

# **GENERAL TECHNICAL SPECIFICATION**

**FOR CIVIL WORKS : BTG AND BOP**

## TABLE OF CONTENTS

| SECTIONS                                                                    | PAGE |
|-----------------------------------------------------------------------------|------|
| 1.0 GENERAL SCOPE OF WORK.....                                              | 4    |
| 2.0 CODES & STANDARDS .....                                                 | 7    |
| 3.0 GENERAL REQUIREMENT .....                                               | 11   |
| 3.1 FAMILIARITY WITH SITE CONDITIONS .....                                  | 11   |
| 3.2 SAFETY PRECAUTIONS.....                                                 | 11   |
| 3.3 TOOLS & PLANTS .....                                                    | 12   |
| 4.0 SPECIFIC REQUIREMENTS OF CIVIL WORKS .....                              | 12   |
| 4.1 MATERIAL .....                                                          | 12   |
| 4.2 GROUTING .....                                                          | 16   |
| 4.3 RE-BARING.....                                                          | 17   |
| 4.4 STRUCTURAL STEEL.....                                                   | 17   |
| 4.5 EMBEDDED PARTS AND ANCHOR FASTENERS .....                               | 18   |
| 4.6 EARTH WORK.....                                                         | 21   |
| 4.7 DAMP PROOFING COURSE.....                                               | 21   |
| 4.8 MASONRY WALL, PLASTER, PLINTH PROTECTION, PAINTING &<br>FINISHING ..... | 21   |
| 4.9 ROOF TREATMENT AND ROOF DRAINAGE .....                                  | 22   |
| 4.10 DOORS & WINDOWS .....                                                  | 23   |
| 4.11 STORM WATER DRAINAGE .....                                             | 25   |
| 4.12 MISCELLANEOUS DETAILS .....                                            | 25   |
| 4.13 RECORDS OF CONSTRUCTION.....                                           | 27   |
| 5.0 DISMENTALING & DEMOLITION WORK .....                                    | 28   |
| 5.1 INTRODUCTION AND SCOPE OF WORK .....                                    | 28   |
| 5.2 GENERAL .....                                                           | 28   |
| 5.3 SAFETY PRECAUTIONS.....                                                 | 30   |
| 5.4 PROCEDURE.....                                                          | 31   |

|     |                                              |     |
|-----|----------------------------------------------|-----|
| 5.5 | STACKING AND DISPOSAL.....                   | 32  |
| 5.6 | MEASUREMENT & PAYMENT .....                  | 32  |
| 6.0 | DESCRIPTION OF CIVIL & STRUCTURAL WORKS..... | 33  |
| 6.1 | EARTH WORK.....                              | 33  |
| 6.2 | ANTI-TERMITE TREATMENT .....                 | 42  |
| 6.3 | PLAIN AND REINFORCED CEMENT CONCRETE.....    | 45  |
| 6.4 | PILE FOUNDATION .....                        | 88  |
| 6.5 | WATER PROOFING .....                         | 97  |
| 6.6 | STRUCTURAL STEEL WORK.....                   | 99  |
| 6.7 | BRICK MASONRY .....                          | 107 |
| 6.8 | FLOORING AND CLADDING.....                   | 113 |
| 6.9 | FINISHES .....                               | 116 |
| 7.0 | DISMANTLING OF WORK .....                    | 125 |
| 7.1 | GENERAL .....                                | 125 |
| 7.2 | SAFETY PRECAUTIONS .....                     | 126 |
| 7.3 | PROCEDURE.....                               | 128 |
| 7.4 | STACKING & DISPOSAL .....                    | 128 |
| 7.5 | MEASUREMENT & PAYMENT.....                   | 129 |

## 1.0 GENERAL SCOPE OF WORK

The scope of work covered in this specification in general comprises of Civil/Structural works pertaining to BTG (Boiler, Turbine & Generator), ESP area and BOP area for R & M Projects. The Contractor shall carry out all the following works / jobs meant within the intent of this specification even if not explicitly mentioned herein. All works shall be executed in accordance with following specifications in the mentioned order of preference along with approved drawings

- 1) Statutory Regulations
- 2) Customer specification
- 3) Items in Schedule of quantities
- 4) IS/BS standards
- 5) BHEL's standard specification (with prior approval of Engineer-in-charge).
- 6) Latest CPWD Specification

General idea for Main civil works covered under the scope is as under:

|      |                                                                                                                                                                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I.   | Bowl mill foundation: Dismantling of old bowl mill foundations and Construction of new bowl mill foundations as per drawings. Dismantling, construction of RCC work and Structural steel work at required floor levels and approach platforms in mill bay area as per requirement. |
| II.  | Dismantling of existing column footings and structures fouling with proposed footings                                                                                                                                                                                              |
| III. | Equipment foundation like PA Fan, ID Fan, FD Fan, Seal Air: Construction of foundations for equipment as per drawings.                                                                                                                                                             |
| IV.  | Duct support foundation (This includes construction/ modification of footings with re-bars as per requirement. Dismantling of existing column footings and structures fouling with proposed footings shall also be applicable.)                                                    |
| V.   | ESP foundation (This includes construction of footings as per drawing for new ESP structure. Dismantling of existing column footings and structures fouling with proposed footings shall also be applicable).Concrete paving shall be provided for ESP area as required.           |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VI.   | <p>Main control room modification for housing of control panels and MCC as per approved layout. (Includes dismantling and construction as per drawing).</p> <p>Doors and window shall be replaced. Modification/Dismantling of trenches/ cable racks for panels. Floor tiles and false ceiling inside the building to be replaced.</p> <p>Construction of UPS battery Room, battery charger Room, SWAS Room.</p>                                     |
| VII.  | <p>ESP control room construction/modification. (Includes dismantling as required and construction in existing building as per drawing).</p> <p>Doors and window shall be refurbished/replaced. Construction/Modification/Dismantling of trenches/ cable racks for panels. Floor tiles and false ceiling inside the building to be replaced/added.</p>                                                                                                |
| VIII. | <p>General rectification works for concrete works &amp; structural steel works of turbine generator, Boiler and their auxiliaries including epoxy injection grout/normal grout, etc.</p> <p>Rectification of the damaged pipe supports, replacement of damaged RCC cover slabs, providing pre-cast RCC slab with edge angle all-round over the drains in the BTG area wherever missing including checking and rectifying the clogging of drains.</p> |
| IX.   | <p>Foundation for fuel oil pump house, air preheater columns, handling arrangement of bowl mill, etc.</p>                                                                                                                                                                                                                                                                                                                                            |
| X.    | <p>Civil work in switch yard, GT Transformers, service transformers, pumps etc</p>                                                                                                                                                                                                                                                                                                                                                                   |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| XI.  | <b>CIVIL WORKS ASSOCIATED WITH BOP SUCH AS</b><br><br>Tube Well System, Aeration System , DM Plant, Softening Plant , CW Chlorination Plant, Ventilation System, Air Washer Units , Air Compressor , LP Dosing System , Air Conditioning System , Ash Handling System, Coal Handling Plant, Fire Protection System, Equipment Cooling System , Fuel Oil System, Foundations for Various Equipments(Mechanical and Electrical) and other miscellaneous works. |
| XII. | Any other works assigned by Engineer In Charge as per requirement.                                                                                                                                                                                                                                                                                                                                                                                           |

Note–: The work mentioned above is to give general idea for bidder .

#### **Instructions to Bidder:**

The detailed specifications given hereafter are for the items of works described in the schedule of quantities attached herein as annexure–1, and shall be guidance for proper execution of work to the required standards.

It may also be noted that the specification 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 explicitly mentioned or referred to in these documents but are essential for the entire completion in accordance with standard engineering practice.

The Project manager shall be the sole deciding authority as to the meaning, interpretations and implication for various provisions of the specifications and his decision in writing shall be final and binding on all concerned.

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

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

## 2.0 CODES & STANDARDS

|            |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                 |
|------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| <b>1</b>   |           | <b>CODES AND STANDARDS.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |
|            | <b>a)</b> | All work shall be carried out as per the stipulations contained in various sections of these specifications (to be read in conjunction with corresponding CPWD specifications) and the latest Indian standards acts, codes and best practices. All applicable standards, acts, specifications, codes of practice, hands book, referred to herein shall be the latest editions, including all official amendments and revisions. In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian standards, Codes, etc. the stringent most requirements shall prevail. |                                                                                                 |
|            | <b>b)</b> | In the event that state, city or other local governmental bodies have requirements more stringent than those set forth in this specification do the former shall govern.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                 |
|            | <b>c)</b> | Any special materials used, but not covered here, shall conform to relevant Indian standards, if any, or as specified by the Engineer for any special purpose.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                 |
|            | <b>d)</b> | List of certain important codes and standards applicable to this work is given below. However the list is not exhaustive and applicable standards and codes shall be applicable even if it is not mentioned in the list.                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                 |
| <b>1.1</b> |           | <b>EARTHWORK.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                 |
|            | <b>01</b> | IS :1200(part-I)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Method of Measurement of building and civil engineering work Earthwork.                         |
|            | <b>02</b> | IS :3764                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Safety code for excavation work.                                                                |
|            | <b>03</b> | IS : 9758                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Guide lines for Dewatering during construction.                                                 |
|            |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                 |
| <b>1.2</b> |           | <b>PLAIN AND REINFORCED CEMENT CONCRETE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |
|            | <b>01</b> | IS : 456                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Code of practice for plain and reinforced concrete.                                             |
|            | <b>02</b> | IS :516                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Method of test for strength of concrete.                                                        |
|            | <b>03</b> | IS : 1199                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Methods of sampling and analysis of concrete.                                                   |
|            | <b>04</b> | IS : 1200 (part-II,V,VIII,XVIII)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Method of measurement of building and civil engineering works, waterproofing and damp proofing. |
|            | <b>05</b> | IS : 1609                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Code of practice for laying damp proof treatment using bitumen.                                 |

|    |                            |                                                                                                                              |
|----|----------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 06 | IS : 1791                  | General requirements for batch type concrete mixers.                                                                         |
| 07 | IS : 2386(parts I to VIII) | Methods of test of aggregates for concrete.                                                                                  |
| 08 | IS : 2502                  | Code of practice for bending and fixing of bars for concrete reinforcement.                                                  |
| 09 | IS : 2506                  | General requirements for concrete vibrators.                                                                                 |
| 10 | IS : 2571                  | Code of practice for laying in – situ cement – concrete flooring.                                                            |
| 11 | IS : 2645                  | Specification for integral cement water proofing compounds.                                                                  |
| 12 | IS : 2750                  | Specification for steel scaffoldings.                                                                                        |
| 13 | IS : 2751                  | Code of practice for welding of mild steel plain and deformed bars for                                                       |
|    |                            | reinforced concrete construction.                                                                                            |
| 14 | IS : 3067                  | Codes of practice for general details and preparatory work for damp proofing & water proofing & water proofing of buildings. |
| 15 | IS : 3370(part –I to IV )  | Code of practice for concrete structures for the storage of liquids.                                                         |
| 16 | IS : 3384                  | Specification for bitumen primer for use in waterproofing and damp proofing.                                                 |
| 17 | IS : 3414                  | Code of practice for design and installation of joints in buildings.                                                         |
| 18 | IS : 3696 (part –I & II )  | Safety code for scaffolds and ladders.                                                                                       |
| 19 | IS : 4130                  | Safety code for demolition of buildings.                                                                                     |
| 20 | IS : 4326                  | Code for practice for earthquake resistant design and construction of buildings.                                             |
| 21 | IS : 4656                  | Specification for form vibrators for concrete.                                                                               |
| 22 | IS : 4925                  | Specification for batching and mixing plant.                                                                                 |
| 23 | IS : 4990                  | Specification for plywood for concrete shuttering work.                                                                      |
| 24 | IS : 5525                  | Recommendations for detailing or reinforcement in reinforced concrete work.                                                  |
| 25 | IS : 9103                  | Specification for admixtures for concrete.                                                                                   |
| 26 | IS : 10262                 | Recommendation guideline for concrete mix design.                                                                            |
| 27 | IS : 12269                 | 53 Grade ordinary Portland cement.                                                                                           |
| 28 | IS : 8112                  | 43 Grade ordinary Portland cement.                                                                                           |
| 29 | IS : 1489                  | Portland Pozzolan Cement                                                                                                     |

|            |           |                              |                                                                                                 |
|------------|-----------|------------------------------|-------------------------------------------------------------------------------------------------|
|            | <b>30</b> | IS : 12600                   | Portland cement, low heat.                                                                      |
|            | <b>31</b> | SP : 23                      | Handbook of concrete mixes.                                                                     |
| <b>1.3</b> |           | <b>STRUCTURAL STEEL WORK</b> |                                                                                                 |
|            | <b>A)</b> | <b>Materials</b>             |                                                                                                 |
|            | <b>01</b> | IS : 808                     | Rolled steel Beam, Channel and Angle Sections.                                                  |
|            | <b>02</b> | IS : 814                     | Specification for covered Electrodes for metal Arc welding for weld steel.                      |
|            | <b>03</b> | IS : 2074                    | Ready mixed paints Red Oxide Zinc chromate primer.                                              |
|            | <b>04</b> | IS : 3502                    | Specification for chequered plate.                                                              |
|            | <b>05</b> | IS : 1367                    | Technical supply conditions for threaded steel fasteners                                        |
|            | <b>06</b> | IS : 5624                    | Foundation Bolt Specifications                                                                  |
|            | <b>B)</b> | <b>Codes of Practice</b>     |                                                                                                 |
|            | <b>01</b> | IS : 800                     | Code of practice for general construction in steel.                                             |
|            | <b>02</b> | IS : 816                     | Code of practice for use metal Arc welding for general.                                         |
|            | <b>03</b> | IS : 817                     | Code of practice for training and Testing of Metal Arc welders.                                 |
|            | <b>04</b> | IS : 3696                    | Safety codes of scaffolds and ladders.                                                          |
|            | <b>05</b> | IS : 7205                    | Indian standard safety code for erection of structural steel.                                   |
|            | <b>06</b> | IS : 7215                    | Tolerances for fabrication of steel structures.                                                 |
|            | <b>07</b> | IS : 7293                    | Safety codes for working with construction machinery.                                           |
|            | <b>08</b> | IS : 9595                    | Code of procedure of manual metal Arc welding of mild steel.                                    |
|            | <b>09</b> | IS : 12843                   | Tolerances for Erection of structural steel.                                                    |
|            | <b>C)</b> | <b>Standards for Testing</b> |                                                                                                 |
|            | <b>01</b> | IS : 228                     | Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.       |
|            | <b>02</b> | IS : 1182                    | Recommended practices for radiographic examination of fusion welded but joints in steel plates. |
|            | <b>03</b> | IS : 1599                    | Method of Bend Tests for steel products other than sheets, strip, wire and tube.                |
|            | <b>04</b> | IS : 1608                    | Method of Tensile Testing of steel products                                                     |

|            |           |                            |                                                                                        |
|------------|-----------|----------------------------|----------------------------------------------------------------------------------------|
|            |           |                            | other than sheets, strip, wire and tube.                                               |
|            | <b>05</b> | <b>IS : 2595</b>           | Code of practice for Radio graphic testing.                                            |
| <b>1.4</b> |           | <b>BRICK MASONRY WORKS</b> |                                                                                        |
|            | <b>01</b> | IS : 1200 ( part- III )    | Method of measurement of building and civil engineering works Brick work.              |
|            | <b>02</b> | IS : 1200 (part – IV )     | Method of measurement of building and civil engineering works Stone masonry.           |
|            | <b>03</b> | IS : 1905                  | Code of practice for structural safety of Building Masonry walls.                      |
|            | <b>04</b> | IS : 2116                  | Specification for sand for masonry mortars.                                            |
|            | <b>05</b> | IS : 2212                  | Code of practice for Brickwork.                                                        |
|            | <b>06</b> | IS : 2250                  | Code of practice for preparation and use of Masonry mortar.                            |
|            | <b>07</b> | IS : 3414                  | Design and installation of joints in buildings.                                        |
|            | <b>08</b> | IS : 3696                  | Safety code for scaffolds and ladders.                                                 |
|            | <b>09</b> | IS : 4326                  | Code of practice for earthquake resistant design and construction of buildings.        |
|            | <b>10</b> | SP : 20                    | Explanatory hand book on masonry code.                                                 |
| <b>1.5</b> |           | <b>FINISHES</b>            |                                                                                        |
|            | <b>01</b> | IS : 383                   | Coarse & fine aggregates from natural source for concrete.                             |
|            | <b>02</b> | IS : 1200 (part – XII )    | Method of measurement of building and civil Engineering works plastering and pointing. |
|            | <b>03</b> | IS : 1542                  | Specification for sand for plaster.                                                    |
|            | <b>04</b> | IS : 1635                  | Code of practice for field slaking of building lime and preparation of putty.          |
|            | <b>05</b> | IS : 2250                  | Code of practice for preparation and use of masonry mortar.                            |
|            | <b>06</b> | IS : 2333                  | Plaster – of –Paris.                                                                   |
|            | <b>07</b> | IS : 2402                  | Code of practice for external rendered finishes.                                       |
| <b>1.6</b> |           | <b>GLASS AND GLAZING</b>   |                                                                                        |
|            | <b>01</b> | IS : 419                   | Putty for use on window frames.                                                        |
|            | <b>02</b> | IS : 1081                  | Code of practice for fixing and glazing metal doors, windows and ventilators.          |
|            | <b>03</b> | IS : 3548                  | Code of practice for glazing in building.                                              |
| <b>1.7</b> |           | <b>ROOF WATER PROOFING</b> |                                                                                        |
|            | <b>01</b> | IS : 702                   | Specification for industrial bitumen.                                                  |
|            | <b>02</b> | IS : 1203                  | Method of testing tar and bitumen.                                                     |

|  |           |           |                                                                                                                     |
|--|-----------|-----------|---------------------------------------------------------------------------------------------------------------------|
|  | <b>03</b> | IS : 1237 | Specification for cement concrete flooring tiles.                                                                   |
|  | <b>04</b> | IS : 1322 | Specification for bitumen felts for water proofing and damp.                                                        |
|  | <b>05</b> | IS : 1346 | Code of practice for water proofing of roofs with bitumen felts.                                                    |
|  | <b>06</b> | IS : 1580 | Specification for bitumen compound for water proofing and caulking purpose.                                         |
|  | <b>07</b> | IS : 3067 | Code of practice for general design details and preparatory work for damp –proofing and water proofing of building. |
|  | <b>08</b> | IS : 3384 | Specification for bitumen primer for use in water proofing and damp proofing.                                       |
|  | <b>09</b> | IS : 5916 | Safety code for construction involving use of hot bituminous materials.                                             |

Note–: Codes can be changes as per customer requirement.

### **3.0 GENERAL REQUIREMENT**

#### **3.1 FAMILIARITY WITH SITE CONDITIONS**

The bidders shall visit the site and surroundings before submitting the bid to get them satisfied about the working environment, site conditions and constraints. They shall also satisfy themselves about the nature of ground and subsoil, availability of materials, approach and access to the site and in general shall obtain all necessary information, which may influence or affect their offer. No extra claim on ground of lack of knowledge, any misunderstanding or otherwise shall be allowed. Geo Technical investigation report carried out at site will be made available by the BHEL.

#### **3.2 SAFETY PRECAUTIONS**

- a. The contractor shall adopt standard practices and procedures, use appropriate tools and workmen at all stages of work to guard against accidents to ensure complete safety.
- b. Contractor shall provide necessary passageways as may be required, safety belts, helmets, safety shoes, lights and other safety equipments/gadgets as per standard rules of local authorities and for protection to his men and materials.
- c. Wherever required and/or instructed by Engineer-in-charge temporary enclosures made out of GI sheet, fencing, including danger lights etc. shall

- be provided by the Contractor and got approved by the Engineer-in-charge before start of work to prevent accidents and to restricted entries.
- d. Necessary precautions shall be taken to keep the dust –nuisance down as and when necessary.
  - e. Contractor must ensure the availability of adequate fire fighting equipment / arrangements before starting works. These facilities shall be made available till the completion of works.
  - f. Roads and working spaces shall be kept free of any debris/materials at the end of day's work.
  - g. A large part of construction involves proper dress and the use of appropriate safety accessories, especially when using power tools.
    - Do not wear loose clothing that can get caught in machinery
    - Wear safety helmet all the time during work.
    - Remove any jewellery that can interfere with safe machinery operation
    - Wear safety goggles or glasses with side protection
    - Use a face mask in dusty applications, ear plugs when the site is especially noisy or for extended periods of work
    - Heavy work gloves should be worn to protect against the steady vibration of power tools and the heat that can be generated, especially in the bit
    - Wear steel-toed safety shoes or boots.

