dense</td>
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Borehole Terminated @ 10.00M
<table>
<thead>
<tr>
<th>DEPTH OF SAMPLING</th>
<th>I.S. SOIL CLASSIFICATION</th>
<th>NATURAL WET DENSITY (KN/m³)</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>DENSITY OF ROCK (GM/CC)</th>
<th>COMPRESSIVE STRENGTH (Kg/cm²)</th>
<th>C捣</th>
<th>PLASTICITY INDEX</th>
<th>GRAVEL (%)</th>
<th>SAND (%)</th>
<th>MEDIUM (%)</th>
<th>COARSE (%)</th>
<th>FREE SWELL INDEX (%)</th>
<th>SAND (%)</th>
<th>FINES</th>
<th>SPECIFIC GRAVITY</th>
<th>COHESION (Kg/cm²)</th>
<th>ANGLE OF INTERNAL FRICTION</th>
<th>DEPTH OF TESTING (M)</th>
<th>OBSERVED N VALUE</th>
<th>CORRECTED N VALUE</th>
<th>CONSISTENCY / RELATIVE DENSITY</th>
<th>COMPRESSION INDEX Cc</th>
<th>CONSOLIDATION PRESSURE KG/CM²</th>
<th>INITIAL voids Ratio (%)</th>
<th>COEFFICIENT OF CONSOLIDATION CV IN CM² / SEC</th>
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<th>DEPTH OF SAMPLING</th>
<th>I.S. SOIL CLASSIFICATION</th>
<th>LABORATORY TEST RESULTS</th>
<th>SHEAR TEST</th>
<th>STANDARD PENETRATION TEST</th>
<th>CONSOLIDATION TEST</th>
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<td>NATURAL WET DENSITY (Kn/m³)</td>
<td>NATURAL MOISTURE CONTENT (%)</td>
<td>DENSITY OF ROCK (Gm/cc)</td>
<td>COMPRRESSIVE STRENGTH (kg/cm²)</td>
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Contd…
## Laboratory Test Results

**Client:** M/s. National Centre for Sustainable Coastal Management, Chennai

**Name of Work:** Geo-Technical Investigation for Construction of the Building

**Location:** NCSCM (BH: 02)

**Ground Water Level:** 1.63m

**Lab Work Started On:** 08-06-2011

**Lab Work Completed On:** 11-06-2012

<table>
<thead>
<tr>
<th>Depth of Sampling</th>
<th>I.S. Soil Classification</th>
<th>Natural Wet Density KN/m³</th>
<th>Natural Moisture Content</th>
<th>Density of Rock (Gm/cc)</th>
<th>Compressive Strength (Kg/cm²)</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Plasticity Index</th>
<th>Gravel (%)</th>
<th>Coarse (%)</th>
<th>Medium (%)</th>
<th>Fine (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>Specific Gravity</th>
<th>Sand (%)</th>
<th>Fines (%)</th>
<th>Coefficient of Consolidation Cv (in cm²/sec)</th>
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<th>DENSITY OF ROCK (Gm/cc)</th>
<th>NATURAL WET DENSITY KN/m³</th>
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<th>INDEX TEST</th>
<th>GRAIN SIZE DISTRIBUTION</th>
<th>SHEAR TEST</th>
<th>CONSOLIDATION PRESSURE KG/CM²</th>
<th>INITIAL VOIDS RATIO (φ%)</th>
<th>CONSOLIDATION INDEX Cc</th>
<th>COMPRESSION INDEX Cc</th>
<th>ANGLE OF INTERNAL FRICTION (°)</th>
<th>DEPTH OF TESTING (M)</th>
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<th>OBSERVED N VALUE</th>
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<th>SPECIFIC GRAVITY</th>
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# LABORATORY TEST RESULTS

**CLIENT:** M/s. NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI  
**NAME OF WORK:** GEO-TECHNICAL INVESTIGATION FOR CONSTRUCTION OF THE BUILDING  
**LOCATION:** NCSCM (BH - 05)  
**GROUND WATER LEVEL:** 0.36M  
**LAB WORK STARTED ON:** 24-12-2013  
**LAB WORK COMPLETED ON:** 23-01-2013