### **3.3 TOOLS & PLANTS**

- a. The contractor shall deploy proper tools & plants in adequate numbers for speedy and quality execution of work.
- b. If there is a requirement of some special tools for a specific job to be carried out in a specific fashion, the same shall be arranged by the contractor.
- c. The trained personnel only shall operate these tools and plants only

## **4.0 SPECIFIC REQUIREMENTS OF CIVIL WORKS**

### **4.1 MATERIAL**

#### **4.1.1 Cement**

Unless otherwise specified or called for by the Engineer-In-Charge cement shall be ordinary Portland cement (OPC 43 grade cement). Changing of brand or type of cement within the same structure will not be permitted. In case it is required to change the brand of cement in the same structure, prior permission shall be obtained from the Engineer-In-Charge. Cement held in storage for a period of Ninety (90) days or longer shall be tested before use in work

#### **4.1.2 Aggregate**

- Aggregate in general designates fine & coarse inert materials used in the manufacture of concrete. All fine and coarse aggregate proposed for use in the work shall be subjected to 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.
- Aggregates shall consist of natural sand, crushed stone and gravel from source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, and durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and/ or durability of concrete. The grading of aggregate shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mixed design" and preliminary test on concrete specified by IS code.

Aggregate for use in concrete in all respect shall be in accordance with IS 2386:1963 & IS 383:1999.

#### **4.1.3 Water**

Water used for both mixing and curing shall be free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally satisfactory for mixing and curing of concrete. In case of doubt the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in I.S. 456. The sample of water taken for testing shall be typical for the water proposed to be used for concrete, due account being paid to seasonal variation. The sample 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.

#### **4.1.4 Reinforcement**

Steel reinforcement bars, if supplied or arranged by the contractor, shall be either plain round mild steel bars grade – I or medium tensile steel bars as per IS: 432 or Thermo-mechanically treated (TMT)/ high yield strength deformed bars as per IS: 1786:2008 as shown and specified on the drawings and shall be manufactured by M/s SAIL or TISCO or JSW or RINL only & shall be rolled from their own plants and from virgin material. Materials manufactured by their authorized conversion agents & re-rollers shall not be accepted. Documentary evidence of purchasing steel

produced from these manufacturers and their manufacturing test certificate shall be submitted. The third party test shall be carried out as directed in line with the relevant Indian standards and cost of which shall be included in the item rate and no separate payment shall be made on account of this.

#### 4.1.5 Concrete

All reinforced concrete in the work shall be "Design Mix Concrete" as defined in IS: 456. The contractor at no extra cost shall get the design mix done for particular grade as per the requirement of work from Government accredited laboratory and submit the same to BHEL/customer for acceptance. Grades of concrete for different civil jobs shall be as mentioned below:

- Design mix of grade M25 shall be used for all Structural Concrete Work unless specified otherwise.
- Design Mix of grade M20 shall be used for all other jobs including paving, cable trenches, drains etc.
- Nominal concrete Mix of M10 shall be used as blinding concrete All RCC & PCC Construction shall conform to IS: 456-2000

#### 4.1.6 Sampling And Testing Of Concrete

The contractor at no extra cost shall set up a field laboratory at site with all facilities for sampling & testing of different construction materials like cement, aggregate (coarse & fine), concrete, bricks etc. as per approved quality plan. The following equipments (in serviceable condition) with operator shall be made available at Engineer's request. The list is not exhaustive. This is only for guideline. The contractor is required to give copy of valid calibration certificate of the equipments

| S.N. | Equipment                                                                    | Requirement                              |
|------|------------------------------------------------------------------------------|------------------------------------------|
| 1    | Cast Iron cube moulds of 150 mm size                                         | As Required                              |
| 2    | Slump cone complete set with tamping rod                                     | 1 set                                    |
| 3    | Laboratory balance (Digital) to weight up to 5 kg. With sensitivity of 10gm. | 1 No.                                    |
| 4    | Compressive strength testing Machine                                         | 1 No.                                    |
| 5    | Laboratory balance (Digital) of 2 kg. Capacity and sensitivity of 1 gm.      | 1 No.                                    |
| 6    | I.S. sieves for coarse and fine aggregates                                   | 1 set each for fine and coarse aggregate |
| 7    | A set of measure from 0.1 liter to 5 liters.                                 | 1 set                                    |
| 8    | Electric oven with thermostat up to 120 degree centigrade.                   | 1 No.                                    |

|    |                                                                          |             |
|----|--------------------------------------------------------------------------|-------------|
| 9  | Flakiness gauge                                                          | 1 No.       |
| 10 | Elongation index gauge                                                   | 1 No.       |
| 11 | Sedimentation pipette                                                    | 1 No.       |
| 12 | Pyconometer                                                              | 1 No.       |
| 13 | Calibrated glass jar of 1 liter capacity                                 | 2 No.       |
| 14 | Glass flasks and metal containers                                        | As Required |
| 15 | Chemical reagents like Sodium Hydroxide, Tannic Acid, Litmus papers etc. | As Required |
| 16 | Aggregate crushing strength test                                         | 1 No.       |
| 17 | Aggregate impact test                                                    | 1 No.       |

#### 4.1.7 Frequency of Sampling:

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

| Sr.No. | (c)Quantity of Concrete        | (d) Number of Samples                                                               |
|--------|--------------------------------|-------------------------------------------------------------------------------------|
| 1      | 1.00 to 5.00 m <sup>3</sup>    | One                                                                                 |
| 2      | 6.00 to 15.00 m <sup>3</sup>   | Two                                                                                 |
| 3      | 16.00 to 30.00 m <sup>3</sup>  | Three                                                                               |
| 4      | 31.00 to 50.00 m <sup>3</sup>  | Four                                                                                |
| 5      | 51.00 m <sup>3</sup> and above | Four Plus one additional sample for each additional 50 m <sup>3</sup> part Thereof. |

- b. At least one sample shall be taken from each shift. Where concrete is produced at continuous production unit, such as ready-mixed concrete plant, frequency of sampling shall be as per direction of Engineer.
- c. 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 formwork or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing, those cured by accelerated methods as described in I.S. 9013. The specimen shall be tested as described in I.S. 516.

- d. Slump test shall be carried out as often as demanded by the Engineer-In-Charge and invariably from the same batch of concrete from which the test cubes are made. Slump test shall be done immediately after sampling.
- e. Concrete of each grade shall be liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joints, 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.

Note:

- 1.0 Acceptance criteria, sampling & testing etc. of concrete as per clause no. 15, 16 & 17 of IS 456: 2000.
- 2.0 Minimum cement content & maximum water cement ratio etc. as per table no. 5 of IS 456: 2000.

## **4.2 GROUTING**

### **4.2.1 Grout Material**

- a. Grout material should be of approved non shrink quality (premix type), free flow grout of brand 'TILO GROUT' make Sika India Pvt. Ltd. / 'FOSROC make Foroc chemicals Pvt. Ltd. or equivalent make as approved by customer/BHEL shall be provided for all anchor bolt sleeves, pockets and spaces under column bases, shoe plates etc. with a crushing strength of (28 days) minimum 30 MPa.
- b. Ready mixed non-shrink cementitious grout for Grouting under base plates and foundation pockets shall be done as indicated in the drawings, or as directed by Engineer-In-Charge. The contact area between the grout and base plate shall not be less than 80%
- c. Grouting of pockets/holes in concrete can also be done with prior approval of BHEL/customer using cement-sand grout or cement, sand and aggregate grout with an expanding admixture of approved type as per manufacturer's specification depending upon the size of the pockets/holes in the concrete. This mix shall generally be used for grout thickness above 40 mm. The grade of such concrete/mortar shall not be less than the grade of parent concrete.

- d. Surface to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance. The blockouts, bolt holes etc. which have to be grouted, shall be cleaned thoroughly by use of compressed air just prior to taking up the grouting operation.

#### **4.2.2 Pressure Grouting**

##### **Non-shrink cementitious grout**

Approved quality non-shrink grout consisting of non-shrink ingredients as specified by SIKA or FOSROC or equivalent shall be used using appropriate injection grouting pumps under pressure as specified by manufacturer for arresting leakage/seepage in concrete structures. Grouting is to be carried out by the authorized applicator of the product manufacturer only as per manufacturer specification. The operator while working should use safety goggles, breathing mask and helmet with hand gloves. The contractor shall make available Material safety data sheet to customer/BHEL.

##### **Epoxy Resin Injection Grouting**

For General concrete repair for voids, loose pockets or external/internal cracks epoxy resin injection grouting should be resorted to using low viscous epoxy resin system from manufacturer like Fosroc, Pidilite, Sika or equivalent as approved by BHEL/customer. Grouting is to be carried out by the authorized applicator of the product manufacturer only as per manufacturer specification. The operator while working should use safety goggles, breathing mask and helmet with hand gloves. The contractor shall make available Material safety data sheet to customer/BHEL.

#### **4.3 RE-BARING**

Re-baring to be done with proper anchorage as per standards using provision of full strength utilization capacity. Re-bars so provided shall be done with proper approval of competent agency who have testing facility for pullout tests of 8mm dia to 32mm dia reinforcing bars. Re-barring kit should be used of approved make only.

#### **4.4 STRUCTURAL STEEL**

- a. Structural steel to be used for general structural purpose shall be of grade Fe 410 Mpa. conforming to IS: 2062. The minimum tensile strength shall be as follows

|     |                           |         |
|-----|---------------------------|---------|
| i.  | Thickness < 20mm          | 250 Mpa |
| ii. | Thickness between 20-40mm | 240 Mpa |

|      |                  |         |
|------|------------------|---------|
| iii. | Thickness > 40mm | 230 Mpa |
|------|------------------|---------|

All welds shall be free from defects like blowholes, slag inclusions, lack of penetration, under cutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, feathered edges without overlap and freedom from porosity. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations etc.

Welding shall conform to IS 814: 1963

- b. Structural Steel shapes shall conform to IS: 808 (for hot rolled steel beam, column channel and angle sections)
- c. Engineer-in-charge or their authorized representatives or customer shall have free access to all parts of the job during erection and all erection shall be subject to their approval. In case of faulty erection, all such dismantling and re-erection required will be at contractor's cost. No paint shall be applied to field welds until these have been approved by Engineer-in-charge.
- d. Requirement for off-site structural fabrication  
The contractor is required to follow followings with respect to offsite structural fabrication
  - a. To submit complete detailed fabrication drawings.
  - b. Furnish all materials, labour, tools and plant, power and all consumables required for fabrication and supply, all necessary, bolts, nuts, washers, tie nuts and welding electrodes for field connections. The field connection materials supply by the contractor shall be to the extent of actual requirement plus 10 percent.
  - c. Suitably mark, bundle and pack for transportation of all fabricated materials.
  - d. Prepare and furnish detailed bill of materials, dispatch lists and bolt lists and any other list of bought out items required in connection with the fabrication and erection of structural steel work.
  - e. Insuring, loading and transportation of all fabricated steel work and field connection materials to site.

## **4.5 EMBEDDED PARTS AND ANCHOR FASTENERS**

### **4.5.1 General Requirements**

This part of the technical specification covers the requirement of transportation and erection of embedded steel parts, providing and installation of mild steel/PVC pipes, providing and Fixing of Anchor Fasteners etc.

For fabrication and erection of insert at site, specification for structural steel works shall be referred to.

Embedded steel part if supplied by the owner shall be furnished anywhere within the project area and the contractor shall transport the same to the work site.

Embedded steel part shall include items such as, but not limited to, foundations grillages, anchor bolts, pipe sleeves, equipment mounting plates, steel pieces with/without lugs, auxiliary framing for equipment supports, miscellaneous frames, etc, deformed steel bars shall not be used for lugs.

Concreting of the adjacent area of the embedded parts shall be done carefully to avoid displacement of the embedded parts and honeycombing/voids.

#### **4.5.2 Pipe Material**

Rolled steel and structural steel shall conform to IS: 2062. Mild steel pipes shall conform to IS: 1161. Unless otherwise specified, medium class pipe shall be provided. PVC pipes shall conform to IS: 4985. Minimum pressure rating for PVC pipes shall be 6kgf/cm<sup>2</sup>.

#### **4.5.3 Embedded Steel Parts**

The contractor shall transport to site and erect accurately in position all embedded steel parts as directed by Engineer-In-Charge. Exposed surfaces of embedded parts other than holding down bolts, are to be painted with primer painting with chlorinated rubber based Zinc Phosphate

During erection, the contractor shall provide necessary strong temporary bracings and supports to ensure proper installation of the embedded parts which shall be erected at the true location as shown on the drawings and these shall be in plumb and level (unless otherwise shown on drawings).

#### **4.5.4 Anchor Fasteners**

Expansion Fasteners shall be used for fixing steel members, embedment, equipment mounting frames and similar other parts subsequent to concrete work. Fasteners shall be of appropriate type size and capacity as per manufacturer's specification, and shall be installed by drilling holes of appropriate size in the concrete.

The anchor fasteners shall be of two types VIZ. medium duty for carrying tensile load (uplift) up to 1.0 MT per fasteners and heavy duty for carrying tensile load of more than 1.0 MT and upto 5.0 MT per fastener.

- a. The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of safety of 2.5 on the characteristic load of the anchor. Minimum size of anchors shall be M8
- b. All anchors shall be from established and approved manufacturers.
- c. Anchors shall be fixed in position as recommended by the manufactures and as approved by the Engineer.
- d. Anchor fasteners can be of mechanical bonding such as keying, friction, combined friction-keying or chemical bonding.
- e. Capacity of the anchors shall be established after considering the effect of concrete grade, embedded depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- f. The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth and load to be transferred, space available for installing anchors.

#### **4.5.5 Bonding of anchors**

Bonding of anchors anchors can either be mechanical and / or chemical

- a. The mechanical bonding anchors are torque controlled anchors made from carbon steel of grade 8.8 as per IS: 1367 Part III. Anchors in bolt as well as nuts version are acceptable. The bolt version anchors consist of bolt, washers, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchors consist of nuts, threaded rod, washers, sleeve, plastic section, expansion sleeve and a cone. All steel components of anchors shall be electro galvanized to minimum 5 micron coating thickness. The plastic section shall be of polyacetal derlin 100 or equivalent.
- b. Chemical bonding anchors shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiseled tip. The anchors shall be tested for its behavior under fire as per heating curve ISO: 834 for up to 120 minutes and furnish the test result. Anchors of size M8 to M24 shall conform to grade 5.8 and M39 anchors shall conform to 8.8 grade. The grades are as per IS: 1367 Part-III. All steel components of the anchors shall be electro galvanized to minimum 5 micron coating thickness.

- c. These anchors shall comprise of studs, nuts, washers and expansion sleeves. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro galvanized to minimum 5 micron coating thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to min grade of 5.8 as per IS: 1367

#### **4.6 EARTH WORK**

Earth work in Excavation and filling work shall be done and measured as per IS: 1200.

#### **PILE WORK**

Pile work shall be carried out as per standard procedure given in respective IS codes & General specifications. All routine loads tests, frequency and requirements of tests, grade of concrete, measurements shall be as per detailed specifications. Length of pile for payment shall be measured from Cut off level to bottom of pile, however removal of extra concrete up to cutoff level as specified shall be included in the rates.

#### **4.7 DAMP PROOFING COURSE**

Providing and laying damp-proof course 40 mm thick with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) including using water proofing material as per manufacturers specification and applying a coat of hot residual bitumen @ 1.45 kg/sqm and sprinkling coarse sand for proper bondage complete.

#### **4.8 MASONRY WALL, PLASTER, PLINTH PROTECTION, PAINTING & FINISHING**

- i. Brick work & Plastering: Brick work with first class bricks having minimum strength of 105 Kg per sqcm in cement mortar 1:5 (1 cement : 5 coarse sand) in superstructure etc as per IS standards. Providing 12 mm thick finished cement plaster in mortar 1:4 (1 cement: 4 sand) on brickwork or reinforced cement concrete surfaces internally. Providing 20mm thick cement plaster in two coats, under layer 12mm thick in cement mortar (1:4) mix and above layer 8mm thick with water proofing compound in cement mortar (1:4). All exposed structural concrete surfaces like soffits of slab, chhajjas etc. should be plastered with 6mm thick plaster with CM 1:4.

- ii. All bricks shall be specify made from good brick earth, free from saline deposits and shall be sand modified. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges parallel faces and of deep red or copper color. The bricks shall be homogeneous in texture and emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and nodules of lime. The brick in general shall confirm to the requirements of IS: 1077-1992.
- iii. Plinth Protection: Buildings shall be provided with 1000 mm wide plinth protection all around and shall generally be 100 mm above respective finished ground level. The plinth protection shall consists of 100 mm thick PCC 1: 3: 6 over 100 mm thick compacted jhama brick blast soling
- iv. Flooring: Flooring in plant and building area shall consists of 100 mm thick with "hard Crete" concrete hardener topping with under layer 88 mm thick RCC(M25) (8 dia tor steel bar @ 200 mm c/c) over 75 mm thick PCC 1:3:6 over 150mm thick boulder soling and top layer 12 mm thick hardcrete cement hardener consisting of mix 1:2(1 cement hardener mix: 2 stone aggregate 6 mm nominal size) by volume in which Hardcrete hardening compound of Snowcem India Ltd. or equivalent shall be mixed with cement in proportion as recommended by manufacturer.
- v. Painting & Finishing: External surface of the walls shall be provided with two coats cement based waterproof paint of SNOCEM India Limited or equivalent of approved colour and shade on new surfaces. Internal faces of the walls should be painted with two coats of Plastic Emulsion paint of approved brand, make, colour and shade over a coat of suitable primer. Ceiling should be provided with two coats of Oil Bound Distemper of approved brand, make colour and shade over a suitable coat of primer. All steel structures shall receive two coats of red oxide Zinc Chromate primer and two coats of Synthetic Enamel Paint of approved brand, manufacture, colour and shade. Before applying primer or paint surface should be prepared as per specifications.

#### **4.9 ROOF TREATMENT AND ROOF DRAINAGE**

Water proofing treatment rendered to roof slab shall be strictly as per the manufacturer's specification and shall be executed at site by the person deputed / authorized by the manufacturer.

For roof water proofing course the material used shall be manufactured by approved companies like Pidilite, Fosroc, CICO, Shalimar tar Products or equivalent.

Seven course water proofing treatment with APP (Atactic poly Propylene) modified polymeric membrane manufactured by Bengal Bitumen, Integrated Waterproofing Ltd. Or general membranes over roof consisting of first coat of bitumen primer @ 0.40 kg per sqm, 2nd, 4th & 6th course of bonding material @ 1.20 Kg/sqm, which shall consist of blown type bitumen of grade 85/25 conforming to IS:702, 3rd and 5th layers of roofing membrane APP modified polymeric membrane 1.5mm thick of 2.25 kg/sqm weight consisting of five layers prefabricated with center core as 20 micron HMHDPE film sandwiched on both sides with polymeric mix and polymeric mix is protected on both sides with 20 micron HMHDPE film.

7th, the top most layer shall be finished with brick tiles of class designation 100 grouted with cement mortar 1 : 3 (1 cement : 3 fine sand) mixed with 2 % integral water proofing compound by weight of cement over a 12mm layer of cement mortar 1:3 (1 cement : 3 fine sand) and finished.

Water from the roof surface shall be drained by system of roof drain heads, rainwater down comers and necessary fixtures. The roof shall be provided with a slope of 1 in 75(min) for efficient drainage.

100mm dia Unplasticised rigid PVC rain water down comers Type B conforming to IS: 13592 with watertight joints or medium class galvanized mild steel pipes conforming to IS: 1239 / IS: 3589 shall be provided to drain off rainwater from the roof.

#### **4.10 DOORS & WINDOWS**

The work covered under this specification consists of providing, making and fixing of doors and windows in accordance with these specifications and drawings.

##### **4.10.1 Teakwood**

- a. Unless otherwise specified all timber shall be of best quality C.P. teak wood well seasoned and free from cracks, sap wood, knots, sags, warps etc. and shall have uniform grains of good pattern.

- b. The rate of wood works shall include the cost of all the labour, tools and materials including wood preservative paint nails, pins, keys, wedges, screws, holdfasts etc. and erecting the same in position and for painting with one coat of approved wood primer all specified.

The rate shall also include for wastage if any.

#### **4.10.2 Flush Door Shutter**

- a. Flush door shutter shall have a solid core and may be of the decorative or non-decorative type conforming to I.S. 2202.
- b. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to I.S. 1708.
- c. Adhesive used for bonding various components like core, core frame, lipping, cross bands, face veneers, plywood etc. of flush door shutters and for bonding plywood shall be phenol formaldehyde synthetic resin conforming to I.S. 848.
- d. All the sample shutters when tested shall satisfy the requirements of the tests as laid down in I.S. 2202 (Part – I & II) if the number of samples found unsatisfactory or a test is two or more the entire lot shall be considered unsatisfactory.

#### **4.10.3 Steel/ Aluminium Glazed Doors & Windows**

Steel/aluminum doors with iron/aluminum mongry shall be provided at appropriate locations to prevent dust ingress from outside and to suit the respective system requirements and convenience.

Steel / Aluminium windows shall be provided as per the requirements. The number of windows so decided to allow natural ventilation and lighting. Minimum requirements of natural ventilation and lighting shall be as per National building code of India.

The frames of all the doors and window shall be fabricated from extruded aluminium sections of standard INDAL/ JINDAL/MANN or other approved equivalent sections.

Aluminium alloy used in the manufacture for extruded sections for this work shall correspond to I.S. 733 and shall be anodized before incorporating in the work. The rate quoted for these items is deemed to include the cost of anodizing also.

**4.11 STORM WATER DRAINAGE**

The design of storm water drainage for the area under consideration shall be based on maximum hourly precipitation for storm deviation of 20 minutes and roof drainage system shall be designed for hourly precipitation for a storm of 5 min.

Coefficient for runoff for drainage shall be as follows:

|     |                                  |   |      |
|-----|----------------------------------|---|------|
| i)  | Open areas                       | – | 0.5  |
| ii) | Road and paved area/parking area | – | 0.70 |
| ii) | Roof Surface                     | – | 1.0  |

The drainage system shall be so designed that the velocity of flow shall be between 1m/ sec. to 2.5 m/ sec. Open drains with M 25 RCC shall be provided on both sides of the road and also on periphery of the plot to carry storm water from plot area to nearby drain. The drain shall have slope of 1 in 750 (minimum). Minimum free board shall be 150 mm.

Suitable arrangement in the form of drain pits , connected by buried RCC for draining out water from the equipment, leakage, floor washings, fire fighting, etc. shall be provided complete up to plant sewers/ drains.

**4.12 MISCELLANEOUS DETAILS**

**4.12.1 Platforms, hand Railing and Cat Ladders**

Safety cages for the ladders shall be provided if the height is more than 3.5 m. The ladders shall be preferably vertical; in no case shall the angle with the vertical exceed 5 degrees. Minimum width of ladder shall be not less than 400 mm. 1000 mm high handrails shall be provided to all the walkways & platforms as per specification. M.S. gratings shall be provided as per the requirement indicated in the drawings. As far as possible, welded connections shall be provided. Any bolted connection shall have a minimum of two bolts of 16 mm dia., unless restricted by the member size. All the fabrication shall be coated with two coat of approved quality primer and the final painting shall be done as per the relevant specification Minimum two nuts shall be provided for all anchor bolts.

#### **4.12.2 Miscellaneous Specification**

- i. Monorails and fixtures shall be provided by the Bidder as per specification.
- ii. All monorail openings in the walls shall be provided with double plate flush steel door shutter with suitable access platform and ladder as required.
- iii. As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.
- iv. All foundation embedment, inserts, block outs required for mounting of equipments and supporting any other facility like pipes etc. shall be provided conforming to manufacturer's requirement.
- v. MS Angles of minimum size 50X50X6 mm with 8 mm dia - 150 mm long MS lugs @ 150 mm c/c shall be provided for edge protection around all cutouts/ openings in floor slabs/ walls, RCC stair case, edges of manhole supporting covers, around periphery of all removable precast covers and any other place where breakage of corners of concrete is expected.
- vi. All drains inside the building shall have minimum 40 mm thick M.S. grating covers unless otherwise specified. All drains outside the building shall have perforated precast RCC cover of minimum 50 mm thickness with provision of minimum 40 mm thick & 500 mm wide open able steel grating covers at about 4M intervals. In areas where heavy equipment load would be coming or where the movement of loaded vehicle is there, suitably designed and strong enough solid pre- cast/cast-in-situ RCC covers shall be provided in place of steel gratings / chequered plates / precast covers. Edges of all pre- cast RCC trench covers should be protected by providing suitable sized M.S. Angles all around.
- vii. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays.
- viii. All internal cable trenches shall have minimum 6 mm thick (o/p) chequered plate covers while external cable trenches shall have pre-cast RCC covers. However, the portion of the cable trench behind and sides of control panel/ MCC shall be provided with suitable chequered plate covers as directed by the Engineer In Charge.
- ix. Blinding concrete of layer not less than 100 mm thick shall be provided below all the water retaining structures. A layer of bitumen paper or craft shall be provided over the blinding layer to destroy the bond between structural concrete and blinding layer.

- x. Blinding concrete of minimum 75 mm thickness shall be provided below all other underground structures, foundations, trenches etc.
- xi. Earthing mat shall be provided around buildings and structures as per specifications/ drawings. Excavated earth shall not be dumped within the plant area. Earth shall be transported immediately after the excavation, to disposal areas as directed by the Engineer In Charge. A maximum lead of about 5 KM for disposal of surplus earth is envisaged.
- xii. Anti- termite treatment shall be provide to foundations including column pits, wall trenches, filling below the floors etc. for all the buildings conforming to IS 6313 and other relevant Indian Standards.
- xiii. If the sulphate/ chloride concentration in soil / sub- soil water exceeds the permissible limit prescribed in IS 456 (2000) necessary treatments/ precautions shall be provided / taken for all sub structures coming in contact with soil, after taking prior approval from the Engineer In Charge. For all galvanized structures, rate of zinc coating shall not be less than 610 gms/ Sq.M Unless otherwise specified.
- xiv. For all galvanized structures, rate of zinc coating shall not be less than 610 gms /Sq.m unless otherwise specified.
- xv. RCC Pipe supports ( pedestals) to be repaired by removing the loose concrete & guniting the damaged portion with M25 grade concrete and/ or equivalent grade grout and as directed by Engineer-In-Charge.
- xvi. Carbonated zones of concrete to be repaired as directed by Engineer-In-Charge, by cleaning and removing loose concrete, fixing nozzle and repairing the damaged part by epoxy pressure grouting.
- xvii. Corroded structural steel and its parts like plates, angle, channel of existing structure to be removed or repaired by cutting, De-welding as directed by Engineer-In-Charge. If part is not repairable replacing the same by new fabricated member single or built up welded section as per drawing & as directed by Engineer-In-Charge.
- xviii. Paving of minimum 100 mm thickness all around ESP area with gutter leading to drain shall also be provided.

#### **4.13 RECORDS OF CONSTRUCTION**

All records of concreting, reinforcement, testing of materials, as -built dimensions, tolerances, the detail of rectification, etc., shall be maintained as

given below. Full copies of such record in a bound form shall be submitted to owner for their record and future reference.

- a. Testing date of aggregates.
- b. Mix Design details.
- c. Testing records of admixture including dosages, workability and setting time.
- d. Approved scheme for concreting.
- e. Hourly records of concreting including pour card.
- f. Protocol indicating the dimensional tolerance and details of inserts.
- g. Records giving the details of rectifications giving the location of grouting, the quantity of grout used at each location, type of grout used.
- h. Bar bending schedule.
- i. Location and details of mechanical anchoring used for reinforcement. Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification. Report on petrographic examination & potential reactivity of aggregate and the repeated temperature cycle tests.

## **5.0 DISMANTLING & DEMOLITION WORK**

### **5.1 INTRODUCTION AND SCOPE OF WORK**

This specification covers the general requirements, procedure, application of tools and safety precautions for demolition and dismantling work for Renovation and Maintenance work in BTG area. It deals with dismantling of RCC equipment foundation, floor slab, grade slab, rammed morum/brick & boulders under grade slab, columns, pedestals, structural steel and earth work etc. It also covers supply, delivery of all necessary materials, labour, scaffolding, tools, tackles, equipment and everything that is necessary for the satisfactory completion of the job on schedule.

### **5.2 GENERAL**

1. The contractor should visit the site and acquaint himself about site conditions and thoroughly understand the scope and nature of the work. The contractor is also required to submit the proposed execution plan and schedule of demolishing and dismantling and list of all available tools (manula & power tools) along with his quotation.

2. Dismantling/Demolishing needs to be vibration-less or with minimum vibrations so that adjacent structure is not affected. Use of chemical like crackamite is desirable. Crackamite chemical is used for expanding and splitting RCC by drilling holes and putting chemical in the holes thereby facilitating breaking and splitting.
3. Dismantling/Demolishing shall also requires power driven concrete saw, concrete splitting m/c, pock lain and other such tools as may be required for successful & safe execution of work.
4. Entire work of demolishing and dismantling shall be meticulously planned. Prior to start of work, the Contractor shall examine all the drawings, locations, adjoining structures, available working space etc. and then prepare his action/execution plan for demolishing and dismantling and submit to the Engineer-in-charge for his review. Comments, if any, shall be taken care by the Contractor and execution of the work shall be done based on the approved execution plan.
5. The contractor is required to submit complete proposal with sequence-wise operations.
6. The term Dismantling implies carefully taking up or down and removing without damage to adjoining parts of the structures. Apart from this specification, the demolition and dismantling of structures (part or whole) shall be in compliance with all statutory safety regulations. This shall consist of dismantling one or more part of the structures as specified or shown on the drawings. Prior consent and approval of the Engineer-in-charge shall be obtained in writing before starting any dismantling work. Any restriction imposed regarding working hours shall also be followed by the Contractor.
7. All materials obtained from dismantling/demolition operations shall be the property of Owner and shall be kept in safe custody until handed over to the owner.
8. Where it becomes necessary to disconnect any existing service line(s) (such as electrical, piping etc.) during dismantling/demolishing operation,

the same shall be immediately brought to the knowledge of Engineer-In-Charge to maintain continuity and proper functioning of the service line(s).

9. Before the start of dismantling work, the contractor shall ensure that all the mechanical & electrical equipments or parts are removed from the foundation/structure planned for dismantling.

### **5.3 SAFETY PRECAUTIONS**

1. The contractor shall adopt standard practices and procedures, use appropriate tools and workmen at all stages of work to guard against accidents to ensure complete safety.
2. Contractor shall provide necessary passageways as may be required, safety belts, helmets, safety shoes, lights and other safety equipments/gadgets as per standard rules of local authorities and for protection to his men and materials.
3. Necessary propping, shoring and/or underpinning shall be provided for the safety of the adjoining structure which is to be left intact before dismantling and demolishing is taken up. The work shall be carried out in such a way that no damage is caused to the adjoining property/structure.
4. Wherever required and/or instructed by Engineer-in-charge temporary enclosures made out of GI sheet, fencing, including danger lights etc. shall be provided by the Contractor and got approved by the engineer-in-charge before start of work to prevent accidents and to restricts entries.
5. Necessary precautions shall be taken to keep the dust –nuisance down as and when necessary.
6. Contractor must ensure the availability of adequate fire fighting equipment / arrangements before starting actual demolishing / dismantling works. These facilities shall be made available throughout the entire operation of demolition and dismantling of structures.

7. All equipments, pipes, fittings and instruments, underground utilities etc. located in the vicinity shall be protected by suitable means, as directed by the Engineer-in-charge, during demolishing & dismantling operations.
8. Roads and working spaces shall be kept free of any debris/dismantled materials at the end of day's work.
9. Dismantled elements/components shall not be dropped from a height or thrown from a distance. Dismantling of elements fixed by screws/bolts/hooks etc. shall be done by taking out the fixtures with proper tools only. Such fixtures may be allowed to be cut by sawing or flame cutting, in the event of their being struck up due to corrosion etc. however the decision of Engineer-in-charge in this regard shall be final and binding. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any condition.
10. A large part of demolition safety involves proper dress and the use of appropriate safety accessories, especially when using power tools.
  - Do not wear loose clothing that can get caught in machinery
  - Wear safety helmet all the time during work.
  - Remove any jewelry that can interfere with safe machinery operation
  - Wear safety goggles or glasses with side protection
  - Use a face mask in dusty applications, ear plugs when the site is especially noisy or for extended periods of work
  - Heavy work gloves should be worn to protect against the steady vibration of power tools and the heat that can be generated, especially in the bit
  - Wear steel-toed safety shoes or boots.

#### **5.4 PROCEDURE**

1. The contractor shall plan appropriate application of tools and machinery as per requirement of work with consent of the Engineer-in-charge. It is expected that the contractor shall employ the required power operated tools/chemicals like crackamite for dismantling of RCC. Reinforcing steel shall also be recovered from dismantled RCC and shall be cleaned, stacked and be handed over to the Engineer-In-Charge.

2. Demolition and dismantling shall be restricted to the extent shown on drawings and as directed by the Engineer-in-charge.
3. Dismantling shall be commenced in a systematic manner. All elements shall be carefully removed without causing any damage. All materials which are likely to be damaged by dropping from a height shall be carefully dismantled first. The dismantling articles shall be passed by hands or proper tools depending upon requirements where necessary and lowered to the ground and not thrown or torn off by force. The materials then properly stacked as directed by the Engineer –in-charge.
4. Demolition of any structure shall be carried out in a proper sequence, as approved by the Engineer –in-charge.
5. Blasting in any form shall not be permitted.

## **5.5 STACKING AND DISPOSAL**

1. Any serviceable material, obtained during dismantling or demolition such as bricks, stones, reinforcement bars, structural steel, sheeting etc. shall be separated out, cleaned and stacked properly in separate lots with in the plant boundary as directed by the Engineer-in-charge.
2. All unserviceable materials shall be disposed off within or outside the plant boundary as per the direction of the Engineer-in-charge. Areas required outside the plant boundary within 5 Km lead for dumping of disposed material shall given by owner.

## **5.6 MEASUREMENT & PAYMENT**

1. Measurement of all works shall be taken prior to start of demolishing/ dismantling works.
2. Payment for dismantling of reinforced and plain Cement Concrete shall be made on the basis of actual volume in cubic meters (cu.m.) so demolished. Thickness of flooring & plaster shall be included in measurement.
3. Payment shall also be made for reinforcement removed, cleaned and stacked as per specifications on basis of weight of reinforcement steel.

4. Payment for demolishing of rammed morum, boulders & excavation of earthwork shall be made on the basis of actual volume in cubic meters (cu.m.) as existing.
5. Payment of dismantling of structural steel shall be made on the basis of weight (MT) of the structure/components being dismantled. Assessment of weight shall be done as per the standard structural handbook specifications or as per the direction of Engineer-in-charge.
6. Incase a parallel lumpsum proposal is submitted, the payment schedule shall be worked out based on item wise progress of work.
7. In all cases the rate for demolishing/dismantling shall include:

Necessary safety measures, Supply of all labour, tools & tackles, propping, underpinning, scaffolding, handling, cutting, straightening, scraping and cleaning of reinforcement bars and other embedment, equipment, consumables, unbolting, cutting (by sawing or flame cutting) of gussets/plates/bolts/hooks/welds, including cleaning, sorting out and stacking of all serviceable materials & handling over to owner, disposal of all unserviceable material, clearing the site, etc. all complete as specified and directed by the Engineer-in-charge.

## **6.0 DESCRIPTION OF CIVIL & STRUCTURAL WORKS**

### **6.1 EARTH WORK**

The works covered by this section of the specifications consists of furnishing all plant, labor, equipment, appliances & materials and in performing all operations in connection with earthworks of all underground supplies & services and for all structural units, stock piling of specifications and applicable drawings and subject to terms & conditions of the contract. The scope of this section of specifications is also covered with detailed specifications as laid down here in.

#### **6.1.1 GENERAL**

The contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil which might be

encountered during excavation of earth works. The owner does not guarantee or warrant in any way that the material to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the report, drawings or in any other document or to material obtained from boring or trial holes. The contractor shall be deemed to have made local & independent inquiries and shall take the whole risk of the nature of the ground subsoil or material to be excavated or penetrated and the contractor shall not be entitled to receive any extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil.

All excavations , cutting and fills shall be constructed to the lines , levels and gradients specified with any necessary allowance for consolidation, settlement & drainage so that at the ends of the period of maintenance the ground shall be at the required lines, levels & gradients. During the course of the contract and during the period of maintenance any damage or defect in cuttings & fills, structures & other works, caused by slips, fails or basins or any other ground movement due to the contractor's negligence shall be made good by the contractor at his own cost.

#### **6.1.2 SITE PREPARATION**

The contractor shall set out the works & shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the contractor shall at its own expense rectify such error, to the satisfaction of the Engineer-In- Charge.

The contractor shall construct and maintain accurate bench mark so that the lines and levels can be easily checked by the Engineer-In- Charge.

The contractor shall construct and maintain such ditches, in addition to those shown on the plans, as well adequately drain areas under consideration.

The contractor shall perform a joint survey with the Engineer-In- Charge or his representative of the area where earth work is

required, plot the ground levels on the drawings & obtain approval from him before starting the earth work.

### **6.1.3 EXCAVATION**

Excavation shall include the removal of all materials of every name & nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the drawings and as directed by the Engineer-In-Charge.

The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on soil as per drawings as directed by the Engineer-In-Charge. The excavation which cannot be done by mechanical means including leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and back fill shall be stock piled within the free haulage limit of the boundary of the works.

The contractor shall give the reasonable notice that he intends to commence any excavation and he shall submit to the Engineer-In-Charge full details of his proposals. The Engineer-In-Charge may require modifications to be made if he considers the contractor's proposal to be unsatisfactory & the contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.

Excavated material suitable for use as filling material shall be stock piled within the free haulage limit upto 100m from site of works as directed by the Engineer-In-Charge. This stock piled material shall be transported back to places requiring fill or back fill. Surplus or material unsuitable for use as filling shall be disposed off by the contractor at locations approved by the Engineer-In-Charge within specified free haulage limits.

The excavation work shall include excavation in above water table and excavations below water table. The contractor shall submit the proposal for dewatering from the areas of excavation for the approval of Engineer-In-Charge & shall provide all plant equipments, pumps, sheeting, well points as required to keep the

water table below 1.0m from the deepest foundation as shown on the drawings till the completion of foundation works.

The contractor shall make independent inquiries and perform and make independent observations to ascertain the water table in the areas of excavation during the period when the construction works are in progress. The contractor shall take whole risk of any nature or fluctuation of water table from his own findings. The owner is not bound in any way and shall not be responsible for any information given by him or any information, observation or values obtained from his reports, drawings & documents.

Excavation for pits, cable trenches and equipments foundations and other structures shall be taken out to the levels & dimensions as the Engineer-In-Charge may direct.

Before starting the excavations, the contractor shall ensure the correct alignment of the pipe line on the ground, the depth & width of the excavation of the trench all in accordance with the drawings and instructions of the Engineer-In-Charge. The contractor shall make profiles with the cement concrete pillars.

Excavation shall be carried out true to line, grade and width as shown on the drawings or as directed by the Engineer-In-Charge ensuring the proper laying of the pipe line, the bedding fill, construction of chambers for appurtenant and any other structures. The trench bottom shall be graded to provide even and substantial bearing over the specified bedding.

The contractor at his cost shall provide to the satisfaction of the Engineer-In-Charge all timbering approved supports and shores and bracings to the side of the excavated trench and foundation in such a manner to secure the sides of the trench and excavations from failing or adverse movement. All responsibility connected with such shoring shall rest with the contractor. Adequate clearance /working space on both sides of the structure/pipe line shall be provided for which no payment shall be made.

Without the written permission of the Engineer-In-Charge not more than 200 m of the trench shall be opened by him advance of the completed pipeline.

The bottom of all the excavations shall be carefully levelled. Any pockets of soft or loose material in the bottom of all the excavations shall be removed and the cavities so formed filled with lean concrete at the contractor's expense.

The Engineer-In-Charge may require the contractor to excavate below the elevations shown on the drawing or he may order him to step above the elevations shown depending upon the suitable foundation material encountered.

If for any reasons, the levels grades or profiles of the excavation are changed adversely, the contractor at his own cost shall be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Engineer-In-Charge.

#### **6.1.4 EXCAVATION TOLERANCE**

The excavation shall be performed within the tolerances for excavation limits Indicated on the drawings. Where no tolerance limits are Indicated, excavation shall be performed to tolerances established by the Engineer-In- Charge as accepted for the design.