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<th>NATURAL MOISTURE CONTENT</th>
<th>DENSITY OF ROCK (G/M³)</th>
<th>COMPRESSION STRENGTH (Kg/cm²)</th>
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<th>PLASTIC LIMIT</th>
<th>PLASTICITY INDEX</th>
<th>SIZE DISTRIBUTION</th>
<th>SAND</th>
<th>FINE</th>
<th>CLAY</th>
<th>FREE SWELL INDEX (%)</th>
<th>CONSOLIDATION TEST</th>
<th>CONSOLIDATION PRESSURE KG/CM²</th>
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<th>CORRECTED N VALUE</th>
<th>CONSISTENCY / RELATIVE DENSITY</th>
<th>CONSOLIDATION PRESSURE K/CM²</th>
<th>INITIAL VOID RATIO (%)</th>
<th>COEFFICIENT OF CONSOLIDATION Cv IN CM² / SEC</th>
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<th>NATURAL MOISTURE CONTENT (%)</th>
<th>DENSITY OF ROCK (G/M²)</th>
<th>COMPRESSION STRENGTH (Kg/cm²)</th>
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<th>PLASTIC LIMIT (%)</th>
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<th>FINE (%)</th>
<th>SILT (%)</th>
<th>CLAY (%)</th>
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<td>MEDIUM (%)</td>
<td>FINE (%)</td>
<td>SILT (%)</td>
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<td>DEPTH OF Penetration (M)</td>
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<td>CORRECTED N value</td>
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| DEPTH OF SAMPLING | I.S.SOIL CLASSIFICATION | NATURAL WET DENSITY Kn/m³ | NATURAL MOISTURE CONTENT | DENSITY OF ROCK (G/M³) | COMPRRESSIVE STRENGTH (Kg/cm²) | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | GRAVEL (%) | COARSE (% | MEDIUM (%) | FINE (%) | SILT (%) | CLAY (%) | FREE SWELL INDEX (%) | SPECIFIC GRAVITY | COHESION (Kg/Cm²) | ANGLE OF INTERNAL FRICTION | DEPTH OF TESTING (M) | OBSERVED N VALUE | CORRECTED N VALUE | CONSISTENCY / RELATIVE DENSITY | CONSOLIDATION PRESSURE (Kg/Cm²) | INITIAL VOIDS RATIO (eₐ) | COEFFICIENT OF CONSOLIDATION Cv IN CM2 / SEC |
|-------------------|--------------------------|---------------------------|--------------------------|------------------------|-------------------------------|---------------|---------------|------------------|-----------|-----------|-------------|-------|--------|---------|------------------|----------------|----------------|---------------------------------|-------------------|----------------|------------------------|-------------------------------|----------------|---------------------|
| 5.00 to 6.00      | Soft rock [TCR-22% RQD-NIL] | 2.410                     |                          |                        |                               |               |               |                  |           |           |             |       |        |         |                  |                 |                |                                 | 5.00 to 6.00       |               |                       |                               |                 |                      |
| 6.00 to 7.00      | Soft rock [TCR-25% RQD-NIL] | 2.460                     |                          |                        |                               |               |               |                  |           |           |             |       |        |         |                  |                 |                |                                 | 6.00 to 7.00       |               |                       |                               |                 |                      |
| 7.00 to 8.00      | Soft rock [TCR-29% RQD-NIL] | 2.520                     |                          |                        |                               |               |               |                  |           |           |             |       |        |         |                  |                 |                |                                 | 7.00 to 8.00       |               |                       |                               |                 |                      |
| 8.00 to 9.00      | Soft rock [TCR-33% RQD-NIL] | 2.580                     |                          |                        |                               |               |               |                  |           |           |             |       |        |         |                  |                 |                |                                 | 8.00 to 9.00       |               |                       |                               |                 |                      |
| 9.00 to 10.00     | Soft rock [TCR-35% RQD-NIL] | 2.590                     |                          |                        |                               |               |               |                  |           |           |             |       |        |         |                  |                 |                |                                 | 9.00 to 10.00      |               |                       |                               |                 |                      |
| DEPTH OF SAMPLING | I.S.SOIL CLASSIFICATION | NATURAL WET DENSITY (KN/m³) | NATURAL MOISTURE CONTENT | DENSITY OF ROCK (GM/CC) | COMPRESSIVE STRENGTH (Kg/cm²) | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | GRAVEL (%) | MEDIUM (%) | FINE (%) | SILT (%) | CLAY (%) | FREE SWELL INDEX (%) | SAND | FINES | SPECIFIC GRAVITY | COHESION (Kg/Cm³) | ANGLE OF INTERNAL FRICTION | DEPTH OF TESTING (M) | OBSERVED N VALUE | CORRECTED N VALUE | CONSISTENCY / RELATIVE DENSITY | COMPRESSION INDEX Cc | CONSOLIDATION PRESSURE KG/CM² | INITIAL Voids RATION (φ) | CO-EFFICIENT OF CONSOLIDATION Cv IN CM²/SEC |
|------------------|------------------------|---------------------------|--------------------------|--------------------------|-------------------------------|--------------|--------------|-----------------|------------|-----------|---------|---------|--------|-------------------|-------|-------|-----------------|----------------|-------------------------|----------------------|--------------|--------------|--------------------------|-----------------|-------------------------|----------------------|----------------|-------------|
| 0.00             |                        |                           |                          |                          |                               |              |              |                 |            |           |         |        |        |                   |       |       |                 |                 |                         |                      |             |             |                          |                 |                         |                      |
| 1.00             | Greyish brown silty clayey sand | 19                        | 38                       | 19                       | 0                             | 0            | 22           | 53              | 25         | 22        | 2.708   | 1.00    | 35     | Dense             | 0.00  |       |                 |                 |                         |                      |             |             |                          |                 |                         |                      |
| 2.00             | Brown fine to medium sand    | 15                        | 1                         | 29                       | 64                            | 22           | 2.731        |                 | 2.00       | >100      | Very dense |                      |        |       |                 |                 |                         |                      |             |             |                          |                 |                         |                      |
| 3.00             | Brown fine to medium sand    |                           |                           |                          |                               |              |              |                 |            |           |         |        |        |                   |       |       |                 |                 |                         |                      |             |             |                          |                 |                         |                      |
| 3.80 to 4.00     | Soft rock [TCR-10% RQD-NIL]  |                           |                           |                          |                               |              |              |                 |            |           |         |        |        |                   |       |       |                 |                 |                         |                      |             |             |                          |                 |                         |                      |
| 4.00 to 5.00     | Soft rock [TCR-15% RQD-NIL]  |                           |                           |                          |                               |              |              |                 |            |           |         |        |        |                   |       |       |                 |                 |                         |                      |             |             |                          |                 |                         |                      |

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<th>I.S. SOIL CLASSIFICATION</th>
<th>NATURAL WET DENSITY K/nm³</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>DENSITY OF ROCK (G/M³)</th>
<th>COMPRRESSIVE STRENGTH (Kg/cm²)</th>
<th>LIQUID LIMIT</th>
<th>PLASTICITY LIMIT</th>
<th>GRAVEL (%)</th>
<th>COARSE (%)</th>
<th>MEDIUM (%)</th>
<th>FINE (%)</th>
<th>SILT (%)</th>
<th>CLAY (%)</th>
<th>FREE SWELL INDEX (%)</th>
<th>SPECIFIC GRAVITY</th>
<th>COHESION (Kg/Cm²)</th>
<th>ANGLE OF INTERNAL FRICTION</th>
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<th>CONSISTENCY / RELATIVE DENSITY</th>
<th>COMPRESSION INDEX Cc</th>
<th>COMPRESSION INDEX PRESSURE Kg/Cm²</th>
<th>INITIAL voids ratio (%)</th>
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## LABORATORY TEST RESULTS