#### **6.1.5 BACKFILLING**

After completion of foundation footing, foundation walls & other construction below the elevation of the final grades and prior to backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris.

The backfilling shall include filling under floors, around the foundation, trenches, pipes, conduits, ducts and channels and bedding for the pipes.

The backfilling work shall include loading, unloading, transporting, placing, stocking, spreading of earth, watering rolling, ramming and compacting complete as specified herein.

The filling shall be approved selected material from excavation or other predominantly granular material and free from slurry, mud, organic or other unsuitable matter and capable for compaction by ordinary means.

The excavated material if found suitable shall be stock piled within the free haulage limit of the site of the works. This material shall be used for backfilling if approved by the Engineer-In-Charge and shall be transported by the contractor any where required for the purpose of backfilling work in this contract.

The contractor shall provide the approved quality fill and back filling material as required to complete the fill/backfilling work.

The filling in trenches and foundation shall be placed in 200 mm layers & compacted at optimum moisture content by mechanical means or other approved by Engineer-In-Charge.

The fill in around pipes and cables shall be carefully placed with fine material to cover the pipe or cable completely before the normal filling is done.

All filled area shall be left neat, smooth and well compacted with the top surface consisting of the normal site surface soil unless otherwise directed.

Depending on the depth of fill Engineer-In-Charge may instruct increased thickness of successive layers to be placed.

The fill shall not be placed against foundation walls prior to approval by the Engineer-In-Charge. Fill shall be brought up evenly on each side of the wall as far as practicable. Heavy equipment for spreading & compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.

In case the contractor is instructed to arrange for the fill material, the quality of the fill material will be subject to the approval of the Engineer-In-Charge. The Engineer-In-Charge shall require the contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the contractor. Once a material from a specific be used. Any fill material from borrow pits which has not been approved or the quality of which differs from the approved material shall be rejected outright.

The Engineer-In-Charge reserves the right to order removal of any such material brought to the site of work at his discretion and contractors expense, in order to ensure satisfactory compaction , it will be necessary to carry out, depending upon the type of material,

particle size distribution tests, max. & min. density tests and determination of optimum moisture content for filling material.

The method of compaction, namely type of compactor, type of roller, weight of roller and number of passes proposed by the contractor for any particular fill material shall be subjected to the approval of the Engineer-In-Charge after completion of satisfactory field tests, subsequent to the laboratory analysis, using the material and equipment proposed to be used for the earth work in conditions similar to those likely to be encountered during construction. The final selection of the soil moisture content, the thickness of layers, the type of compaction equipment and the number of passes shall be decided after these tests, which shall be conducted at contractor's expense.

Having established the method of compaction to be used, no departure from this approved method shall be permitted without the prior approval of the Engineer-In-Charge. Adequate control of the fill and compacting operations shall be ensured by in situ density tests and in order to obtain significant results, not less than two measurements shall be determined on site and may be varied at the discretion of the Engineer-In-Charge. Compaction shall not be less than 95% in situ density with respect to the maximum density, at optimum moisture content.

The exact thickness of layers, and the method of placing and compacting the fill shall be determined by the field tests, as stated above, but notwithstanding the results of these trials, fill shall not be placed in layers exceeding 200 mm in thickness. In order to maintain control of the thickness of the layers, timber profiles shall be used whenever feasible. The travelers of such profile for each layer of fill shall be checked by the supervisory staff of the Engineer-In-Charge.

The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk before excavating and no allowance shall be made for any subsequent variation in bulk or for any extra excavation unless otherwise shown on the drawings. Measurements shall be as per IS: 1200 as directed by the Engineer-In-Charge.

### **6.1.6 PAYMENT**

Payment will be made for measured quantity of excavation on the basis of unit rate per cum quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

### **6.1.7 BACKFILL/FILL**

#### **Measurement**

Measurements shall be as per IS: 1200 or as directed by the Engineer-In-Charge.

#### **Payment**

Payment will be made for acceptable measured quantity of backfill/fill on the basis of unit rate / cum quoted in the bill of quantities & shall constitute full compensation for all the works related to the item.

### **6.1.8 SAMPLING, TESTING & QUALITY CONTROL**

#### **6.1.8.1 General**

The contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Engineer-In-Charge. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering procedures to the directions of the Engineer-In-Charge and the contractor shall submit to the Engineer, the test results in triplicate within three days after the completion of a test. The Engineer may at his discretion, waive some of the stipulations given below, for small and unimportant operations.

The work found unsuitable for acceptance shall be removed and replaced by the contractor. The work shall be redone as per specifications requirements and to the satisfaction of the Engineer-In-Charge.

Only as a very special case and that too in non-critical areas, the Engineer-In-Charge may accept filling work which is marginally unacceptable as per the criteria laid down. For such accepted work,

payment shall be made at a reduced rate prorata to the compaction obtained against that stipulated.

#### **6.1.8.2 QUALITY ASSURANCE PROGRAMME**

The contractor shall submit and finalize a detailed field quality assurance programme within 30 days from the date of award of the contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus /equipments, deployment of qualified/experienced manpower, preparation of format for record, field quality plan, the Owner shall identify customer hold points beyond which work shall not proceed without written approval from the Engineer-In-Charge.

The frequency of sampling and testing including the methods for conducting the tests are given in quality control as testing section of the specifications. The testing frequencies set forth are the desirable minimum and the Engineer-In-Charge shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

#### **6.1.8.3 Acceptance Criteria**

Following Acceptance Criteria shall be followed:–

All individual samples collected and tested should pass without any deviation when only one set of sample is tested.

For retest of any sample two additional samples shall be collected & tested, and both should pass without any deviation.

Where a large number of samples are tested for a particular test than 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

The tolerance on finished levels for unimportant filling areas at approved interval shall be + 20 mm. However for an unimportant area, tolerance upto +75 mm shall be accepted at the discretion of Engineer-In-Charge. However, these tolerances shall be applicable for localized areas only.

## **6.2 ANTI-TERMITE TREATMENT**

### **6.2.1 GENERAL**

Prevention of termite from reaching the superstructure can be achieved by creating a chemical barrier the ground and the building by treating the soil beneath the building and around the foundations. The work shall be carried out as per IS: 6313 part II of 1981.

### **6.2.2 MATERIAL**

Chloro Pyrifos 1 % Emulsifiable concentrate.

### **6.2.3 PRE - CONSTRUCTION CHEMICAL TREATMENT**

This is a process in which chemical treatment is applied to a building in the early stages of its construction. Hand operated pressure pump shall be used for uniform spraying of the chemical, graduated container shall be used. Proper check should be kept that the specified quantity of chemical is used for the required area during the operation.

### **6.2.4 TIME AND APPLICATION**

Soil treatment shall start when foundation trenches and pits are ready to take mass concrete in foundation. Layering of mass concrete shall start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or when soil is wet with rain water or sub soil water. The foregoing applies also in the case of treatment to the filled earth surface within the plinth before laying the sub-grade.

### **6.2.5 DISTURBANCE**

The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of barrier system.

### **6.2.6 TREATMENT OF EXCAVATION**

The bottom surface and the sides (up to a height of above 300mm) of the Excavation made for column pits, wall trenches shall be treated with at the rate specified in IS 6313(1981) Part II of 1981.

After the column foundations come up, the backfill in immediate contact with the foundation structure shall be treated at the rate specified in IS: 6313 of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried after the ramming operation is done by rodding the earth at 150mm centres close to the wall surface and spraying the chemical with the above dose. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemicals.

In the case of RC framed structures with columns and plinth beams and RC basements/tanks with concrete mixes rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom of the excavation for columns and plinth beams. The treatment shall start at the depth of 500mm below ground level. From this depth the back-fill around the columns, beams and RC basement wall shall be treated at the rate as per IS: 6113 part II.

### **6.2.7 TREATMENT OF TOP SURFACE OF PLINTH FILLING**

The top surface of the filled earth within plinth wall shall be treated with chemical emulsion at the rate as per IS: 6313 (part II) (Surface area) before the sand/sub-grade is laid. Holes up to 50 to 75mm deep at 150mm centers to centers spacing (both ways) shall be

made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

#### **6.2.8 TREATMENT OF INNER WALL SURFACE**

To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, small channel 30x30mm shall be made at all the junctions of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel up to ground level 150mm apart and the chemical emulsion poured along the channel as per rate of application, – mentioned in IS: 6113 (part II) so as to soak the soil right up to bottom. The soil shall be tamped back into place after this operation.

#### **6.2.9 TREATMENT OF SOIL ALONG PERIPHERY OF BUILDING**

During progress of work, provide holes in the soil with iron rods along the External perimeter of the building at intervals of about 150mm and depth 300mm and filling these holes with chemical emulsion at the rate (as per IS : 313 Part II) per meter of the external wall.

#### **6.2.10 TREATMENT AT EXPENSION JOINT**

Anti-termite treatment shall be supplemented by treating through the expansion Joint after the sub grade has been laid as per IS: 6313(Part II)

#### **6.2.11 TREATMENT OF SOIL AROUND CONDUITS**

When pipes and conduits enter the soil inside the foundation area, the soil surrounding the entry points shall be loosened around each such pipe or conduit for a distance of 150mm and to a depth of 75mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75mm for distance of over 30mm from ground.

#### **6.2.12 SAFETY PRECAUTION**

All chemical used for anti-termite treatment are poisonous and hazardous to health. These chemical can have an adverse effect on health when absorbed through skin, inhaled as vapors or spray mists or swallowed. Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below.

These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labeled and should be stored carefully so the children and pets cannot get at them. They should be kept securely closed. Particular care should be taken to prevent skin contact with concentrates prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water specially before eating and smoking in the event of severe contamination, clothing should be removed at once and the skin washed with soap and water if chemical splash into eyes they should be flushed with plenty of fresh 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 nearby during the mixing.

Care should be taken in application of chemicals to see that they are not allowed to contaminate wells or springs which serves as a source of drinking water

#### **6.2.13 MEASUREMENTS**

The measurements shall be made on the basis of item rate for all operations described in schedule of quantities.

#### **6.2.14 RATE**

The rate shall include the cost of all materials and labor involved in all the operations described above including making holes and refilling and making good the same.

### **6.3 PLAIN AND REINFORCED CEMENT CONCRETE**

### **6.3.1 SCOPE**

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials, and in performing all operations in connection with the supply and installation of plain and reinforced concrete work, complete in strict accordance with this section of the specifications and relevant documents, subject to the conditions of the contract.

### **6.3.2 GENERAL**

Full co-operation shall be given to other trades to install embedded items and/or any associated services.

Embedded items shall have been inspected, and tests for concrete and other material or for mechanical operations shall have been completed and approved, before concrete is placed.

Formwork shop drawings shall be designed and prepared by the contractor at his own cost. Approval of shop drawings as well as those of mock-ups/ actual samples of finished concrete shall be obtained before work is commenced.

The contractor shall prepare bar bending schedule, and get the same approved by the Engineer-In-Charge, prior to commencement of work.

### **6.3.3 MATERIALS**

#### **6.3.3.1 Cements**

- a. Cement shall conform to standards listed in section 2 of IS: 456 grade 43.
- b. Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.
- c. There shall be sufficient cement at site to ensure that each section of work is completed without interruption.

- d. The cement reclaimed from cleaning of bags or from leaky containers shall not be used.
- e. The contractor shall provide and erect, at his own cost, in a suitable place, dry, well ventilated, and water proof shed of sufficient capacity to store the cement.
- f. The cement shall be used as soon as possible after delivery, and cement which the Engineer-In-Charge considers has been stale or unsuitable through absorption of moisture from the atmosphere of otherwise shall be rejected and removed immediately from the site at contractor's expense.
- g. The mixing together of different types of cement shall not be permitted.

#### 6.3.3.2 Aggregates

The sources of supply of all fine and coarse aggregates shall be subjected to the approval of Engineer- in-Charge. All fine and coarse aggregates shall be clean and free from clay, loam, silt and other deleterious matter. If required, Engineer-In-Charge reserves the right to have them washed by the contractor at no additional expenses. Coarse and fine aggregates shall be delivered and stored separately at site. Aggregates shall not be store in muddy ground or where they are likely to become dirty and contaminated.

Fine aggregate shall be hard coarse sand, crushed stone or gravel screening and shall conform to requirement of IS: 383. Coarse aggregate shall be gravel or broken stone or hard, durable material free from laminated structure and conforming to IS: 383. The aggregates shall be graded as follows for used in mass concrete as in foundation.

| TOTAL PASSING | PERCENTAGE BY WEIGHT |
|---------------|----------------------|
| 50.00mm sieve | 100                  |
| 38.10mm sieve | 95-100               |
| 19.00mm sieve | 35-70                |
| 9.50mm sieve  | 10-30                |

4.75mm sieve

0-5

Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits:

| <b>TOTAL PASSING</b> | <b>PERCENTAGE BY WEIGHT</b> |
|----------------------|-----------------------------|
| 38.10mm sieve        | 100                         |
| 19.00mm sieve        | 90-100                      |
| 9.50mm sieve         | 20-55                       |
| 4.75mm sieve         | 0-10                        |

Wherever feasible the normal maximum size of aggregate for cast-in-place reinforced concrete slabs and other thin members shall also be 20mm. If there are difficulties in placing such a concrete the maximum size may be restricted to 12.5mm provided the requirements for strength are satisfied. The nominal maximum size of aggregate for pre-cast fair face concrete shall not be larger than one-fifth of the narrowest dimensions between sides of forms, one-third of the depth of slabs, nor three-fourth of the minimum clear distance between reinforcing bars or between bars and form but in no case greater than 12.5mm whichever is least.

Coarse aggregate in pre-cast concrete of normal weight may be of one maximum size for all concrete place in one day when quantities to be place are too small to permit economical use of more than one mix design. When a single mix design is so used, the maximum nominal size shall be as required for the most critical conditions of concreting, in accordance with the requirement of section above.

Except where it can be show to the satisfaction of Engineer-In-Charge that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the coarse aggregate in two sizes for aggregate of 20mm maximum nominal size, the different size being stacked in separate stock-piles and recombined in the correct proportions for each batch at batching plant.

The material shall be stockpiles for a period before use so as, to drain nearly too constant moisture content (as long as site and other condition permit, preferably for at least a day). The grading of the coarse and fine aggregate shall be tested at least once for every 100 tons supplied to ensure that the grading is uniform and the same as that of the samples used in the preliminary tests.

#### 6.3.3.3 Water

Only clean potable water from the city supply, tube well installed at the site or from other sources approved by Engineer-In-Charge shall be used. Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where doubts exist as to the suitability of the water, it shall be tested in accordance with IS: 3025. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, Engineer-In-Charge may refuse to permit use. As a guide the following concentrations represent the maximum permissible values:

- a. To neutralize 200ml sample it should not required more than 2ml of 0.1 normal NaOH.
- b. To neutralize 200ml sample it should not required more than 10ml of 0.1 normal HCL

Percentage of solids should not exceed the following:

| MATERIAL        | PERCENTAGE                             |
|-----------------|----------------------------------------|
| Organic         | 0.02                                   |
| Inorganic       | 0.30                                   |
| Sulphates       | 0.05                                   |
| Alkali          | 0.10                                   |
| Chlorides as Cl | 0.20 for PCC work<br>0.10 for RCC work |

In case of doubt, Engineer-In-Charge may require that concrete mixed with water proposed to be used should not have a compressive strength lower than 90% of the strength of concrete mixed with distilled water.

The source of water will be treated at the beginning of the project in case of any change in the source of water it should be tested before use. A routine check of water every month must be carried out.

#### **6.3.3.4 Reinforcement**

Reinforcement for concrete shall conform to the respective IS or other standards as specified in the drawings and contract documents or as may be specified by Engineer-In-Charge. Unless otherwise specified, all plain reinforcing bars shall comply with the requirements of IS: 432 Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of IS: 1789 for deformed cold worked steel bars and shall have minimum characteristic stress of 415N/sqmm.

Reinforcement shall be obtained only from manufacturers approved by Engineer-In-Charge. If and when required contractor shall provide all necessary facilities to Engineer-In-Charge for the selection of test pieces and shall cause these to be prepared and submitted where directed for tests at contractors cost.

If the reinforcement is to be supplied by the owner, contractor shall inform Engineer-In-Charge of his requirements much before its use in construction.

Reinforcement of all types is to be stored at site in an approved manner so as to avoid damage. The contractor shall report immediately on receipt of any consignment, having any deviation in the standard weights of the reinforcing bars beyond those allowed in respective. The contractor will submit the manufacturer's certificate for the test results giving the yield strength, 0.2% proof strength, % elongation, bend and rebend tests etc.

#### **6.3.4 CONCRETE MIX PROPORTIONS GENERAL**

The proportions of ingredients shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the work, but without permitting the materials to segregate or excessive free water to collect on the surface. Specific approval of the Engineer-In-Charge is required to

waive limitations on mixture proportions. The proportions of ingredients shall be selected to produce the proper placability, durability, strength and the other required properties.

### **6.3.5 CONCRETE GRADES**

Grade of concrete used in the works shall be shown on the drawings or as directed by the Engineer-In-Charge. For each grade of concrete the requirements are set out in the following table:

#### **6.3.5.1 Controlled concrete**

For controlled concrete by strength, the minimum stresses shall not be less than as specified below:

| Grade | Minimum cement content(*) | strength at 28 days |
|-------|---------------------------|---------------------|
|       | KG                        | N/sq mm             |
| M-10  | 170                       | 10                  |
| M-15  | 270                       | 15                  |
| M-20  | 330                       | 20                  |
| M-25  | 370                       | 25                  |
| M-30  | 420                       | 30                  |
| M-35  | 460                       | 35                  |
| M-40  | 490                       | 40                  |

This is only minimum quantity to be used and the contractor should actually use the required quantity of cement to achieve the required strength based on the trial mixes and the cube test results without any extra cost if it is more than minimum.

#### **6.3.5.2 Durability**

Requirements of clause 7 of IS: 456 shall be followed.

#### **6.3.5.3 Slump**

Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 100mm or less. A tolerance of upto 25mm above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may

be used provided it is properly placed and consolidated. Note: If SR cement is used, permissible water–cement ratio may be increased by 0.05. Slump shall be determined by the "Test for slump for Portland cement concrete "as per relevant IS code.

#### **6.3.5.4 Maximum size of coarse aggregate:**

The normal maximum size of the aggregate shall be 20mm for all portions of the structure except footings which may be 38mm. These limitations may be waived if, in the judgment of the Engineer–In–Charge, workability and methods of consolidation are such that the concrete can be placed without honeycomb or voids.

#### **6.3.5.5 Admixture**

If required or permitted, admixtures used shall be in accordance with the manufacturer’s instructions except as otherwise specified herein.

#### **6.3.5.6 Method of obtaining mix design**

For concrete of normal weight, mix proportions to provide the desired characteristics shall be developed using the methods/procedure covered by the recommended practice for selecting proportions for normal weight concrete as per IS: 10262 &IS: 456.

Trial mixtures having proportions and consistencies suitable for the work shall be made based on above codes. Using at least three different water–cement ratios which will produce a range of strengths encompassing those required for the work. The trial mixes shall be designed to produce the specified slump. The temperature of concrete used in trial batches shall be reported.

For each water–cement ratio, compression test of cube shall be made, cured and tested in accordance with IS: 1199 and IS: 516 from the results of these tests a curve shall be plotted showing the relationship between the water–cement ratio and compressive strength. From this curve, the water–cement ratio to be used in the concrete shall be selected to produce the required design strength. The cement content and mixture proportions to be used shall be such that this water–cement ratio is not exceeded when slump is maximum permitted. Control in the field shall be based upon maintenance of proper cement content and slump.

#### **6.3.5.7 Design mix from outside agency**

The contractor will at his own expenses shall appoint an outside agency to prepare the design mix. The agency will have to approve by the project manager.

### **6.3.6 PLANT AND WORKMANSHIP**

#### **6.3.6.1 Formwork**

1. The forms shall be used, wherever necessary, to confine the concrete and shape it to the required dimensions. The forms shall have sufficient strength to with stand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances. The main architectural theme is to retain the concrete as the finish facade material. Therefore, the contractor shall provide a special and perfect formwork. The drawings set out details and locations of these special formwork. The Engineer-In-Charge shall refuse any formwork in any part of the building which has been constructed with a non-approved formwork. The Engineer-In-Charge shall refuse any concreting which will not be as perfect or conform to the approval model.
2. Earth cuts shall not be used as forms for vertical surface of reinforcement concrete work unless required or permitted.
3. Mud centering shall not be permitted without the prior approval of the Engineer-In-Charge.
4. The formwork shall be of wrought timber, steel, plywood, proprietary building boards and such special materials, as may be shown on the drawings or approved by the Engineer-In-Charge which gives the required finish to the surface of concrete, wooden formwork shall be free from loose knots and shall be well seasoned.
5. The formwork shall conform to the shape, lines and dimensions as shown on the plans, and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficient tight to prevent loss of liquid from the concrete.
6. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the contractor. Where necessary to maintain the specified tolerances the formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to the construction loads. The

contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project sufficient control points and bench marks to be used for reference purposes to check tolerances.