**CLIENT:** M/s. NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI  
**NAME OF WORK:** GEO-TECHNICAL INVESTIGATION FOR CONSTRUCTION OF THE BUILDING  
**LOCATION:** NCSCM (BH - 08)  
**GROUND WATER LEVEL:** 0.98M  
**LAB WORK STARTED ON:** 07-01-2013  
**LAB WORK COMPLETED ON:** 24-01-2013

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<th>NATURAL WET DENSITY Kgm⁻³</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>DENSITY OF ROCK (GM/CC)</th>
<th>COMPRESSION TEST</th>
<th>INDEX TEST</th>
<th>GRAIN SIZE DISTRIBUTION</th>
<th>GROUND WATER LEVEL</th>
<th>LAB WORK STARTED ON</th>
<th>LAB WORK COMPLETED ON</th>
<th>SHEAR TEST</th>
<th>STANDARD PENETRATION TEST</th>
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**LABORATORY TEST RESULTS**

**CLIENT:** M/s. NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI

**NAME OF WORK:** GEO-TECHNICAL INVESTIGATION FOR CONSTRUCTION OF THE BUILDING

**LOCATION:** NCSCM (BH - 08)  **GROUND WATER LEVEL:** 0.98M  **LAB WORK STARTED ON:** 07-01-2013  **LAB WORK COMPLETED ON:** 24-01-2013

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<tr>
<th>DEPTH OF TESTING (M)</th>
<th>OBSERVED N VALUE</th>
<th>CORRECTED N VALUE</th>
<th>CONSISTENCY / RELATIVE DENSITY</th>
<th>COMPRESSION INDEX Cc</th>
<th>CONSOLIDATION PRESSURE KG/cm²</th>
<th>INITIAL void ratio (e0)</th>
<th>COEFFICIENT OF CONSOLIDATION Cv IN CM2 / SEC</th>
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|-------------------|--------------------------|----------------------------|--------------------------|--------------------|----------------------------|-------------|-------------|-----------------|------------|---------|---------|---------------------|----------------|----------------|--------------------------------|-----------------|----------------|----------------|--------------------------------|----------------|----------------|-------------------------|----------------|----------------|-------------------|
| 6.00 to 7.00      | Soft rock [TCR-19% RQD-NIL] | 2.584                      |                          |                    |                            |             |             |                 |            |         |         |                     |                 |                |                              | 6.00 to 7.00     |                |                |                               |                |                |                         |                |                |                    |
| 7.00 to 8.00      | Soft rock [TCR-22% RQD-NIL] | 2.747                      |                          |                    |                            |             |             |                 |            |         |         |                     |                 |                |                              | 7.00 to 8.00     |                |                |                               |                |                |                         |                |                |                    |
| 8.00 to 9.00      | Soft rock [TCR-27% RQD-NIL] | 2.511                      |                          |                    |                            |             |             |                 |            |         |         |                     |                 |                |                              | 8.00 to 9.00     |                |                |                               |                |                |                         |                |                |                    |
| 9.00 to 9.50      | Soft rock [TCR-31% RQD-NIL] | 2.774                      |                          |                    |                            |             |             |                 |            |         |         |                     |                 |                |                              | 9.00 to 9.50     |                |                |                               |                |                |                         |                |                |                    |
| 9.50 to 10.00     | Soft rock [TCR-33% RQD-NIL] | 2.330                      |                          |                    |                            |             |             |                 |            |         |         |                     |                 |                |                              | 9.50 to 10.00    |                |                |                               |                |                |                         |                |                |                    |</p>
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## Laboratory Test Results

**Client:** M/s. National Centre for Sustainable Coastal Management, Chennai

**Name of Work:** Geo-Technical Investigation for Construction of the Building

**Location:** NCSCM (BH - 10)  
**Ground Water Level:** 1.54 M  
**Lab Work Started On:** 09-01-2013  
**Lab Work Completed On:** 24-01-2013

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<th>Shear Test</th>
<th>Standard Penetration Test</th>
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### Laboratory Test Results

**Client:** M/s. National Centre for Sustainable Coastal Management, Chennai  
**Name of Work:** Geo-Technical Investigation for Construction of the Building  
**Location:** NCSCM (BH - 11)

**Ground Water Level:** 1.50m  
**Lab Work Started On:** 07-01-2013  
**Lab Work Completed On:** 24-01-2013

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<th>Plastic Limit (%)</th>
<th>Plasticity Index</th>
<th>Coarse (%)</th>
<th>Medium (%)</th>
<th>Fine (%)</th>
<th>Clay (%)</th>
<th>Specific Gravity</th>
<th>Free-Swell Index (%)</th>
<th>Cohesion (Kg/Cm)²</th>
<th>Depth of Testing (M)</th>
<th>Observed N Value</th>
<th>Corrected N Value</th>
<th>Consistency / Relative Density</th>
<th>Compression Index Cc</th>
<th>Compression Pressure Kg/CM²</th>
<th>Initial Voids Ratio (%)</th>
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## LABORATORY TEST RESULTS

**CLIENT:** M/s. NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI  
**NAME OF WORK:** GEO-TECHNICAL INVESTIGATION FOR CONSTRUCTION OF THE BUILDING  
**LOCATION:** NCSCM (BH - 12)  
**GROUND WATER LEVEL:** 1.50m  
**LAB WORK STARTED ON:** 17-01-2013  
**LAB WORK COMPLETED ON:** 24-01-2013

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<th>NATURAL WET DENSITY KN/m³</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>DENSITY OF ROCK (GM/CC)</th>
<th>COMPRESSIVE STRENGTH (Kg/cm²)</th>
<th>LIQUID LIMIT</th>
<th>PLASTIC LIMIT</th>
<th>PLASTICITY INDEX</th>
<th>GRAVEL (%)</th>
<th>MEDIUM (%)</th>
<th>FINE (%)</th>
<th>SILT (%)</th>
<th>CLAY (%)</th>
<th>SAND (%)</th>
<th>FINES</th>
<th>SPECIFIC GRAVITY</th>
<th>COHESION (Kg/Cm²)</th>
<th>ANGLE OF INTERNAL FRICTION (°)</th>
<th>DEPTH OF TESTING (M)</th>
<th>OBSERVED N VALUE</th>
<th>CORRECTED N VALUE</th>
<th>CONSISTENCY / RELATIVE DENSITY</th>
<th>COMPRESSION INDEX Cc</th>
<th>CONSOLIDATION PRESSURE Kg/cm²</th>
<th>INITIAL VOIDS RATIO (e0)</th>
<th>CO-EFFICIENT OF CONSOLIDATION Cv IN CM²/SEC</th>
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<tbody>
<tr>
<td>5.00 to 6.00</td>
<td>Soft rock [TCR-19% RQD-NIL]</td>
<td>2.753</td>
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<td>6.00 to 7.00</td>
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<tr>
<td>7.00 to 8.00</td>
<td>Soft rock [TCR-25% RQD-NIL]</td>
<td>3.040</td>
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<tr>
<td>8.00 to 9.00</td>
<td>Soft rock [TCR-29% RQD-NIL]</td>
<td>2.515</td>
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<tr>
<td>9.00 to 10.00</td>
<td>Hard rock [TCR-37% RQD-NIL]</td>
<td>2.580</td>
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</tr>
</tbody>
</table>
WEIGHT PASSING, %

PARTICLE SIZE, mm

LOCATION: BH: 01

I.S. 1490 CLASSIFICATION

CLIENT: NCSCM

CLIENT: NCSCM

DEPTH - 1.00 M

DEPTH - 2.00 M

SILT

FINE SAND

MEDIUM SAND

COARSE GRAVEL

CLAY

0.002

0.075

0.425

2.0

4.75

I.S. 1490 CLASSIFICATION
I.S. 1490 CLASSIFICATION

DEPTH - 1.00 M

LOCATION :- BH : 03

CLAY | SILT | FINE SAND | MEDIUM SAND | COARSE | GRAVEL
---|-----|-----------|-------------|--------|--------
0.002 | 0.075 | 0.425     | 2.0         | 4.75   |
WEIGHT PASSING, %

PARTICLE SIZE, mm

I.S. 1490 CLASSIFICATION

CLAY
SILT
FINE SAND
MEDIUM SAND
COARSE
GRAVEL

LOCATION :- BH : 04

CLIENT : NCSCM
WEIGHT PASSING, %

PARTICLE SIZE, mm

I.S. 1490 CLASSIFICATION

LOCATION :- BH : 12

CLIENT : NCSCM

Depth - 1.00 M

Depth - 2.00 M

CLAY  SILT  FINE SAND  MEDIUM SAND  COARSE  GRAVEL

0.002  0.075  0.425  2.0  4.75

I.S. 1490 CLASSIFICATION

Page 60 of 61
REFERENCES

1. IS : 6403 - 1981

2. IS : 2720 (Methods of test of soils)

3. IS : 2911 - (Part / Sec-2) - 1979

4. IS : 2131 - 1980

5. IS:8009 (Part-1) 1976

6. IRC 78 : 2000


SOIL INVESTIGATION FOR CONSTRUCTION OF BUILDING AT NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI

SOIL EXPLORATION REPORT

«« Prepared for »»

M/s. NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, CHENNAI

«« Prepared by »»

VELCITI CONSULTING ENGINEERS PVT. LTD.
4A, 4th Cross Street,
Dhandeeswaram Nagar,
Velachery, Chennai - 600 042.
Ph. Nos. 91- 44 - 43  5659 / 2243 2659
E-mail: velciti@gmail.com
SOIL EXPLORATION REPORT

CLIENT : M/s. NCSCM, Chennai

PROJECT : Construction of Building

LOCATION : NCSCM, Chennai

TOTAL NUMBER OF LOCATIONS : 4 Nos.

VELCITI CONSULTING ENGINEERS PVT. LTD.
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<table>
<thead>
<tr>
<th>INDEX</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GENERAL</td>
<td>1</td>
</tr>
<tr>
<td>2. OBJECTIVE</td>
<td>2</td>
</tr>
<tr>
<td>3. FIELD INVESTIGATION</td>
<td>3 to 5</td>
</tr>
<tr>
<td>3.1 Rotary Boring</td>
<td></td>
</tr>
<tr>
<td>3.2 Standard Penetration Test</td>
<td></td>
</tr>
<tr>
<td>3.3 Sampling</td>
<td></td>
</tr>
<tr>
<td>4. LABORATORY INVESTIGATION</td>
<td>6</td>
</tr>
<tr>
<td>5. FOUNDATION ANALYSIS</td>
<td>7</td>
</tr>
<tr>
<td>5.1 Soil Profile</td>
<td></td>
</tr>
<tr>
<td>5.2 Safe Bearing Capacity</td>
<td></td>
</tr>
<tr>
<td>6. SBC CALCULATION</td>
<td>8 to 11</td>
</tr>
<tr>
<td>6.1 to 6.5 SBC calculation based on Shear Criteria</td>
<td></td>
</tr>
<tr>
<td>6.6 SBC calculation based on Settlement Analysis</td>
<td></td>
</tr>
<tr>
<td>7. ANNEXURE</td>
<td>12</td>
</tr>
<tr>
<td>7.1 Log of Boring</td>
<td>13 to 16</td>
</tr>
<tr>
<td>7.2 Laboratory Test Results</td>
<td>17 to 22</td>
</tr>
<tr>
<td>7.3 Gradation</td>
<td>23 to 27</td>
</tr>
<tr>
<td>8. REFERENCES</td>
<td>28</td>
</tr>
</tbody>
</table>
1. GENERAL

➢ The proposed site is located at anna university campus.