7. The requirements for facing materials are given in section for 'finishing of formed surface'. The maximum deflection of facing materials reflected in concrete surface exposed to view shall be  $1/240$  of the span between structural members.
  8. Where natural plywood from finish, grout cleaned finish, smooth rubbed finish, scrubbed finish, or sand floated finish is required, forms shall be smooth( faced with plywood, liner sheets, or pre-fabricated panels) and true to line, in order that the surface produced will required little dressing shall to arrive at true surfaces. Where any as-cast finish is required, no dressing shall be permitted in the finishing operation.
  9. Whereas cast surfaces, including natural plywood from finish are specified, the panels of material against which is cast shall be orderly in arrangement, with joints between panels planned in approved relation to opening, Building corners and other architectural features.
  10. Where panels for as-cast surfaces are separated by recessed or otherwise emphasized joints, the structural design of the forms shall provide for locating from ties, where possible, within the joints so that patches of tie holes will not fall within the panel areas.
- ❖ The form shall not be reused if there is any evidence of surface wear and tear or defect which would impair the quality of the surface. Forms shall be thoroughly cleaned and properly coated before use.
  - ❖ The formwork shall be designed so that the soffit of slabs and side of beams, columns and walls may be removed first, leaving the forms to the soffit of beams and their supports in position.
  - ❖ The forms shall be sufficiently tight to prevent the loss of mortar from the concrete. Unless otherwise specified in the contract documents chamfer strips shall be placed in the corners of forms to produce beveled edges on permanently exposed surfaces. Interior corners on such surface and the edges of formed joints will not be required beveling unless required by the contract documents.

- ❖ Positive means wedges or jacks of accurate adjustment and proper removal of shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Forms shall be securely braced against lateral deflections.
- ❖ Where concreting of narrow members is required to be carried out within formwork of considerable depth, temporary openings in the side of the formwork shall be provided where necessary to facilitate the placing and consolidation of the concrete. Small temporary openings shall be provided at the bottom of the formwork to columns, walls and deep beams to permit the cleaning out the debris and observation immediately before concrete is done.
- ❖ The forms ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the face of the concrete.
- ❖ After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameter or twice the minimum dimension of the site from the formed faces of concrete to be permanently exposed to view, except that in no case shall this distance be less than 20mm. when the formed face of the concrete is not to be permanently exposed to view, from ties may be cut off flush with the formed surfaces.
- ❖ Through bolt shall be permitted provided that they are greased to allow for easy withdrawal and the hole subsequently made good. Through bolts are not to be used on water-retaining structures.
- ❖ At construction joints, contact surface of the form sheeting for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by on less than 25mm. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joints and to maintain a true surface.
- ❖ Wood forms for wall opening shall be constructed to facilitate loosening, if necessary to counteract swelling of the forms.

- ❖ The wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.
- ❖ The formwork shall be so anchored to shores or other supporting surface or members that upward or lateral movement of any part of the formwork system during concrete placement will be prevented.
- ❖ The formwork shall be provided with struts or legs and shall be supported directly on the formwork or structure member without resting on the reinforcement steel.
- ❖ All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed in them.
- ❖ The forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opening by shrinkage of the wood shall be swelled until closed by wetting before concrete is placed.
- ❖ The plywood and the other wood surfaces not subjected to shrinkage shall be sealed against absorption of moisture from the concrete to by either (1) a field applied, approved form oil and sealer, or (2) a factory applied non-absorptive liner. When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against which fresh concrete will be placed.
- ❖ Care shall be taken that such approved composition is kept out of contact with the reinforcement. Where as-cast finishes are required, materials, which will impart a stain to the concrete, shall not be applied to the form surfaces. Where the finishes surface is required to be painted, the material applied to form surface shall be compatible with the type of paint to be used.
- ❖ For reinforced concrete, in no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress to which concrete may be subject at the time of striking.

- ❖ The strength referred to shall be that of concrete using the same cement and aggregates. With the same proportions, and cured under condition of temperature and moisture similar to those existing on the work. Where possible, the formwork should be left longer, as it would assist the curing.

In normal circumstances (generally where temperatures are above 20°C) and where ordinary cement is used, forms may be struck after expiry of the following periods.

- a. Walls. Columns and vertical beams – 24– 48hours as decided by Engineer-In-Charge.
- b. Soffit formwork to slabs, (shores or props left under) – 03 days.
- c. Beams soffit (shores or props left under) – 07 days
- d. Removal of shores or props to slabs
- e. Spanning up to 4.5m –07 days
- f. Spanning over 4.5m –14 days
- g. Removal of shores or props to beams
- h. Spanning up to 6m –14 days
- i. Spanning over 6m –21 days

For rapid hardening cement 3/7 of above period will be sufficient in all cases except vertical sides of slabs, beams and columns which should be retained for minimum 24 hours. The number of shores or props, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab and beams as the case may be proper allowance shall be made for the decrease in the rate of hardening of concrete in cold weather and the above minimum times must be increase when the means daily temperature is below 20°C.

- ❖ When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal.
- ❖ Top forms on slipping surface of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surface shall be performed at once and be followed by the specified curing.
- ❖ Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.
- ❖ All formwork shall be removed without such shock or vibration as would damage the reinforcement concrete before the soffit

and struts are removed, the concrete surface shall be exposed where necessary in order ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cement in the cold weather.

- ❖ When reshoring or repropping is permitted or required, the operations shall be planned in advance and shall be subjected to approval. While reshoring is underway no live load shall be permitted on the new construction.
- ❖ In no case during reshoring shall concrete in beams, slabs columns and any other structural member be subjected to combined dead and construction load in excess of the load permitted by the Engineer-In-Charge for the developed concrete strength at the time of reshoring.
- ❖ The reshores shall be placed as soon as practicable after stripping operations are complete but in no case later than the end of working day on which stripping occurs. The reshores shall be tightened to carry their required loads without overstressing the construction. Reshores shall remain in place at least until tests representative of the concrete being supported the strength specified above.
- ❖ The floor supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half of capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are permitted.
- ❖ The reshoring or re-propping shall extend over a sufficient number of stories to distribute the weight of newly placed concrete forms, and construction live load in such a manner that the design superimposed loads of the floors supporting shores or props are not exceeded. Shoring or reshoring in multistory construction shall comply with ACI 347 or as specified.
- ❖ Extend shoring at least 3 floors under floor or roof being placed for structure over 4 stories. Shore floor directly under floor or roof being placed, so that loads from construction

above will transfer directly to these shores space out shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile strength in concrete members where no reinforcement steel is provided. Extend shores beyond minimum if required to ensure the proper distribution of loads throughout the structure. Remove shores and reshores in a sequence to avoid damage to partially cured concrete located and provided adequate reshoring to safely support the work. Keep reshores in place a minimum of 15 days after placing supper ties and longer if required, until the concrete has attained its required 28 days strength and heavy loads due to construction operations have been removed.

- ❖ It is generally desirable to give forms for reinforced concrete an upward chamber to ensure that the beams or slabs (specially cantilever slabs) do not have taken up their deflection, but this should not be done, unless permitted by the Engineer-In-Charge.
- ❖ No loads, other than man and light plant required in connection with the actual work in hand, shall be allowed on suspended floor until 28 days after concreting where ordinary Portland cement is used and 14 days when rapid hardening Portland cement is used .
- ❖ Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil or release agent shall not react with the concrete to affect the strength nor shall it given any color, it shall be supplied in such a manner as not to be embedded in concrete.

#### **6.3.7 BENDING AND PLACING OF REINFORCEMENT**

- ❖ All metal for reinforcement shall be free from loose mill scale, loose rust, mud, oil, grease, or other harmful matter immediately before the concrete is placed.
- ❖ The reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 16 gauge G.I wire ties or suitable slips at intersection and supported from the formwork by using concrete, metals or plastic chairs and spacers or hangers of an approved pattern. Concrete blocks are used for ensuring the cover, they shall be

made of mortar not leaner than 1 part of cement to 2 parts of sand.

- ❖ The bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer-In-Charge.
- ❖ The cutting tolerance for all bars shall be in accordance with IS: 2502.

Where an overall or internal dimension of a bent is specified in the schedule, the bending tolerance, unless otherwise stated, shall be as in table 1

**TABLE 1: BENDING TOLERANCES**

Bars shall be placed to the following tolerances

Concrete cover to formed surface =  $\pm 5\text{mm}$

Minimum spacing between bars =  $\pm 5\text{mm}$

Top bar in slabs and beams

i) Members 200mm deep or less =  $\pm 5\text{mm}$

ii) Members more than 200mm deep but not over 600mm deep =  $\pm 10\text{mm}$

iii) Members more than 600mm deep =  $\pm 25\text{mm}$

Crosswise of members spaced evenly within =  $\pm 50\text{mm}$

Lengthwise of members =  $\pm 50\text{mm}$

The bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subjected to approval of Engineer-In-Charge.

- ❖ The vertical bar in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels. Reinforcement shall not be bent or straightened in a manner that will injure the material.
- ❖ No bar shall be bent twice in the same place, nor shall they be straightened after bending, unless permitted, by the Engineer-In-Charge, reinforcement shall not be bent after being partially embedded in hardened concrete.

- ❖ The bars which depend for their strength on cold working shall not be heated for any reason. Other kinds of reinforcement larger than 40mm dia. may be bent by the use of heat at cherry red heat (not exceed 840°C). Bars bent shall not be cooled by quenching.
- ❖ No splice of reinforcement shall be made except as shown on the working drawings.
- ❖ Welding shall be permitted for bars only under suitable condition and with suitable safeguards in accordance with IS: 2751 and Indian standard Recommendation for welding cold worked steel bars for reinforced concrete, provided the type of reinforcement bar has the required welding properties. Tack welding may be used to fix in position bars that cross each other, only with prior approval of Engineer-in- Charge.
- ❖ The exposed reinforcement intended for bonding with future extension is to be effectively protected for corrosion. Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.
- ❖ No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer-in- Charge.
- ❖ Welding shall be done as in section "structural steel works".

#### **6.3.8 BATCHING**

- ❖ All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement may be taken as 50kg with the prior approval of Engineer-in- Charge.
- ❖ Aggregate shall be batched by weight, due to allowance being made by water content. Aggregate may be batched by volume only by the prior permission of Engineer-in- Charge. The apparatus for weight batching may be an integral part of the mixer or a separate unit of a type approved by Engineer-in- Charge. It shall be accurate within 2% and shall be checked for accuracy at least once a week.
- ❖ Where the batching plant is of the type in which cement and aggregate are weighed in the same compartment, the cement

shall be introduced into compartment between two sizes of aggregate.

- ❖ Where volumetric batching of aggregate is permitted gauge box shall be provided for measuring the coarse and the fine aggregate. These shall be deep and narrow rather than shallow and wide and shall be fitted with suitable handles. Tests for the bulking of sand shall be made at intervals and the necessary quantity of sand added.
- ❖ Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue to flow for a period which may extend to the end of the first 25% of the specified mixing time.

#### **6.3.9 MIXING**

- ❖ The concrete shall be mixed in an approved batch mixer conforming to the requirement of IS: 1791. It shall be fitted with the manufacturer's plate stating the rated capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water measuring device.
- ❖ Mixing shall continue for a period recommended by the mixer manufacturer or until apparently the mix is uniform in color, whichever period is longer. If it is desired to use a mixing period less than 1.5 minute Engineer-in-Charge approval shall be obtained.
- ❖ The controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.
- ❖ The interior of the mixer shall be free of accumulation that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10% of their original height.
- ❖ The concrete shall be mixed only in quantities for immediate use. The concrete which has set shall not be re-tempered, but shall be discarded.

### **6.3.10 TRANSPORT**

- ❖ The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means which will prevent segregation or loss or addition to ingredients. It shall be deposited as nearly as practicable in its final position so as to avoid rehandling or flowing. All skips vehicles, or containers used for transporting the concrete shall be thoroughly cleaned.
- ❖ During hot and cold weather, concrete shall be transported in a deep container; the deep containers, on account of their lower ratios of surface area to mass, reduce the rate of loss of water by evaporation during hot weather and loss of heat during cold weather.

### **6.3.11 PLACING**

- ❖ Before placing of concrete, formwork shall have completed, water shall have been removed, reinforcement shall have been secured in place, expansion joint material, anchors and other embedded items shall have been kept in position, and the entire preparation shall have been approved.
- ❖ The concrete shall have been deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the drawings or as approved by Engineer-in-Charge. Placing shall be carried out at such a rate that the concrete which is being integrated with fresh concrete is still plastic.
- ❖ The concrete which has partially hardened or has been contaminated by foreign materials shall not deposit. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approved.
- ❖ The actual sequence of construction proposed by the contractor shall be subject to Engineer-in-Charge approval before construction starts on any part of the structure, and this

sequence shall not varied without Engineer-in-Charge prior approval.

- ❖ The concrete shall be placed after it has been mixed as soon as is practicable. Once the concrete has left the mixer no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means are available.
- ❖ The time between mixing and placing, should be reduced if the mix is richer or the initial workability of the mix is lower than normal, if a rapid hardening cement or an accelerator is used, or if the work is carried out at a high temperature or exposed to a drying atmosphere . The contractor shall ensure that the delay between mixing and placing does not exceed 45 minutes under any circumstances. Any concrete which does not satisfy this requirement shall not be used.
- ❖ The concrete shall be deposited as nearly as possible in its final position to avoid rehandling. In no circumstances may concrete be made to flow along the forms by the use of vibrators. Concreting shall be carried out on as a continuous operation using methods which shall prevent separation or loss of ingredients.
- ❖ The free fall of concrete shall not be allowed to exceed 2500mm. where it is necessary for the concrete to be lowered more than this; it shall be placed through pipe, the lower end of which shall be kept in or close to the fresh deposited concrete. The size of pipe shall be not less than 225mm diameter.
- ❖ For massive concrete, concrete shall be placed in layer approximately 450mm thick. Vibrator heads shall extend into the previously placed layer.
- ❖ The workmen carrying concrete to the site, and all other workmen moving about on the reinforcement before the concrete is placed shall moved only along runway or planks placed for the reinforcement itself.
- ❖ Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by

Engineer-in-Charge, the surface will be brought to a true, hard smooth, level using a cement sand mortar in the ratio of 1 volume of cement to 3 volumes of sand. Two layer of building paper weighing 400g/m (1.3oz/sft) will then be laid flat to separate the concrete from the surface on which it is to be laid. Engineer-in-Charge d.

#### **6.3.12 CONSTRUCTION JOINTS**

- ❖ The concreting shall be carried out continuously joints, the position and arrangement of which shall be pre-determined by Engineer-In- Charge.
- ❖ The joints not shown on the drawings shall be so made and located as to least impair the strength of the concrete and shall need prior approval of Engineer-In- Charge. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset to a distance equal to twice the width of the secondary beam. Joints in walls and columns shall be at the underside of floors slab or beam, and at the top at the footings beams, panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- ❖ All reinforcing steel shall be continued across joints. Key and inclined dowels shall be provided as directed by Engineer-In- Charge. Longitudinal keys at least 40mm deep shall be provided in all joints in wall and between walls and slabs or footings.
- ❖ When the work is to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will exposed the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete on the surface.
- ❖ The hardened concrete of construction joint and of joints between footing and walls or columns, between walls or columns and beams or floors they support, joint in un-exposed walls and all others not mentioned below shall be dampened (but not saturated) immediately prior to placing of fresh concrete.
- ❖ The hardened concrete of joints in exposed work, joints in the middle of beams, and slabs and joints in work designed to

contained liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout of similar proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surface and at least 12.5mm thick on horizontal surface. The fresh concrete shall be placed before the grout has attained its initial set.

- ❖ Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brush, care being taken to avoid dislodging of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150mm in thickness, and shall be well rammed against old work, particular attention being paid to corners and close spots.
- ❖ The stop ends for movement joints or construction joints shall be made by splitting them along the lines of reinforcement or the concrete. Stop ends made of expanded metal or similar material may only be left permanently in the concrete with prior approval of Engineer-in-Charge. Where such stop ends are used, no metal may be left permanently in the concrete closer to the surface of the concrete than the specified cover to the reinforcement. Wood strips inserted for architectural treatment, shall be kernalled to permit swelling without pressure on the concrete.

### **6.3.13 EMBEDDED ITEMS**

- ❖ The material, design and location of water-stops in joints shall be as indicated in the drawings. Each piece of pre-molded water stop shall be of maximum practicable length in order that the number of end joints will be held to a minimum. Joint at intersection and at end of piece shall be made in the manner most appropriate to the material being used. Joints shall develop effective water tightness fully equal to that of the continuous water-stop material, and shall permanently develop not less than 50% of the mechanical strength of the parent section, and shall permanently retain their flexibility.
- ❖ The electric conduits and other pipes which are planned to be embedded shall not, with their fittings displace more than four percent of the area of the cross section of a column on which stress is calculated or which is required for fire protection. Sleeves, conduits, or other piles passing through floors walls,

or beams shall be such size or in such location so as not to impair unduly the strength of the construction. Such sleeves, conduits in compression in the displaced concrete, provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 50mm and are spaced at center not less than thrice their diameter on centers.

- ❖ Except when plans of conduits and pipe are approved by Engineer-In-Charge embedded pipes or conduits other than those merely passing through, shall not be larger in outside diameter than one-third the thickness of the slabs, walls or beams in which they are embedded nor shall be spaced closer than three diameters on center, nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits with-in the limitation of this section may be embedded in concrete with the approval of Engineer-In-Charge, provided they are not considered to replace the displaced concrete.
- ❖ All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.
- ❖ All contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.
- ❖ The expansion joint material, water stop and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

#### **6.3.14 CONSOLIDATION**

- ❖ 4.5.9.1 All concrete shall be consolidated by vibration, so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of form, eliminating all air or stone pockets which may cause honeycombing, pitting or planes of weakness. Internal vibrators shall have a minimum frequency of 800 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of

vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 450mm apart. At each insertion, the duration shall be sufficient to cause segregation, generally from 5 to 15 sec. a spare vibrator shall be kept on the site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process supplement if necessary by spading to work the coarse aggregate back from the formed surface.

- ❖ If there is any tendency for the mix to segregate during consolidation, particularly if this produced excessive laitance, the mix proportions shall be modified to affect an improvement in the quality of the concrete to the satisfaction of Engineer-In-Charge.
- ❖ Vibrators shall not be allowed to contact the formwork for exposed concrete surface.
- ❖ Mechanical vibrator shall be of a type suited in the opinion of Engineer-In-Charge to the particular conditions.
- ❖ Over-vibration or vibration of very wet mix is harmful and should be avoided.

### **6.3.15 CURING AND PROTECTION**

- ❖ Beginning immediately after placement, concrete shall be protected from premature drying excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimum moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of concrete. The materials and methods of curing shall be subject to approval of Engineer-In-Charge.
- ❖ For concrete surfaces not in contact with forms. One of the following procedures shall be applied immediately after completion and finishing.
  - a. Pounding or continuous sprinkling.
  - b. Application of absorptive mats or fabric kept continuously wet.
  - c. Application of water proof sheet material approved by Engineer-In-Charge.

- d. Application of other moisture retaining covering as approved.
  - e. Application of curing compound: – the compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water seems which develops after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from area to receive bonded applications.
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- ❖ Moisture loss from surface placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping forms wet until they can be safely removed. After removal, the concrete shall be cured until the end of the limits prescribed herein.
  - ❖ Curing in accordance with relevant clauses shall be continued for at least ten(10) days in the case of all concrete except concrete with rapid hardening Portland cement for which the period shall be at least three (3) days.
  - ❖ Alternatively, if tests are made of cubes kept adjacent to the structure and cured by the same methods, moisture retention 70% of the minimum specified works cube strength.
  - ❖ When the mean daily outdoor temperature is less than 5°C then temperature of the concrete shall be maintained between 10–20°C for the required curing period. When necessary arrangements for heating covering insulation or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury to concentration of heat. Combustion heater shall not be used during the first 24hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.
  - ❖ When necessary provision for windbreak, shading for spraying, sprinkling, pounding or wet covering with a light colored material shall be made in advance of placement and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

- ❖ Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5°C in any one hour or 10°C in any 24 hour period.
- ❖ During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, material or method by application of curing procedures, and by rain or running water, self-supporting structures shall not be loaded in such a way as to overstress the concrete.