➢ The surface of the earth is Greyish brown.

➢ The field investigation was carried out during the month of March and April 2013.

➢ The laboratory investigation was done during the month of April 2013.

➢ Geotechnical investigation consists of four boreholes in four locations tested up to hard strata from the natural ground level.
2. OBJECTIVE

VELCITI CONSULTING ENGINEERS PVT. LTD., performed a Geotechnical site investigation for the construction of Building at chennai. This work was referred to us by THE Director NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT, The primary purpose of this investigation was to obtain data to ascertain sub-surface soil stratigraphy for the purpose of foundation design.

The locations of borings were selected by client’s representatives. To accomplish these purposes, the following tasks were performed:

1. Detailed four number of soil borings were done up to hard strata to explore the subsurface stratigraphy and obtain soil samples for laboratory testing;

2. Field and laboratory tests were conducted to evaluate the index and engineering properties of the soils.

3. Engineering analyses were performed to develop foundation design information for the proposed structure.
3. FIELD INVESTIGATIONS

Rotary Boring:

Rotary boring was performed at four locations in accordance with IS: 1890.

In this method, boring is effected by the cutting action of a rotating bit which is kept in firm contact with the bottom of the hole. The bit is attached to the lower end of a hollow drill rod which is rotated by a suitable chuck. Drilling mud [usually Bentonite] is continuously forced down the hollow drill rods. The mud returning upwards through the annular space between the drill rods and the side of the hole brings the cuttings to the surface.

Boring was advanced in weathered rock stratum using TC bit attached to the lower end of the hollow drill rod. Soft rock / Hard rock stratum, by using NX size diamond bit.

Standard Penetration Test:

Standard Penetration Test was performed in four locations in accordance with IS: 2131 - 1981.
It is now the most commonly used in situ test. The test measures the penetration resistance of the split-spoon sampler, when it is driven into the soil, at the bottom of a bore hole in a standard manner. The N-value, which is the number of blows required to achieve 300 mm penetration of the soil, indicates the relative density of a sand or gravel, the consistency of other soils such as silts or clays and the strength of weak rocks. The test is described in IS 2131 - 1981. The split-spoon sampler is attached to stiff drill rod and lowered to the bottom of the bore hole. A standard blow consists of dropping a mass of 63.5 kg free fall through 750 mm on to an anvil at the top of the rods and ensuring that this amount of dynamic energy is transferred to the sampler as much as possible.

The number of blows required to achieve each 150 mm penetration is recorded for a full penetration of 450 mm. The initial 150 mm penetration is referred to as seating drive and the blows required for this penetration are not considered as this zone is in disturbed soil. The next 300 mm of penetration is referred to as the test drive and the number of blows required to achieve this fully is termed the penetration resistance or N-value.
**Sampling:**

The soil that is being removed during drilling of boreholes is regularly examined for changes in the soil stratification. At fixed regular intervals and at levels where there is change in soil type samples are collected for closer examination in the laboratory.

The types of samples collected can be grouped under the following two categories.

1. Disturbed samples
2. Undisturbed samples

In disturbed samples there is considerable disturbance in the natural structural arrangement of the soil particles. For meaningful results to be obtained from disturbed samples they must be **representative samples**. That is, the soil sample must contain all the mineral constituents that are present in the soil at the depth from which the sample has been taken and there should not be intermixing of minerals from various depths. Disturbed soil samples can be collected from split spoon sampler used in standard penetration test and also from soil retained in auger.
4. LABORATORY INVESTIGATION

The operations to be performed in the laboratory depend upon the type of the nature of data required for the problem at hand.

In case of cohesion less material, like sand, the laboratory tests are usually minimum and the design parameters are worked out from field test data such as from SPT-N value, core resistance.

For cohesionless soil

a) Specific gravity
b) Sieve analysis
c) Direct shear test

d) UCC test

e) VELCITI

For cohesive soil

a) Specific gravity
b) Natural moisture content
c) Atterberg's limits
d) Sieve Analysis
e) UCC test

VELCITI

CLIENT : NCSCM
5. FOUNDATION ANALYSIS

Soil profile:

In order to obtain the soil profile of the site, four locations (one borehole in each location) have been bored. The soil profile reveals that it consists of weathered rock with clay binder / weathered rock / soft rock / hard rock stratum. The detailed borelogs and laboratory test results are enclosed in the annexure.

Safe Bearing Capacity:

The SBC calculations are made based on the information obtained from borehole – 16 from the four locations. Extrapolating information from just one borehole may be misleading the designs. However, this may be overlooked by way of conforming the uniformity of soil (with borelog data), during execution of the foundation. And also the Dynamic Analysis for wind load should be considered during Structural Design of the structure.

The bearing capacity of granular soil depends upon the unit weight and angle of internal friction of the soil. These two properties of granular soils are determined by standard penetration tests. The following SBC calculation is made based on Static Analysis.
For the location :- NCSCM

Depth : @ 2.00m. from NGL.

(BH No. 16 Datas are taken for calculation purpose)

6.COMPUTATION OF BEARING CAPACITY (AS PER IS: 6403)
   BASED ON SHEAR CRITERIA:

6.1 Geometrical Data:
   Type of Foundation System: Open
   R.L. of the top of Borehole (m): 0.00 m
   Depth of Foundation below existing ground level (Deg): 2.00 m
   R.L. of the depth of foundation system (m): - 2.00 m
   Effective Depth of Foundation below existing ground level (Df): 2.00 m
   Minimum Design Width of Foundation (B): 1.00 m
   Thickness of Foundation (T): 0.45 m

6.2 Soil Data:
   Type of Bearing Strata: Weathered rock with clay binder
   Design SPT-value of the Bearing Strata: \( \frac{(22+25+50)}{3} \) =32
   (Considered based upon the density of the strata)
   Type of Shear Failure: General
   Angle of Shearing Resistance – Limited to a Maximum of: 36.00 Deg.

6.3 Design Parameters:
   Bulk Density of Soil above the foundation depth (\( \gamma_{bulk} \)) 18.50 kN/m³
   Effective Overburden pressure at foundation level (q) 17.00 kPa
Water Table Correction Factor (w') 0.50

Bearing Capacity Factors:

\[ N_c = N/A \]
\[ N_q = 39.48 \]
\[ N_\gamma = 60.30 \]

Shape Factors:

\[ S_c = N/A \]
\[ S_q = 1.20 \]
\[ S_\gamma = 0.80 \]

Depth Factors:

\[ D_c = N/A \]
\[ D_q = 1.00 \]
\[ D_\gamma = 1.00 \]

Inclination Factor:

\[ I_c = N/A \]
\[ I_q = 1.00 \]
\[ I_\gamma = 1.00 \]

6.4 Ultimate Bearing Capacity (Qu):

\[ Q_u = Cu*N_c*S_c*D_c*I_c+q*(N_q-1) *S_q*D_q-I_q + 0.5*B*\gamma*N_\gamma*S_\gamma*D_\gamma*I_\gamma*w' \]
\[ = 784.992 + 223.11 \]
\[ Q_u = 1008.102 \text{ kPa} \]

6.5 Safe Bearing Capacity (Qsafe):

Factor of Safety (F.S.): \( 1008.102 / 2.50 \)

\[ Q_{safe}: 403.240 \text{ kPa (or) } 40.324 \text{ t/m}^2 \]
6.2 SBC CALCULATIONS BASED ON SETTLEMENT ANALYSIS:

The allowable bearing pressure based on tolerable settlement has been established empirically by Terzaghi and Peck, 1948 and may be expressed by the equation:

Safe bearing capacity (SBC) = 3.5 (N-3) \{(B+0.3)/2B\}^2 \alpha \beta + W

Net Safe bearing capacity = SBC - W

Where

N = SPT N. value at the level (corrected)
B = Breadth of foundation
\alpha = 0.5, if this level is submersible
\beta = 1.0, if water level is always below this level
\beta = \{1+(D/B)\}, but not greater than 2.0
D = Depth below ground level at which SPT is done
W = Wt. of soil above the level in t/m² (effective over burden pressure)

The above equation was further modified by TENG (1962) as given below:

Net Safe Bearing Pressure \(q_a\) = 3.5 (N-3) \{(B+0.3)/2B\}^2 r'_w C_D

\(r'_w\) = Water table correction factor
C_D = Depth correction factor
\(\leq 2\)
SBC = 3.5 (N-3) \{(B+0.3) /2B\}^2 r'w C_D

Observed N = 35 (Average)

D_f = 2.00 m
B = 2.00 m
r'w = 0.50
C_D = 2.0

q_a = 3.5 (N-3) \{(B+0.3) /2B\}^2 r'w C_D

= 3.5 (32-3) \times 0.330 \times 0.5 \times 2.0

q_a = 33.495 \text{ t/m}^2

\textbf{Recommended Safe Bearing Capacity: 250.00 kPa (or) 25.0 t/m}^2

\textbf{Note:}

The above SBC has been worked out with available one borehole data. The foundation should be rested over weathered rock with clay binder stratum. The site Engineer should verify the layer at founding level while excavation, to confirm the same. If any changes found, please inform to our office.
ANNEXURE

»» LOG OF BORING

»» LABORATORY TEST RESULTS

»» GRADATION CURVES
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td>0 20 40 60 80 100</td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>Brownish grey weathered rock</td>
<td>1.00</td>
<td>55 [06/26/29]</td>
<td>Very dense</td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td>Brownish grey weathered rock</td>
<td>2.00</td>
<td>&gt;100 34/503cm</td>
<td>Very dense</td>
</tr>
<tr>
<td>3.00</td>
<td></td>
<td>Brownish grey weathered rock</td>
<td>3.00</td>
<td>&gt;100 20/504cm</td>
<td>Very dense</td>
</tr>
<tr>
<td>4.00</td>
<td></td>
<td>Brownish grey weathered rock</td>
<td>4.00</td>
<td>&gt;100 50Blows [Rebound]</td>
<td>Very dense</td>
</tr>
<tr>
<td>5.00</td>
<td></td>
<td>Brownish grey weathered rock</td>
<td>5.00</td>
<td>&gt;100 50Blows [Rebound]</td>
<td>Very dense</td>
</tr>
<tr>
<td>5.20 to 6.00</td>
<td>Soft rock</td>
<td>[TCR-27% RQD-NIL]</td>
<td>0.80</td>
<td>5.20 to 6.00</td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td>Hard rock</td>
<td>[TCR-28% RQD-NIL]</td>
<td>6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00 to 7.80</td>
<td>Hard rock</td>
<td>[TCR-48% RQD-NIL]</td>
<td>7.00</td>
<td></td>
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</tr>
</tbody>
</table>