### **6.3.16 WORK IN EXTREME WEATHER**

- ❖ Unless adequate protection is provided and approval is obtained concrete shall not be placed during rain. Rain water shall not be allowed to increase the mixing water nor to damage the surface finish.
- ❖ When the temperature of the surrounding air is expected to be below 4.4°C during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed shall be no lower than 12.5°C for section less than 300mm in any dimension nor 10°C for any other. When necessary concrete materials should be heated before mixing and carefully protected after placing, in general heating or mixing water alone to about 60°C may be sufficient for this purpose.
- ❖ Dependence should not be placed on salt or other chemicals for the prevention of freezing. Calcium Chloride upto 1-1/2 percent of the weight of cement may be used to accelerate the rate hardening only with prior written permission of Engineer-In-Charge. Use of calcium chloride in excess of 1-1/2 percent is harmful. No frozen material or materials, containing ice shall be used. All concrete damaged by frozen shall be replaced.
- ❖ It is recommended that concrete exposed to the action of freezing weather should have entrained air and the water content of the mix should not exceed 25 liters per bag of cement. If water or aggregate is heated above 37.8°C the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with

mixtures of water and aggregate having a temperature greater than 37.8°C.

- ❖ During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not be exceed 32°C. For massive concrete this temperature should not exceed 21.1°C. When the temperature of the concrete exceeds 32.2°C, precautionary measures approved by Engineer-In-Charge shall be put into effect. When the temperature of the steel is greater than 50°C steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or flake ice or well crushed ice of a size that will melt completely during mixing may be substituted for all or part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered. Other precaution recommended by IS: 761 (Part-I) and/or IS: 7861 (Part-II) and/or ACI standard 305-72 shall also be adopted.

### **6.3.17 TEST FOR CONCRETE QUALITY**

#### **6.3.17.1 General**

- ❖ The contractor shall provide samples of concrete for testing at Engineer-In-Charge direction. Proper facilities shall be provided for making and curing the test specimens in accordance with relevant IS standards. A competent person shall be employed by contractor whose first duty shall be to supervise all stages in the preparation and placing of the concrete. All test specimens shall be prepared and tested under his supervision and as per direction of Engineer-in-charge.

#### **6.3.17.2 Samples : As per IS :456**

Conduct strength tests on at least one test sample per concrete pour. Each test sample shall consist of no less than three concrete test cubes made from a single sample of concrete from a randomly selected batch of concrete, taken at point of discharge from mixer or truck, cured under standard conditions. One cube for each sample shall be tested at age 7 days and two at the 28 days unless otherwise directed by the Engineer-In-Charge. The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

### **6.3.17.3 Adequacy of Mix : As per IS :456**

In case of concrete mix, the appropriate strength required shall be considered to be satisfied if none of the strengths of the specimen is below the specified strength or if the average strength of the three specimens is not less than the specified strength and the difference between the greatest and the least strengths is not more than 20% of the average. When the results of test show that the strength of any concrete is below the minimum specified, Engineer-In-Charge may give instructions for the whole or part of the work concerned to be removed and be replaced at the expense of contractor. The contractor shall bear the cost of any other part of his or any other contractor's work, which has to be removed and replaced as a result of the defective concrete. If any concrete is held to have failed, Engineer-In-Charge may order the proportions of that class of concrete to be changed in order to provide the specified strength.

## **6.3.18 FINISHING OF FORMED CONCRETE**

### **6.3.18.1 General**

After removal of forms the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the drawing. When finishing is required to match a small sample furnished to contractor, the sample finish shall be reproduced on an area at least 10 sqm. in an inconspicuous location designated by Engineer-In-Charge before proceeding with the finishing the specified location.

### **6.3.18.2 Rough Form Finish**

No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Unless if required to be retained if so directed by Engineer.

Fins exceeding 6mm in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

### **Smooth Form Finish**

The form facing material shall produce a smooth hard uniform texture on the concrete.

It may be plywood, tempered concrete-form grade hard board, metal, plastic paper, or other approved material capable of producing the desired finish. The arrangement of the facing material

shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worm edge, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

### **6.3.18.3 Architectural Finishes:**

#### **Textured Finishes:**

Textured form liners may be of formed plastic sheet, wood, sheet metal, or other material designated in drawings. Liner panels shall be secured in forms by cementing or stapling, but not by methods which will permit impressions of nail heads, screw heads washers, or the like to be imparted to the surface of the concrete, unless shown otherwise on the drawings. Edges of textured panels shall be sealed to each other or to dividing strips, if specified or shown, to prevent bleeding of grout. The sealant used shall be non-staining to the surface.

#### **Applied Finishes:**

When finishes of plaster or similar trowel led materials are to be applied, the surface of the concrete shall be prepared to ensure permanent adhesion of the finish. If the concrete is less than 24 hours old, it can be roughened with a heavy wire brush or scouring tool. If the concrete is older the surface may be roughened mechanically or by etching with dilute hydrochloric acid. After roughening, the surface shall be washed free of all dust, acid, chemical retarder, and other foreign material before the final finish is applied.

#### **Rubbed Finishes:**

The following finishes shall be produced on concrete with a smooth form finish. Where smooth rubbed finish is to be applied, the forms shall have been removed and necessary patching completed as soon after the placement of the concrete as possible without compromising any structural requirements.

#### **Smooth Rubbed Finish:**

Smooth rubbed finish shall be produced on newly hardened concrete not later than a day following form removal. Surfaces shall be wetted and rubbed with carborundum brick or other abrasive until uniform color and

texture are produced. No cement grout shall be used other than the cement paste drawn from the concrete itself by the rubbing process.

### **Grout Cleaned Finish**

No cleaning operations shall be undertaken until all contiguous surfaces to be cleaned are completed and accessible. Cleaning as the work progresses shall not be permitted. Mix 1 part Portland cement and 1-1/2 part fine sand with sufficient water to produce a grout having the consistency of thick paint. White Portland Cement shall be substituted for a part of the grey Portland Cement in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.

Wet the surface of the concrete sufficiently to prevent absorption of water from the grout and apply the grout uniformly with a brush or a spray gun. Immediately after applying the grout, scrub surface vigorously with a cork float or stone and fill all air bubbles and holes. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, sack or other means. After the surface whitens from drying (about thirty minutes at normal temperature) rub vigorously with clean burlap. The finish shall be kept damp for at least 36 hours after final rubbing.

### **Cork Floated Finish**

- a) Remove forms at an early stage, within 2 to 3 days of placement where possible.
- b) Remove ties, and all burns and fins.
- c) Mix 1 part Portland cement and 1 part fine sand with sufficient water to stiff mortar.
- d) Dampen surface.
- e) Apply mortar with firm rubber float or with trowel, filling all surface voids.
- f) Apply a small amount of water with a fog spray to prevent too rapid drying of compressed mortar.
- g) Apply a small amount of water with a fog sprayer.
- h) Produce the final texture with a cork float using a swirling motion.

### **Unspecified Finisher**

If the finish is not designated in the drawings, the following finishes shall be used as applicable:

- a) Rough from finish:  
For all concrete surfaces not exposed to public view.
- b) Smooth Form finish:  
For all concrete surfaces exposed to public view.

### **Related Unformed Surfaces**

Tops of wall or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonable consistent with that of the formed surfaces. Final treatment on form surfaces shall continue uniformly across the unformed Surfaces.

## **6.3.19 REPAIR OF SURFACE DEFECT**

### **6.3.19.1 General**

- ❖ Any concrete failing to meet the specified strength or not formed as shown on drawings, concrete with surface beyond tolerances or with defective surfaces which cannot be properly repaired or patched in the opinion of Engineer-In-Charge and / or structural Engineer shall be removed and replace at contractors expenses. Engineer-In-Charge may reject any defective concrete and order it to be cut out in part or in whole and replaced at the contractor's expenses. Only in case of minor surface defects, Engineer-In-Charge may approve a surface treatment in accordance with the relevant clause.
- ❖ All ties and bolt holes and all repairable defective areas shall be patched immediately after the removal of forms.

### **6.3.19.2 Repair Of Defective Areas**

- ❖ All honeycombed and other defective concrete shall be removed down to sound concrete. The area to be patched and area at least 150mm wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand and shall than be well brushed into the surface.
- ❖ The patching mixture shall be made of the same material and of approximately the same proportions as used for the

concrete expect that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2.5 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the grey Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete as determined by a trial patch.

- ❖ The quantity of mixing water shall be not more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water until it has reached the stiffest consistency that will permit placing.
- ❖ After surface water has evaporated from the area to be patches, the bond coat shall be well brushed into the surface. When the bond coat beings to loose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface to permit initial shrinkage; it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.
- ❖ Whereas-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast concrete surfaces shall not exceed 2sqm. in each 1000sqm. of as-cast surface. This is in addition to form tie patches, if the project design permits to fall within as-cast areas.
- ❖ Any patches in as-cast Architectural concrete shall be indistinguishable from surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good color match with the concrete when both patch and concrete are cured and dry. After initial set, surface of patches shall be dressed manually to obtain the same texture as surrounding surfaces.
- ❖ Patches in architectural concrete surfaces shall be cured for 7 days. Patches shall be protected from premature drying to the same extent as the body of the concrete.

### 6.3.19.3 Tie and Bolt Holes

- ❖ After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar.

### 6.3.19.4 Proprietary Materials

- ❖ If permitted or required by Engineer-In-Charge proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendation with prior approval of Engineer-In-Charge.

## 6.3.20 CONCRETE CONSTRUCTION TOLERANCE

- ❖ Where tolerances are not stated in the specifications or drawing for any individual structure or feature maximum permissible deviations from established lines grades and dimensions shall conform to the following. The contract is expected to set and maintain concrete forms so as to ensure completed work with in the tolerance limits. These allowable tolerances shall not relieve contractor of his responsibility for correct fitting of indicated materials. Those tolerances are not cumulative.
- ❖ Variation from the plump (or as specified for sloped walls).
  - a) In the lines and surfaces of columns, piers and walls.

|    |                                         |      |
|----|-----------------------------------------|------|
| 1. | In any 3m of length or height           | 06mm |
| 2. | In any storey or 6 meters Max           | 10mm |
| 3. | Maximum for the entire length or height | 20mm |

- b) For exposed corner columns control joint grooves and other conspicuous lines.

|    |                                         |        |
|----|-----------------------------------------|--------|
| 1. | In any bay or 6 meter maximum           | 06mm   |
| 2. | Maximum for the entire length or height | 12.5mm |

- ❖ Variation from the levels or the grades indicated on drawings:
  - c) In floors, ceiling, beam soffit and in risers.

|    |                               |      |
|----|-------------------------------|------|
| 1. | In any 3 meter of length      | 06mm |
| 2. | In any bay or 6 meter maximum | 10mm |
| 3. | Maximum for the entire length | 20mm |

- d) For exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

|    |                               |        |
|----|-------------------------------|--------|
| 1. | In any bay or 6 m maximum     | 06mm   |
| 2. | Maximum for the entire length | 12.5mm |

- ❖ Variation of the entire building lines from established position in plan and related position of columns, walls and partitions.

|    |                               |        |
|----|-------------------------------|--------|
| 1. | In any bay or 6m maximum      | 12.5mm |
| 2. | Maximum for the entire length | 25mm   |

- ❖ Variation of the size and locations of Sleeves,

|    |                                   |      |
|----|-----------------------------------|------|
| 1. | Floors openings and wall opening: | 6mm. |
|----|-----------------------------------|------|

- ❖ Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.

|       |        |
|-------|--------|
| Minus | 06.0mm |
| Plus  | 12.5mm |

- ❖ Footings

- a) Variations in dimensions in plan.

|    |       |        |
|----|-------|--------|
| 1. | Minus | 12.5mm |
| 2. | Plus  | 50mm   |

- b) Misplacement or eccentricity,

1. 2 Percent of the footing width in the direction of misplacement but not more than (Applies to concrete only, not to reinforcing bars or dowels) 50mm.

- c) Reduction in thickness

1. Minus 5 percent of specified thickness.

- ❖ Variation in Steps

- a) Rise 3.0mm  
Tread.....6.0mm
- b) In Consecutive Steps  
Rise ..... 1.5mm  
Tread ..... 3.0mm

### 6.3.21 ACCEPTANCE OF STRUCTURE

#### 6.3.21.1 General

- ❖ Complete concrete work which meets all applicable requirements will be accepted subject to the other terms of the Contract Documents.
- ❖ Complete concrete work which fails to meet one or more requirements and which has been repaired to bring it into compliance will be accepted subject to the other terms of the contract documents.
- ❖ Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these specifications or in the contract documents. In this event, modifications may be required to assure that remaining work complies with the requirements.

#### 6.3.21.2 Dimensional Tolerances

- ❖ Formed surfaces resulting in concrete outlines smaller than permitted as per the tolerances defined shall be considered potentially deficient in strength and subject to the modifications.
- ❖ Formed surfaces resulting in concrete outlines larger than permitted by the tolerances defined may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other application requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this Section.
- ❖ Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is

adversely effected or misplaced items interfere with other construction.

- ❖ Inaccurately formed concrete surface exceeding the limits of tolerance and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.

#### **6.3.21.3 Appearance**

- ❖ Architectural concrete with surface defects exceeding the limitation of shall be removed.
- ❖ Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is adversely effected or misplaced items interfere with other construction.
- ❖ Inaccurately formed concrete surfaces exceeding the limits and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.
- ❖ Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only by approved methods.
- ❖ Concrete not exposed to view but of defective appearance, may be accepted at the discretion of the Engineer-In-Charge.

#### **6.3.21.4 Strength of Structure**

- ❖ The strength of structure in place will be considered potentially deficient, if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions. Concrete strength requirements not considered to be satisfied. Reinforcing steel size, quality, strength, position or arrangement at variance with the requirements of the Contract. Documents Concrete which differs from the required dimensions or location in such a manner as to reduce the strength. Curing less than that specified. Inadequate protection of concrete from extremes of temperature during the early stages of hardening and strength development. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient

strength Poor workmanship likely to result in deficient strength.

- ❖ Structure analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
- ❖ Core tests may be required when the strength of the structure is considered potentially deficient.
- ❖ If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with IS: 456.
- ❖ The concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction, if so directed by Engineer-In-Charge or shall be replaced, at the contractor's expense.
- ❖ The contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this Section.
- ❖ The Owner will pay all costs of additional testing and/or analysis which is made at his request and which is not required by specifications, or the Contract Documents.

#### **6.3.22 METHOD OF MEASUREMENT OF CONCRETE WORK**

- ❖ Unless otherwise specifically stated in the Bill of Quantities, or herein, all items shall be deemed to be inclusive of but not limited to, the following:
  - a) Labour/plant and all costs in connection therewith.
  - b) Material, goods and all costs in connection therewith, e.g. conveyance, delivery, unloading, strong, returning, packing, handling, hoisting, lowering.
  - c) All fixtures and all costs in connection therewith for pre-cast works.
  - d) Fitting and fixing materials and goods in position.
  - e) Waste of materials, and Square cutting.
  - f) Mixing, transporting, hoisting, placing in from at any level, compacting through vibration & curing etc. complete excluding the cost of formwork & its removal and also excluding cost of reinforcement.

- g) Establishment charge, overhead charges and profit.
  - h) All other expenses, charges and taxes specified in Conditions of Contract.
- ❖ Works shall be measured net as fixed in position as per drawings and instructions of Engineer-In-Charge. Each measurement shall be taken to the nearest 10mm. This rule shall not apply to any dimensions stated in descriptions.

#### **6.3.22.1 Measurement of Concrete work**

- ❖ Concrete shall be measured as executed but no deduction shall be made for the following:
  - Volume of any steel embedded in the concrete.
  - Volume occupied by water pipes, conduits etc, not exceeding
- ❖ 250sq. cm. each in cross sectional area.
  - Voids not exceeding 0.1 sqm. If any void exceeds this limit total void shall be deducted.
  - Voids not exceeding 0.3cum. in work. If any void exceeds this limit, total void shall be deducted.
- ❖ Voids, which are not to be deducted as per Section above, refer only to openings or vent which are wholly within the boundaries of measured areas. Openings or vents which are at the boundaries of measured areas shall always be subject to deduction irrespective of size.
- ❖ Junctions between strength and curved works shall in all cases be deemed to be included with the work in which they occur.
- ❖ Concrete work shall be classified and measured separately as follows unless otherwise described elsewhere:–
  - Building foundation beams, foundation slabs, footings, bases of columns, machine foundations, mass concrete etc, in cum.
  - Floor slabs on ground with floor beams in cum.
  - Walls in foundations, plinth and superstructure in cubic meter stating thickness.
  - Columns, pipes, pilasters, pillars etc, in cum.
  - Lintels, beams and brackets in cum. Suspended floors, roofs and stair landings in sqm, stating thickness.

Railings in cubic meter, square meter or linear meter stating description. Parapets, purdees and the like in cubic meter stating thickness. Jali, blocks in square meter stating thickness & description. Pre-cast concrete items shall each be enumerated except if otherwise shown in the bill of quantities, separately stating the description.

- ❖ Measurement of walls shall be taken between attached columns, piers or pilasters. The thickness of attached columns, piers or pilasters shall be taken as the combined thickness of the wall and the columns, piers or pilasters. Attached or isolated columns, piers, pilasters and the like (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as columns. Those having a length over four times the thickness and caused by openings in walls shall be classified as walls. The columns shall be measured from the top of footings/beams or floor surfaces to the under side of beams or slabs as the case may be. Where the width of the beams is less than the width of columns, the extra width at the junction shall be included in the beam.

The depth of the beams shall be measured from bottom of the slab to the bottom of the beams, except in case of inverted beams where it shall be measured from top of slab to the top of beam. The cross section below or above the slab.

#### **6.3.22.2 Measurement of Form work**

- ❖ The formwork (if separate and extra payment is specifically stated in the Bill of Quantities) shall be measured in square meter as the actual surface of the finished structure which required to be supported during the deposition of the concrete, including the upper surfaces to the work sloping more than 15 degree from the horizontal. No allowance shall be made for overlaps and passing at angles and no deduction shall be made for the following:
  - Voids not exceeding 1.0sqm.
  - Intersections of main beams with walls or columns.
  - Intersections of secondary beams with main beams.
- ❖ Formwork shall be deemed to be inclusive of, but not limited to items detailed as the following;

- Battens and struts, reversed cut strings, boltings, welding, easing, striking, removing and making good exposed faces of concrete after removal of formwork. Also yokes, Wales, sheathing, jack rods, jacks, working platforms and furnishers, scaffolds, etc.
- ❖ Forming chamfers not exceeding 50mm wide and forming splayed internal angles not exceeding 12.5mm wide shall be paid for extra.
- ❖ Temporary stop ends for constructed joints shall not be measured and paid for.
- ❖ Classification of formwork (if separate and extra payment is specifically stated in the Bill of Quantities) shall be as follows:
  - To horizontal or slopping soffit of suspended slabs, floor, staircase, landing and the like.
  - To sloping upper surface of suspended slabs, floors, roofs and the like where more 15° from horizontal.
  - To vertical or battering sides of foundations, foundation beams and slabs, ground beams, machine foundations and the like.
  - To vertical or battering sides of walls, solid balustrades and the like.
  - To vertical or battering sides.
  - To vertical or battering sides of stanchion casings, columns, piers, plasters and the like.
  - To sides and soffit of openings in walls, recesses in walls, projecting panels on walls and the like.
  - To side and soffit of horizontal or slopping beam casings, beams, brackets, lintels, staircase, strings and the like.
  - To sloping upper surface of beam casings, beams, brackets, lintels, staircase-strings and the like where more than 15° from horizontal.
  - To edges of beds, roads, footpaths, paving and the like.
  - To edges of suspended slabs, floors, roofs, landing and the like.
  - To risers of steps and staircases.
  - To sides of curbs, up stands and the like.
- ❖ Formwork to throats, grooves, chases, rebates, chamfers over 50mm wide splayed internal angles over 12.5mm wide

molding and the like shall each be measured separately in linear meter stating the size.