Borehole Terminated @ 7.80M
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Thickness of layer (m)</th>
<th>Description of Soil</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>Yellowish brown weathered rock</td>
<td>0.75</td>
<td>0.75 [12/28/32]</td>
<td>60 [12/28/32]</td>
<td>Very dense</td>
</tr>
<tr>
<td>1.50</td>
<td>Yellowish brown weathered rock</td>
<td>1.50</td>
<td>&gt;100 14/5013cm</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>Yellowish brown weathered rock</td>
<td>2.00</td>
<td>&gt;100 27/504cm</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>2.50</td>
<td>Brown weathered rock</td>
<td>2.50</td>
<td>&gt;100 5010cm</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>Yellowish grey weathered rock</td>
<td>3.00</td>
<td>&gt;100 5010cm</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>4.00</td>
<td>Yellowish grey weathered rock</td>
<td>4.00</td>
<td>&gt;100 5010cm</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>5.00</td>
<td>Yellowish grey weathered rock</td>
<td>5.00</td>
<td>&gt;100 50Blows [Rebound]</td>
<td>Very dense</td>
<td></td>
</tr>
<tr>
<td>5.40 to 6.00</td>
<td>Soft rock</td>
<td>5.40</td>
<td>5.40 to 6.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00 to 7.00</td>
<td>Soft rock</td>
<td>6.00</td>
<td>6.00 to 7.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00 to 7.65</td>
<td>Soft rock</td>
<td>7.00</td>
<td>7.00 to 7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.65 to 8.00</td>
<td>Hard rock</td>
<td>7.65</td>
<td>7.65 to 8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00 to 8.50</td>
<td>Hard rock</td>
<td>8.00</td>
<td>8.00 to 8.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Borehole Terminated @ 8.50M
<table>
<thead>
<tr>
<th>Depth Below G.L.</th>
<th>Soil Profile</th>
<th>Description of Soil</th>
<th>Thickness of layer (m)</th>
<th>Standard Penetration Test Data</th>
<th>Graphical Representation of Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>Greyish yellowish brown weathered rock with clay binder</td>
<td>2.40</td>
<td>0.75 0.75 [09/11/16] 27 Medium</td>
<td><img src="image" alt="Graph of penetration resistance" /></td>
</tr>
<tr>
<td>1.50</td>
<td>1.50</td>
<td>Greyish yellowish brown weathered rock with clay binder</td>
<td>2.40</td>
<td>1.50 1.50 [10/12/17] 29 Medium</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>2.00</td>
<td>Greyish yellowish brown weathered rock with clay binder</td>
<td>2.40</td>
<td>2.00 &gt;100 25/50 13cm Very dense</td>
<td></td>
</tr>
<tr>
<td>2.50</td>
<td>2.50</td>
<td>Yellowish brown weathered rock</td>
<td>2.20</td>
<td>2.50 &gt;100 27/50 13cm Very dense</td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>3.00</td>
<td>Yellowish brown weathered rock</td>
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<td>4.00 &gt;100 50Blows [Rebound] Very dense</td>
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<td>4.60 to 5.60</td>
<td>Soft rock [TCR-21% RQD-NIL]</td>
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<td>Hard rock [TCR-36% RQD-NIL]</td>
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Borehole Terminated @ 10.50M
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<th>Relative density / Consistency</th>
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<td>2.00 [09/10/12]</td>
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<td>Hard rock [TCR-21% RQD-NIL]</td>
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Borehole Terminated @ 7.50M
| DEPTH OF SAMPLING | I.S. SOIL CLASSIFICATION | NATURAL WET DENSITY, KN/m³ | NATURAL MOISTURE CONTENT (%) | DENSITY OF ROCK, G/M³ | COMPRESSION STRAIN LIMIT | LIQUID LIMIT | PLASTICITY INDEX | GRAVEL (%) | SAND (%) | MEDIUM (%) | FINE (%) | SILT (%) | CLAY (%) | SPECIFIC GRAVITY | CONSOLIDATION TEST | CONSOLIDATION PRESSURE, KG/CM² | CONSOLIDATION VOLUME RATIO | CONSOLIDATION COMPRESSION INDEX | COMPRESSION INDEX CC | INITIAL VOID RATIO | CONSOLIDATION COEFFICIENT OF CONSOLIDATION (Cv) | CONSOLIDATION DEPTH OF COMPRESSION (M) | ANGLE OF INTERNAL FRICTION (º) | DEPTH OF TESTING (M) | OBSERVED N VALUE | CORRECTED N VALUE | CONSISTENCY / RELATIVE DENSITY | CONSOLIDATION INITIAL VALUE | CONSOLIDATION TEST |
|-------------------|--------------------------|-----------------------------|-------------------------------|----------------------|--------------------------|---------------|-----------------|-------------|----------|------------|---------|---------|---------|----------------|--------------------------|-------------------------------|--------------------------------|---------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| 0.00              |                          | 0.00                        |                               |                      |                          |               |                 |             |          |            |         |         |         |                      |                          |                                |                                |                                |                                |                                |                                |                                |
| 1.00              | Brownish grey weathered rock | 11                          | 2                             | 1                    | 22                       | 51            | 24              | 2.731      | 1.00     | >100       | >100    |         |         |                          |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 2.00              | Brownish grey weathered rock | 10                          | 3                             | 5                    | 25                       | 49            | 18              | 2.774      | 2.00     | >100       | >100    |         |         |                          |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 3.00              | Brownish grey weathered rock | 12                          | 3                             | 5                    | 32                       | 43            | 17              | 2.687      | 3.00     | >100       | >100    |         |         |                          |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 4.00              | Brownish grey weathered rock |                |                               |                      |                          |               |                 |             |          |            |         |         |         |                      |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 5.00              | Brownish grey weathered rock |                |                               |                      |                          |               |                 |             |          |            |         |         |         |                      |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 5.20 - 6.00      | Soft rock [TCR-27% RQD-NIL] | 2.544                      |                               |                      |                          |               |                 |             |          |            |         |         |         |                      |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 6.00 - 7.00      | Hard rock [TCR-28% RQD-NIL] | 2.669                      |                               |                      |                          |               |                 |             |          |            |         |         |         |                      |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| 7.00 - 7.80      | Hard rock [TCR-48% RQD-NIL] | 2.575                      |                               |                      |                          |               |                 |             |          |            |         |         |         |                      |                          |                                |                                |                                |                                |                                |                                |                                |                                |
| DEPTH OF SAMPLING | I.S.SOIL CLASSIFICATION                  | NATURAL WET DENSITY KN/m³ | DENSITY OF ROCK (G/MCC) | COMPRESSION TEST | INDEX TEST | GRAIN SIZE DISTRIBUTION | SAND | FINES | FREE SWELL INDEX (%) | MEDIUM (%) | FINE (%) | SILT (%) | CLAY (%) | SPECIFIC GRAVITY | CORRECTED N VALUE | DEPTH OF TESTING (M) | OBSERVED N VALUE | CONSISTENCY / RELATIVE DENSITY | CONSOLIDATION PRESSURE KG/CM² | INITIAL VOIDS RATIO (e0) | CO-EFFICIENT OF CONSOLIDATION CV IN CM² / SEC |
|------------------|-----------------------------------------|---------------------------|-------------------------|------------------|-------------|--------------------------|------|------|----------------------|-----------|---------|----------|---------|-----------------|---------------------|------------------------|-----------------------|--------------------------------|------------------------|--------------------------------|
| 0.75             | Yellowish brown weathered rock          | 7                         | 7                       | 3                | 6           | 39                       | 32   | 20   | 2.596               | 0.75      | 60      | Very dense |         |                 |                     |                         |                         |                                       |
| 1.50             | Yellowish brown weathered rock          | 11                        | 11                      | 1                | 2           | 33                       | 38   | 26   | 2.656               | 1.50      | >100     | Very dense |         |                 |                     |                         |                         |                                       |
| 2.00             | Yellowish brown weathered rock          | 10                        | 10                      | 3                | 5           | 43                       | 30   | 19   | 2.725               | 2.00      | >100     | Very dense |         |                 |                     |                         |                         |                                       |
| 2.50             | Brown weathered rock                   | 13                        | 13                      | 0                | 6           | 34                       | 42   | 18   | 2.706               | 2.50      | >100     | Very dense |         |                 |                     |                         |                         |                                       |
| 3.00             | Yellowish grey weathered rock           | 13                        | 13                      | 2                | 5           | 37                       | 41   | 15   | 2.648               | 3.00      | >100     | Very dense |         |                 |                     |                         |                         |                                       |
| 4.00             | Yellowish grey weathered rock           | 12                        | 12                      | 16               | 11          | 38                       | 26   | 9    | 2.668               | 4.00      | >100     | Very dense |         |                 |                     |                         |                         |                                       |
| 5.00             | Yellowish grey weathered rock           |                           |                         |                  |             |                          |      |      | 5.00                  | >100     | Very dense |