#### **6.3.22.3 Rate for Reinforcement**

- ❖ The rate tendered for any type of reinforcement by the contractor shall also be inclusive of the cost of wastage, binding wire etc.
- ❖ All reinforcement shall be provided in length shown in drawings and as per Specifications .If the contractor provide lengths of reinforcement which are greater than shown on the drawings no payment of extra length shall be made. Overlaps, unless clearly shown in working drawings, shall not be allowed and measured.
- ❖ The contractor shall be paid for reinforcement by weight computed from table below and from linear measurements or reinforcements actually used at Site as per the drawings, Specifications and instructions of Engineer-In-Charge. No payment shall be made wastage, contractor shall not claim for the difference in the actual weights of bars and their standard weights given below.

| <b>Dia of bar</b> | <b>Weight/m</b> |
|-------------------|-----------------|
| Mm                | Kg/m            |
| 8                 | 0.395           |
| 10                | 0.616           |
| 12                | 0.887           |
| 16                | 1.576           |
| 20                | 2.463           |
| 22                | 2.980           |
| 25                | 3.849           |
| 28                | 4.828           |
| 32                | 6.306           |
| 36                | 7.981           |

#### **6.3.23 SAMPLING, TESTING AND QUALITY ASSURANCE**

##### **6.3.23.1 General**

- ❖ The facilities required for sampling materials concrete, reinforcement, formwork, etc. in the field and in the laboratory shall be provided by the contractor. The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and / or International Standards and this specification. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer-In-Charge. Tests shall be done in the field in the presence of the Engineer-In-Charge or his authorized representative and at a laboratory, approved by the Engineer-In-Charge, and the contractor shall submit to the Engineer the test results in triplicate within three days after completion of any test.
- ❖ The contractor shall maintain records of all inspection and testing which shall be made available to the Engineer-In-Charge. The Engineer-In-Charge at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.
- ❖ Work found unsuitable for acceptance shall be removed and replaced by the contractor. The work shall be redone as per specification requirements and to the satisfaction of the Engineer-In-Charge at no extra cost to the Owner.

#### **6.3.23.2 Test for Cement and aggregates:**

If the Engineer-In-Charge desires he may order tests to be carried out on cement, sand, coarse aggregate, water etc. in accordance with the relevant Indian Standards.

1. Tests on cement 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 of heat of hydration (by experiment and by calculation) in accordance with I.S. 269.
2. Tests on sand shall include:
  - i. Sieve test,
  - ii. Test for organic impurities,
  - iii. Decantation test for determining clay and silt content,
  - iv. Specific gravity test,

- v. Test for unit weight and bulkage factor,
  - vi. Test for sieve analysis and fineness modulus.
3. 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. Test for deleterious materials and organic impurities,
    - vi. Test for aggregate crushing value.
  4. Tests 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 the contractor at an approved test laboratory at his own cost
  5. If a test cannot be done in field lab the same should be get tested by the contractor at Govt, accredited lab at no extra cost to BHEL

### **6.3.23.3 Quality Assurance Programme**

1. The contractor shall submit and finalize a detailed filed Quality Assurance Programme within 30 days from the date of award of the contract, before commencement of work at site, according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus / equipment, deployment of qualified / experienced manpower, preparation of format for record field quality plan etc.
2. On finalized field quality plan the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer-In-Charge. The testing apparatus / equipment installed in the field laboratory shall be calibrated / corrected by the authorized person as frequently as possible to give accurate testing results.
3. Frequency of sampling and testing, etc. and Acceptance Criteria as per IS 456: 2000. However, the testing frequencies set forth are the desirable minimum and the Engineer-In-Charge shall have the full authority to carryout or call for tests as frequently as he may deem necessary to

satisfy himself that the materials and works comply with the appropriate specifications.

## **6.4 PILE FOUNDATION**

### **6.4.1 SCOPE**

1. This specification covers construction of load bearing concrete bored cast-in-situ piles of appropriate diameter which can transmit the load of the structure to the soil by resistance developed at the tip by the end bearing and along the surface of the pile shaft by friction.
2. Tenderer shall be responsible for the construction of the entire pile foundation system as proposed by the department schedule of works.
3. The Tenderer shall submit his offer as per Department's schedule of work, specification and drawings.

### **6.4.2 EQUIPMENT & ACCESSORIES**

1. The equipment and accessories shall depend on type of bored cast-in-situ piles chosen for the job and shall be selected giving due consideration to the sub-soil strata, ground water condition, type of founding materials and the required penetration, manner of operation etc. for bored cast-in-situ piles percussion boring by suitable drilling rings using direct mud circulation (DMC) methods is to be adopted and size of the cutting tool shall not be less than diameter of the pile by more than 75mm. Bentonite shall be used as drilling mud and its basic properties shall conform to Appendix-W of I.S. 2911 (part/Section-2) (LR). Tremie shall be used for placing concrete in to the bore holes.

### **6.4.3 GENERAL CONSIDRATION**

1. The construction of pile foundation shall be in such a way that the load from the structure it support, can be transmitted to the soil without causing any soil failure and without causing such settlement, differential or total under permanent transient loading as may result in a structural damage and/or functional distress to the buildings.
2. When working near the existing structures, any damage to such structures shall be good at no extra to the owner. The contractor shall, therefore, take adequate care to avoid any damage to the existing structures.

3. In case of deep excavation adjacent to piles proper shoring or other suitable arrangement shall be done at no extra cost to the owner. To guard against the lateral moment of soil or releasing the confining soil stress.
4. As per loading details, piles will be required to withstand vertical load axial or otherwise horizontal load associated with moments. Axial load from a pile should be transmitted to the soil through skin friction along the shaft and end bearing at its tip. A horizontal load shall be transmitted to the sub-soil by horizontal sub-grade reaction generated in the upper part of the pile shaft.

#### **6.4.4 COARSE AGGREGATE, FINE AGGREGATE AND WATER**

1. Coarse aggregate fine aggregate and water shall conforming to IS: 456 (LR) and IS: 383 (LR).

##### **6.4.4.1 Concrete**

Concrete to be used for the pile shaft shall be as specified. Materials and method of manufacture for cement concrete shall, in general, be in accordance with the method of concrete under the condition of pile installation. Consistency of concrete mix for cast-in-situ piles shall be suitable to the method of installation of pile s. concrete mix be so design as to have a homogeneous mix having a flowable character consistent with the method of concreting of pile, the slump of concrete shall range between 150mm to 180mm depending on the method/manner of concreting. Minimum cement content shall be 400kg per cubic meter, in case of pile where concreting is done under water or drilling mud using methods other than tremie 10% extra cement over the required for the design grade of concrete at specified slump shall be used subjected to minimum quantities of cement specified above . For mix design, manufacture, placing etc. specification for cement concrete given hereinafter shall be referred.

#### **6.4.5 WORKMAN SHIP**

##### **6.4.5.1 Control of piling installation:**

Bored cast in situ pile shall be installed by employing suitable drilling rigs using a combination of bailer and a suitable chisel with DMC method. Bore hole shall be stabilized by bentonite as drilling mud and concreting shall be done by using of tremie only.

##### **6.4.5.2 Control of alignment:**

Piles shall be installed as accurately as possible as per the designs and drawing. Greater care should be exercised in respect of installation of single pile or piles in two pile groups. The piles shall be installation vertically with a tolerance as stipulated by IS: 2911 (part-I/section-2) (latest revision), pile shall not deviate by more than 75 mm OR  $D/6$  whichever is less in case of piles having diameter less

than 600mm, 75mm or  $D/10$  whichever is more in case of pile having diameters more than 600mm from their designed positions at the working level. In the case of a single pile in a column, position tolerance should not be more than 50mm or  $d/6$  whichever is less (100mm in case of piles having diameter more than 600mm). In case of piles deviation beyond these limits, contractor shall carry out necessary remedial measures duly approved by the owner at no extra cost, piles that are deviated to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pile cap or plinth beams, the pile should be replaced or supplemented by one or more additional piles at no extra cost to the BHEL. A minimum length of two/three meters of temporary guide casing up to piling platform shall be inserted in each bored pile after completion of bailer driving. Additional length or temporary casing may be used depending on the condition of the strata, ground water level etc. Founding level:

The bore hole shall be advanced by the chisel and direct mud circulation method after installation of guide casing till the required founding level is reached. The founding level shall be as per the drawings and as directed by the engineer-in-charge.

In case, drilling mud within the hole stabilizes a bored pile, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. The cleaning of the hole shall be ensured by careful operation of boring tool and / or flushing of the drilling mud through the bottom of the hole by tremie for half an hour minimum. In case, a hole is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, wherever practicable, be determined by suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud. The concreting operations should not be taken up when the specific gravity of Bentonite slurry is more than 1.2.

- ❖ In addition to the normal precautions to be taken in tremie concreting, the following requirements shall be applicable to the use of tremie concrete in piles:
- ❖ The concrete should be coherent, rich in cement (not less than 400 kg/cum) & of slump not less than 150mm.
- ❖ When concreting is carried out under water, a temporary casing should be installed to the full depth of the bore hole or 2 or 3 M into the top stratum, so that fragments of ground cannot drop from the sides of the hole into the concrete as it is placed.
- ❖ The hopper & tremie should be a closed type embedded in the placed concrete, through which water can't pass.

- ❖ The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it 01 with a steel plate of adequate charge to prevent mixing of concrete and water. However, the plug should not be left in the concrete as lump.
- ❖ The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal of the pipe is surged to discharge the concrete.
- ❖ The pile should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile, to prevent the laitance from, being entrapped within the piles.
- ❖ All tremie tubes should be scrupulously cleaned after use.
- ❖ Normally concreting of the piles should be uninterrupted. In the exceptional case of interruption of concreting, but which can be resumed within 1 or 2 hours, the tremie shall not be taken out of the concrete. Instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for easy displacement of the partly set concrete.
- ❖ If the concreting cannot be resumed before final set of concrete already placed, the pile so cast may be rejected.
- ❖ In case of withdrawal of tremie out of the concrete either accidentally or to remove a choke in the tremie may be reintroduced in the following manner to Prevent pregation of laitance or scum lying on the top of the concrete already deposited in the bore.
- ❖ The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug should be introduced in the tremie. Fresh concrete of slump between 150mm and 175 mm should be filled in the tremie, which will push the plug forward and will emerge out of the tremie displacing the laitance /scum in its way. When tremie is buried by about 60 to 100cm, concreting may be resumed.
- ❖ During installation bored cast-in-situ piles, the convenience of installation may be taken in to account while determining the sequence of piling in a group.

- ❖ The top of concrete in a pile shall generally be brought above the cut-off level, up to ground level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap. When concrete is placed by tremie method concrete shall be cast to the piling platform level at ground level to permit overflow of concrete for visual inspection.

#### **6.4.5.3 Defective pile:**

In case defective piles are formed, they shall be removed or left in place whichever is convenient without affecting, performance of the adjacent piles or the cap as a whole without any extra cost to the owner. Additional piles shall be provided to replace them as directed.

Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting of the Pile cap and plinth beam if the deviations are beyond the permissible limit.

During chipping of the pile top manual chipping may be permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting.

After concreting the actual quantity of concrete shall be compared with the average obtained from observation actually made in the case of a few piles initially cast. If the actual quantity is found to be considerable less, special investigations shall be conducted and appropriate measures taken.

#### **6.4.6 GENERAL REQUIREMENTS APPLICABLE TO ALL TYPES OF TESTS**

- a) Pile test may be carried out on a single pile or a group of piles as required. In case of pile groups, caps will be provided such that the required conditions of actual use are fulfilled.
- b) Generally the load application and deflection observation will be made at the pile top.
- c) In particular cases where upper part of pile is likely to be exposed later on due to scour, dredging or otherwise then capacity contributed by that portion of the pile during load test shall be duly accounted for. The pile groups in these conditions shall be tested without their cap resting on the ground.

- d) The test should be carried out at cut-off level wherever practicable, otherwise suitable allowance shall be made in the interpretation of the test results/test load if the test is not carried out at cut-off level.

#### **6.4.7 VERTICAL LOAD TEST (COMPRESSION) : As per IS : 2911 (Part IV)**

##### **6.4.7.1 General**

In this type of test, compression load is applied to the pile top by means of a hydraulic jack against rolled steel joist or suitable load frame capable of providing reaction and the settlement is recorded by suitably positioned dial gauges. Maintained load method as given in 5.9 should be used for determination of safe load.

##### **6.4.7.2 Preparation of Pile Head**

The pile head should be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement should be bent suitably and the top finished smooth and level with plaster of Paris or similar synthetic material where required. A bearing plate with a hole at the centre should be placed on the head of the pile for the jacks to rest.

##### **6.4.7.3 Application of Load**

The test should be carried out by applying a series of vertical downward incremental load each increment being of about 20 percent of safe load on the pile

##### **6.4.7.4 Reaction**

The reaction may be obtained from the following:

- a) Kentledge (Kentledge Deadweight used for applying a test load to a pile.) Placed on a platform supported clear of the test pile. In case of load test below under-pinned structure, the existing structure if having adequate weight and suitable construction may serve as kentledge. The centre of gravity of the kentledge should generally be on the axis of the pile and the load applied by the jack should also be coaxial with this pile.
- b) Anchor piles with centre-to-centre distance with the test pile not less than 3 times the test pile shaft diameter subject to minimum of 2 m. If the anchor piles are permanent working piles, it should be ensured that their residual uplift is within limits. Care should be exercised to ensure that the datum bar supports are not affected by heaving up of the soil.
- c) Rock anchors with distance from the nearest edge of the piles at rock level being 2 times the test pile shaft diameter or 1.5 m whichever is greater.

- ❖ The reaction to be made available for the test should be 25 percent more than the final test load proposed to be applied.
- ❖ Settlement — Settlement shall be recorded with minimum 2 dial gauges for single pile and 4 dial gauges of 0.01 mm sensitivity for groups, each positioned at equal distance around the piles and normally held by datum bars resting on immovable supports at a distance of 3 D (subject to minimum of 1.5 m) from the edge of the piles, where D is the pile stem diameter of circular piles or diameter of the circumscribing circle in the case of square or non-circular piles.
- ❖ The safe load on single pile for the initial test should be least of the following:
  - a) Two-thirds of the final load at which the total displacement attains a value of 12 mm unless otherwise required in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible.
  - b) 50 percent of the final load at which the total displacement equal 10 percent of the pile diameter in case of uniform diameter piles.
  - c) However routine test shall be carried for a test load of at least one and half times the working load; the maximum settlement of test loading in position being not exceeding 12 mm.
- ❖ The safe load on groups of piles for initial test shall be least of the following:
  - a) Final load at which the total displacement attains a value of 25 mm unless otherwise required in a given case on the basis of nature and type of structure, and Two-thirds of the final load at which the total displacement attains a value of 40 mm.
  - b) However, routine test shall be carried for a test load of at least equal to the working load; the maximum settlement of the test loading in position being not exceeding 25 mm.

#### **6.4.7.5 Maintained Load Method**

This is applicable for both initial and routine test. In this method application of increment of test load and taking of measurement or displacement in each stage of loading is maintained till rate of displacement of the pile top is either 0.1 mm in first 30 minutes or

0.2 mm in first one hour or till 2 h whichever occur first. If the limit of permissible displacement as given in 5.8.2 or 5.8.3 is not exceeded, testing of pile is not required to be continued further. The test load shall be maintained for 24 h.

#### **6.4.8 LATERAL LOAD TEST ON PILES : As per IS :2911 (Part IV)**

The test may be carried out by introducing a hydraulic jack with gauge between two piles or pile groups under test or the reaction may be suitably obtained otherwise. If it is conducted by jack located between two piles or groups, the full load imposed by the jack shall be taken as the lateral resistance of each pile or group. The loading should be applied in increments of about 20 percent of the estimated safe load.

The next increment should be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes.

Displacements shall be read by using at least two dial gauges of 0.01 mm sensitivity spaced at 30 cm and kept horizontally one above the other on the test pile and the displacement interpolated at cut-off level from similar triangles where cut-off level is unapproachable and for approachable cut-off level, however, one dial gauge placed diametrically opposite to the jack shall directly measure the displacement. Where, it is not possible to locate one of the dial gauges in the line of the jack axes, then two dial gauges may be kept at a distance of 30 cm at a suitable height and the displacement interpolated at load point from similar triangles. NOTE — One of the methods for keeping dial gauge on pile surface is to chip off uneven concrete on the side of the pile and to fix a piece of glass 20 to 30 mm square. The dial gauges tips shall rest on the central portion of the glass plate.

The safe lateral load on the pile shall be taken as the least of the following:

- a) Fifty percent of the final load at which the total displacement increases to 12 mm;
- b) Final load at which the total displacement corresponds to 5 mm; and
- c) Load corresponding to any other specified displacement as per performance requirements.

NOTE — The displacement is at the cut-off level of the pile.

Pile groups shall be tested under conditions as per actual use in the structure as far as possible.

#### **6.4.9 PULL-OUT TEST ON THE PILES**

- ❖ Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull out set up.

❖ NOTE

One of the methods for pull out tests that may be used is where hydraulic jack is made to rest on rolled steel joist(s) resting on two supports on the ground. The jack reacts against a frame attached to the top of the test pile such that when the jack is operated, the pile gets pulled up and the reaction is transferred to the ground through the supports which are at least  $2.5 D$  away from the test pile periphery (where  $D$  is pile stem diameter of circular piles or diameter of the circumscribing circle in the case of square piles). The framework can be attached to the pile top with the reinforcement bars which may be threaded or to which threaded bolts may be welded. As an alternative it is sometimes preferable to use a central rod designed to take pile load and embedded centrally in the pile to a length equal to the bond length load required. It will have threads at top for fixing it to the framework. For larger loads the number of rods may have to be more and depending on the set-up these may be put in a line or in any other symmetrical pattern. For routine tests, the framework is normally attached to the reinforcing bars but a central rod may also be used in case the upper portion of the pile is required to be built up.

- ❖ The test pile shall have adequate steel to withstand pulling. In some cases, in order to allow for neck tension in a pull out test, it may be necessary to provide additional reinforcement in the piles to be tested.
- ❖ The pull out load increments and consequent displacement readings shall be read as in the case of vertical load test.
- ❖ The safe load shall be taken as the least of the following:
  - a) Two-thirds of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible uplift, and
  - b) Half of the load at which the load-displacement curve shows a clear break (downward trend).
- ❖ The initial test shall be carried out up to twice the estimated safe load or until the load displacement curve shows a clear break (down-ward trend).

- ❖ Routine test shall be carried out to one-and-a-half times the estimated safe load or 12 mm total displacement whichever is earlier.

#### **6.4.10 RECORDING OF DATA AND PRESENTATION**

- ❖ The pile test data essentially concerns three variables, namely, load, displacement and time. These are to be recorded sequentially for the tests under consideration and recorded in a suitable tabular form along with the information about the pile.
- ❖ The data may be suitably presented by curves drawn between the variables and safe loads shown on the graphs. Load displacement curve should be an essential part of presentation.

#### **6.4.11 MODE OF MEASUREMENT OF PILES:**

- ❖ The piles shall be measured in running meters from the cut off level to the bottom of pile. The rates quoted for piling work shall include the cost of concrete, hire charges of tools and plants, bailing out of water, breaking of pile heads to required cut-off level and shape, breaking, cutting through and removing the boulders or any other obstructions, if met with before reaching the required founding level etc. complete and as specified.

### **6.5 WATER PROOFING**

#### **6.5.1 GENRAL**

It is intent of this specification to secure a completely water tight structure guarantee for at least ten (10) years. The contractor shall provide all materials, labor, Plant, Water proofing work shall be commenced only after the surface is prepared, cleaned free of dust and foreign matters, Inspected and approved. The compressed air shall be used for effective leaning of all surfaces. The vents and other projections through the roof shall be made absolutely secure before flashing. Roof and sunken area water proofing (Brick Bat Coba)

The brick bat coba treatment shall be got done from an approved agency. The surface should be prepared and construction joint if any are to be raked and cleaned. The cement slurry mixed with approved chemical compound is to be spread on the e surface so as to fill the undulation and other porous areas. Plaster in specified thickness in cement mortar mixed with approved chemical in CM

1:4 (1 cement: 4 coarse sand) is laid over the prepared surface. A layer of brick bat coba is laid over the mortar to required slope. The joint between the brick bats should be kept 15–25mm wide. These joint be filled with CM 1:4(1 cement: 4 coarse sand) mixed with specialized chemical compound. Curing is done continuously for two day. The top surface should be finished smooth with 20mm thick cement mortar (mixed with specified quantity of approved chemical) the curing of the treatment should be done for two weeks.