Contd...
<p>| DEPTH OF SAMPLING | I.S. SOIL CLASSIFICATION | NATURAL WET DENSITY KN/m³ | NATURAL MOISTURE CONTENT (%) | DENSITY OF ROCK (GM/CC) | COMPRESSION STRENGTH (Kg/cm²) | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | GRAVEL (%) | COARSE (%) | MEDIUM (%) | FINE (%) | SILT (%) | CLAY (%) | FREE SWELL INDEX (%) | SPECIFIC GRAVITY | ANGLE OF INTERNAL FRICTION | DEPTH OF TESTING (M) | OBSERVED N VALUE | CORRECTED N VALUE | CONSISTENCY / RELATIVE DENSITY | COMPRESSION VOLUME KG/Cm³ | CONSOLIDATION PRESSURE KG/Cm² | INITIAL Voids RATIO (e0) | COEFFICIENT OF CONSOLIDATION CV IN CM² / SEC |
|-------------------|--------------------------|---------------------------|-------------------------------|-------------------------|-------------------------------|--------------|--------------|-----------------|------------|----------|-----------|---------|--------|--------|---------------------|----------------|-----------------------------|------------------|------------------|-----------------------|------------------------|------------------------|-----------------------------|----------------------|
| 5.40 to 6.00      | Soft rock [TCR-19% RQD-NIL] | 2.567                     |                               |                         |                               |              |              |                 |            |          |           |         |        |        |                     |                  |                             | 5.40 to 6.00         |                 |                        |                       |                      |                        |                           |                      |
| 6.00 to 7.00      | Soft rock [TCR-39% RQD-NIL] | 2.651                     |                               |                         |                               |              |              |                 |            |          |           |         |        |        |                     |                  |                             | 6.00 to 7.00         |                 |                        |                       |                      |                        |                           |                      |
| 7.00 to 7.65      | Soft rock [TCR-28% RQD-NIL] | 2.680                     |                               |                         |                               |              |              |                 |            |          |           |         |        |        |                     |                  |                             | 7.00 to 7.65         |                 |                        |                       |                      |                        |                           |                      |
| 7.65 to 8.00      | Hard rock [TCR-30% RQD-NIL] | 2.731                     |                               |                         |                               |              |              |                 |            |          |           |         |        |        |                     |                  |                             | 7.65 to 8.00         |                 |                        |                       |                      |                        |                           |                      |
| 8.00 to 8.50      | Hard rock [TCR-42% RQD-NIL] | 2.866                     |                               |                         |                               |              |              |                 |            |          |           |         |        |        |                     |                  |                             | 8.00 to 8.50         |                 |                        |                       |                      |                        |                           |                      |</p>
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<th>NATURAL MOISTURE CONTENT (%)</th>
<th>DENSITY OF ROCK (GM/CC)</th>
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<th>PLASTIC LIMIT (Kg/cm²)</th>
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<th>FINE (%)</th>
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<th>CONSOLIDATION PRESSURE KG/CM²</th>
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<th>CONSISTENCY / RELATIVE DENSITY</th>
<th>CONSOLIDATION TEST</th>
<th>INITIAL VOID RATIO (dr)</th>
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<td>DEPTH OF SAMPLING</td>
<td>I.S. SOIL CLASSIFICATION</td>
<td>NATURAL DENSITY KN/m³</td>
<td>NATURAL MOISTURE CONTENT (%)</td>
<td>DENSITY OF ROCK GM/CC</td>
<td>COMPRESSIVE STRENGTH (Kg/cm²)</td>
<td>INDEX TEST</td>
<td>GRAIN SIZE DISTRIBUTION (%)</td>
<td>SPECIFIC GRAVITY</td>
<td>CONSOLIDATION PRESSURE KG/CM²</td>
<td>CONSOLIDATION CV (%)</td>
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<td>42</td>
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1  IS : 6403 - 1981

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3  IS : 2911 - (Part / Sec-2) - 1979

4  IS : 2131 - 1980

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