The side wall shall be provided with cement plaster 1:4 mixed with specialized chemical compound unto a height of 300mm or as specified. A gola with brick bats shall be provided and finished with CM 1:4 mixed with approved chemical compound. The wax shall be cured continuously for two weeks. The work shall be executed by a specialized agency duly approved by the Engineer– in–Charge.

### **6.5.2 TAPECRETE OR EQUIVALENT WATER PROOFING**

All the chasings or cuttings in the floors and walls shall be carried out prior to the commencement of the treatment. The prepared surface then shall be plastered with 10 mm thick average cement mortar 1:3 mix al as per manufactures specifications. The plastering shall be carried out throughout the sunken portion and carried up to all sides of the walls up to ceiling level.

The specialist then shall carry out TAPECRETE or equivalent water proofing treatment comprising of 3 coats of tapecrete with 1st coat of TAPECRETE mixed with white cement in proportion of 1:2 (1 part TAPECRETE: 2 white cement), 2nd coat of TAPECRETE mixed with white cement and silica sand in proportion of 1:2:1+ (1TAPECRETE: 2 white cement: 1+ silica), 3rd coat of TAPECRETE mixed with white cement in proportion of 1:2. After the first coat of TAPECRETE all corners, junction, joints of pipes and masonry to be sealed with Epoxy putty. The treatment is laid underneath and behind all pipes. The specification on vertipcals is taken 150mm above the finished floor level and to full height where tubs/ wash basin and WC are being fixed. Treatment for sunken portion pshall be measured and paid for on sqm. Basis for the TAPECRETE work carried out. Plastering to walls, and concrete item will be measured and paid for separately.

### **6.5.3 MEASUREMENT**

All measurement will be for roof area only as measured on plain and no additional area for vertical tucking/embedding up to 300mm height from top of finish will be included for payment. The

contractors' rate will be inclusive of these, to make the work compete.

## **6.6 STRUCTURAL STEEL WORK**

### **6.6.1 FABRICATION**

Workmanship shall be of first – class quality, shall follow the methods normally accepted as being the best practice and shall comply generally with the relevant practice.

### **6.6.2 TEMPLATES**

Extensive use of templates shall be made. The templates shall be steel bushed where consider necessary by the Engineer-In-Charge. In case actual members are used as templates for drilling similar pieces, it will be at the discretion of the Engineer-In-Charge to decide whether such pieces are fit to be incorporated in the finished structure. The contractor shall arrange for Corresponding parts of each unit manufactured from the same drawings to be changeable, as far as economic manufacturing conditions permit, and shall advice the Engineer-In-Charge of precise arrangements made in this respect.

### **6.6.3 STRAIGHTENING**

All materials shall be straight and, if necessary, shall be straightened and/or flattened by pressure, unless required to be of curvilinear form and shall be free from twists. Heating of rolled Sections and plates for purpose of straightening shall not be permitted. Limited straightening may, however be effect by local applications of heat with a gas torch. The sharp kinds of bends shall be cause for rejection.

### **6.6.4 CUTTING**

The gas-cutting shall preferably be done by a mechanically guided torch. Hand flame cutting may however be permitted where the part being cut shall not be subjected to substantial tensile stresses and only when approved by the Engineer-In-Charge. The gas cut edges shall be free of gouges. Any gouges that remain after cutting shall be removed by grinding. The gas cutting shall normally only be permitted for mild steel, though gas cutting of high tensile be permitted, provided special care is taken to leave sufficient metal to be removed by machining so that all metal that has been hardened by flame is removed. The rolled section shall be sawed or flame out to length. The small plate pieces like gussets may be sheared or

cropped to size, sawing, sharing and cropping shall be clean, reasonably square and free from any distortion. The edges shall be ground afterwards, where found necessary by the Engineer-In-Charge.

#### **6.6.5 HOLING**

Punching shall not be resorted to unless previously approved by the Engineer-in charge. Where Punching is permitted, the hole shall be punched 3mm less in diameter the required size and reamed after assembly to the full size. In any case the thickness of material punched shall not be greater than 16mm. The holes through more than one thickness of materials (e.g. compound stanchions and girder Flanges) shall be drilled after assembling and tightly clamping or bolting the members together. The various thickness shall be separated burrs formed by the drill removed and the members reassembled. The holes for rivets or bolts shall not be more than 1.6 mm larger in diameter than the nominal diameter of the bolt. The holes found to be out of the alignment shall be corrected by redrilling and if necessary oversized Bolts (or rivets) shall be provided in such cases. The drifting or holes is not permissible. Gas-cutting of holes shall be strictly prohibited

#### **6.6.6 BOLTING**

All turned and fitted bolts shall be parallel throughout the barrel and within the tolerance of only  $\pm 1/8$ mm unless otherwise specified and faces of heads and nuts bearing steel work shall be machined. All such bolts shall be provided with washer not less than 6mm thick, so that when the Nut is tightened, it shall not bear on the unthreaded body of the bolt, in all cases, where the full Bearing areas of the bolt is to be developed, the threaded portion of the bolt should not be within the thickness of the parts bolted together. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts.

#### **6.6.7 WELDING STANDARD**

Relevant Indian codes shall be followed in respect of the welding procedure. Detail of certain welds shall be prepared by the contractor for the Engineer-In-Charge approval.

#### **6.6.8 WELDING PROCEDURE**

Welding shall be done with the structural in flat position in a down hand manner wherever possible adequate care shall be taken to

maintain the correct arc length, rate of travel, current and polarity for the type of electrode and nature of work. Welding plant capacity shall be adequate to carry out the Welding procedure laid down. Adequate means of measuring the current shall be available either as 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 insure that the weld metal can be fully and satisfactorily deposited throughout the length and thickness of all the joints, that distortion and shrinkage stresses are reduced to a minimum and that the welds meet the requirements of quality specified.

#### **6.6.9 WELDING WORKMANSHIP PREPARATION OF FUSION FACES**

The fusion faces shall be cut by shearing machine or gas cutting and later dressed by filing or grinding, so that they shall be free from irregularities such as fins and tears as would interfere with the deposition of the specified size of weld to be the cause of defects. Welding of joints shall be undertaken only on approval by the Engineer-In-Charge of the alignment, levels, etc. of the members to be jointed. Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials which may affect the quality of the weld. Surface shall be wire-brushed vigorously or machined/ground, if found necessary by the Engineer-In-Charge.

Gaps for joints Parts to be fillet welded shall be brought in as close contact as possible and in no event shall they be separated by more than 1.6mm the size of the fillet weld shall be increased by the amount of the gap. A gap greater than 3mm wide shall be packed with MS shims and the weld increased by the amount of the gap. Abutting parts to be butt welded shall be carefully aligned together with a gap of 3mm.

The gaps shall be set by means of suitable jigs and the steelworks held firmly in position by clamps or bolt until the welded joint is sufficiently rigid to be freed of clamps without causing strain or distortion. Fillet Welds The minimum leg length of a fillet weld as deposited should be not less than the specified size and the throat thickness as deposited should not be less than that tabulated below.

#### **6.6.10 ANGLE BETWEEN THROAT**

| Fusion faces | Thickness |
|--------------|-----------|
| Degree       | mm        |
| 60-90        | 18.0      |
| 90-100       | 16.0      |
| 101-106      | 16.0      |
| 107-113      | 14.0      |
| 114-120      | 12.0      |

In no case should a concave weld be deposited without specific approval of the Engineer-In-Charge, unless the leg length is increased above the specified , so that the resultant throat thickness is as great as would have been obtained by the deposition of a flat. Welding sequence shall be follow to avoid needless distortion and minimize shrinkage stresses. After each run of weld, all slag shall be removed and final run shall be protected by clean boiled linseed oil till approved.

#### **6.6.11 BUTT WELDS**

All main butt welds shall be full penetration butt-welds, unless otherwise specified. The ends of the welds shall have full throat thickness. This shall be obtained on all main welds by use of extension pieces adequately secured on either side of the main plates. Additional metal remaining after the removal of the extension pieces shall be remove by machining or by other approved means, and the ends and be cut and re-welded. Where serious under cutting occurs, additional weld material shall be deposited to make good the reduction.

#### **6.6.12 PROTECTION**

Immediately after infection and approval, all site welds and the surrounding surfaces shall be painted to protect the metal.

#### **6.6.13 CONNECTIONS**

All connection shall be precisely shown on the drawing and shall be strong enough to develop the full strength of the member and to approval of the Engineer-In-Charge. The shop connection shall be riveted or welded and site connection shall be bolted using black steel bolts. Hydraulic pneumatic machines, preferably of the steady pressure type, shall be used for driving all rivets. Rivets shall have concentric heads and shall completely fill the holes through which they are driven.

All contact surface of steel of steel and bolts shall be entirely free of paint, lacquer or other protective substance. All shop connection shall be welded as approved by the Engineer-In-Charge

#### **6.6.14 MACHINING**

The column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close butted over the whole section.

In column caps and bases, the ends of the shafts together with attached angles, channels etc. after welding together, shall be accurately machined so that the parts connected butt over the entire surfaces of contact.

Care shall be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced unduly in thickness in machining. Where sufficient gussets or welding are provided to transmit the entire loading, the column ends need not be machined. Ends of all ring stiffeners shall be machined or ground to fit tightly at both top and bottom.

#### **6.6.15 SHOP ERECTION**

Steel work shall be temporarily shop-erected completely or as directed by the Engineer-In-Charge, so that the accuracy of fit may be checked before dispatch. Due notice shall be given to the Engineer in all cases when the work is ready for inspection and the assembly shall not be dismantled until it has been inspected and approved by the Engineer-In-Charge.

#### **6.6.16 ASSEMBLY**

All steel work which is bolted together shall be in perfect contact over the whole surface. All bearing stiffener shall bear tightly at top and bottom without being drawn or caulked. Where two bolted surfaces are to be in permanent contact after assembly each shall be thoroughly scrapped to remove loose scales, dirt, burrs, and any foreign matter and cleaned and dried and a heavy coat of red oxide zinc chrome or other approved paint applied after cleaning and drying. The surface shall be brought together while the paint is still wet. Drilling done during assembly shall not distort the metal or enlarge the holes. Holes that must be enlarged due to mismatching shall be reamed. Poor matching of holes shall be a cause for rejections.

#### **6.6.17 DISPATCH OF MATERIALS, STACKING AND HANDING**

The contractor shall deliver the fabricated steel work to the site as far as possible in the same sequences as that which he wishes to follow for erection. Dispatches should be scheduled to avoid cluttering up the site. The contractor shall ensure that steel work is not damaged due to careless or haphazard stacking. The steel work shall be stacked at site in such a manner that it shall be free from dirt. Stacking shall, as per as practicable be done in the sequence of erection but heavy members shall not be stacked on top of light ones. Arrangement shall always be made at the time of handling to make sure that damage to steel works is avoided. In the event of damage due to improper stacking and careless handling, the damaged piece will be rejected and shall be replaced by the contractor at his own expense.

#### **6.6.18 METHOD OF ERECTION**

All structural steelworks shall be erected in accordance with relevant Indian codes. The contractor shall prepare and submit to the Engineer-In-Charge's Representative details of erection procedures at least four weeks before commencement of steel erection. The steelworks shall be erected true and plumb and temporary bracing or staging shall be introduced wherever necessary to ensure that the structure is not over stressed and to take care of all erection loads. Attachment of Such temporary steelwork like bracing and staging shall remain in position till the structure is stable and self supporting are permanently making the structure stable and self supporting are permanently bolted or welded to the satisfaction of the Engineer-In-Charge. After removal of temporary steelworks, the permanent structure shall be made good of the complete satisfaction on the Engineer-In-Charge. Crain rails shall be as detailed on drawings, designed to permit horizontal adjustment of rails. Rail joints shall be provided with splice bars. Loose columns base plates and bearing plates for beams and similar members shall be support on wedges, shims or by other means and grouted to proper elevation and level before erecting the supported members. When lifting and fitting steelworks in position, care shall be taken that the parts there of are not strained, twisted, bent or damaged, in any manner whatsoever. Should any part be strained, twisted, bent or damaged, it shall be reinstated in a manner approved by the Engineer-In-Charge by gentle heating and bending and not by hammering. Any parts that are badly damaged shall be replaced with new materials at the contractor expense. No Permanent bolting or welding shall be done until proper alignment has been obtained. Any errors in the fabrication which prevent the proper assembly and

erection of the parts with moderate amount of reaming, chipping, or cutting is likely to render the steel work for rejection, unless corrective action is taken, only if permitted by the Engineer-In-Charge. Any expenditure involved in executing the corrective measures shall be borne by the Contractor.

#### **6.6.19 ERECTION CLEARANCES AND TOLERANCES**

Unless specified otherwise, the underside of base plates shall be within plus or minus 3mm from the elevation shown on the drawings. The lateral deviations of the base-plate shall not exceed 6mm from the centre line. Alignment of individual beams, girders, etc, shall not deviate more than plus minus 6mm from location given on the drawings.

#### **6.6.20 PAINTING**

##### **6.6.20.1 Items to be painted**

All structural steelworks and metals including floor plates, floor gratings, stair treads handrails, brackets and steel inserts shall be painted, except if otherwise specified. No black bolts, nuts, washers etc. shall be painted before assembly or erection. They shall be thoroughly cleaned and dipped into boiling linseed oil and after erection painted as specified herein.

##### **6.6.20.2 Standard**

The operations, workmanship, schedules and equipment for painting shall generally comply with the requirement of relevant Indian codes. All painting shall be carried out by brushing. Spray and roller application of paint shall not be allowed without the written permission of Engineer-In-Charge. No painting shall commence until the cleaned surface are approved by the Engineer-In-Charge. No exterior or exposed painting shall be carried out under adverse weather conditions such as rain, extreme humidity, dust storms, etc,

##### **6.6.20.3 Shop Painting**

After inspection of the fabricated work and before leaving the shop, all steel work shall be thoroughly cleaned by approved means to remove all rust, loose mill scales, drift and other foreign material. Greasy and Oily surfaces shall be cleaned with solvent and dry rags unless otherwise specified, the contractor shall not flame clean or pickle the steelworks prior to painting. Painting shall generally be done immediately after the cleaning and to thoroughly dry surfaces. All steel work shall be given one coat of approved metal primer, applied thoroughly and evenly and well-worked into joints and

other open spaces. All rivets, bolts (except high strength bolts) nuts, washers, etc, shall be thoroughly cleaned and dipped in boiled linseed oil. Parts inaccessible after assembly shall be given two coats of shop paints of approved epoxy paint of different shades. Machine finished surfaces shall be protected against corrosion by a suitable coating. Where galvanized surfaces are to be painted, they shall be cleaned and washed with a solution of copper sulphate before the application of the first coat of primer.

#### **6.6.20.4 Site painting**

After erection, the whole of the steelworks shall be thoroughly cleaned and all dirt, marks, grease and over spills of primer paint removed. Areas where the shop coat has suffered damage or deterioration shall be cut back and repainted with primer in the same manner as in the shop. All exposed surfaces of metal bolt heads and correction left unpainted in the shop shall be similarly treated. After this preliminary work of making good has been approved by the Engineer-In-Charge, all surface shall be thoroughly cleaned and when dry, two finishing coats of approved paint shall be applied. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied.

### **6.6.21 INSPECTION**

#### **6.6.21.1 General**

The supply delivery and erection of structural steel work shall be accordance with the best practice and shall conform in full with the drawings and this specification. No part of the work shall be treated as approved unless so informed by the Engineer-In-Charge in writing. The Engineer-In-Charge and this representative shall have free access at all reasonable times to those parts of the contractor's work which are concerned with the fabrication of the steel work and those portions of the site where assembly or erection is being reasonable help required in connection with the inspection and testing of the work. This shall include supply free of charges, of all labor, gauges templates and tools required.

#### **6.6.21.2 Place of Inspection**

Unless specified otherwise, inspection of steel work shall be made at the place of manufacture, prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work. Stage inspection, during progress of work, shall be carried out during final assembly and erection at site.

#### **6.6.21.3 Inspection of Welds**

All welding shall be subject to inspection and tests as specified by the Engineer-In-Charge. Engineer-In-Charge may require test plates to be prepared as per relevant Indian codes. Defective welding shall be redone/made good by the contractor at his own expense.

At main butt welds, these may be taken from plates cut from extensions of the main plates and fixed as extension at the butt joints, so that the direction of rolling is parallel to that of the main plates and the welds continuous with the main welds. The Engineer-In-Charge may require radiographic or other non-destructive examinations to be carried out. If such tests give satisfactory results the costs of the same shall be borne by the Owner. If welding is found defective the cost of such tests shall be borne by the contractor.

#### **6.6.21.4 Acceptance**

The steelworks shall be free from all faults. Any work found defective or which is not in accordance with the drawings and this specification may be rejected. No structure or part of the structure once rejected shall be resubmitted for inspection, unless the Engineer-In-Charge considers the defect as rectifiable. Defects shall be made good according to the procedure laid down by the Engineer-In-Charge. No work shall be undertaken, painted or packed until it has been inspected and passed.

### **6.7 BRICK MASONRY**

#### **6.7.1 GENERAL**

Brick Masonry shall consist of all work required in connection with constructing brick masonry at locations shown on drawings including, but not limited to, furnishing brick, Portland cement and sand for mortar and all other materials, and mixing, placing brick masonry as per bill of quantities.

#### **6.7.2 MATERIAL**

- a. All Portland cement for mortar shall be furnished by the contractor and shall conform to the applicable requirements specified in the section "Plain and Reinforced concrete".
- b. All sand for mortar shall be furnished by the contractor and shall conform to the applicable requirements for sand specified in the section "Plain and Reinforced concrete".
- c. All water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable

quantities of silt, organic matter, alkali, salts and other impurities, and will be tested and approved by the Engineer-In-Charge as per guidelines of IS:456

### **6.7.3 MORTAR**

- a. Mortar of all brick masonry, except where otherwise directed by Engineer-In-Charge, shall consist of one part cement to six part of damp loose mortar sand by volume for brickwork 230mm and above. For brick piers, half brick walls, honey-combed brickwork and hollow (cavity) walls, the mortar mix shall consist of one part cement and four parts of sand. The quantity of water shall be just sufficient enough to produce proper consistency for the intended use. Where directed and approved by the Engineer-In-Charge, hydrated lime putty, shall be added to the mortar for increased workability. The putty shall, however, not exceed 25% by volume of the dry cement.
- b. Method and equipment used for mixing mortar be such as will accurately determined and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer-In-Charge. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. The mixer shall be thoroughly cleaned and washed at the end of each day's work.

### **6.7.4 BRICK**

- a. All bricks shall be specify made from good brick earth, free from saline deposits and shall be sand modified. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges parallel faces and of deep red or copper color. The first class bricks shall be homogeneous in texture and emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and nodules of lime.

First class brick in an oven dried condition shall not absorb more than  $\frac{1}{5}$  of its weight of water when immersed for one hour in water at 21 to 27 °C and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be 10.5N/sqmm, and shall no result shall fall below 5.0N/sqmm.

The brick in general shall confirm to the requirements of IS: 1077.

- b. All bricks shall be manufactured by the Trench Kiln method or other standard methods approved by the Engineer-In-Charge. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel, coarse sand, roots or other organic matters salts shall not exceed 0.3% and calcium carbonate shall not exceed 2.0%.
- c. The molds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. The size ready for use shall be 229x112x70mm and shall weigh between 3.2 to 4.2kg. All bricks shall have a "Frog" 6.25mm deep on one face.
- d. The average absorption of bricks, when immersed in cold water for 24 hours shall not be more than 20 % by weight for bricks.
- e. The bricks will be tested for compressive strength, water absorption, efflorescence and size by project manager before approving the supplier and every time the source of supply is changed. The project manager at his discretion may also carry out routine tests from time to time.

#### **6.7.5 PLACING**

The methods and equipments used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixer mortar. Bricks shall not be placed during rain sufficiently heavy or prolonged to wash the mortar from the brick. Mortar which became diluted by rain shall be removed and replaced before continuing with work. All bricks to be used in brick masonry shall be moistened with water for three to four hours before they are used. The chosen method of wetting shall ensure that all bricks are thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surfaces when they are placed in the brick masonry. Bricks shall be laid "Frog" upward with mortar joint and English bond as shown on the drawings or as directed by the Engineer-In-Charge. Both bed vertical joints shall be 6mm in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical

joints in alternate course shall be directly over one another. The exterior faces of the wall shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and the finishing the joint with a pointing tool. Horizontal joints shall be struck to form weathered joints and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repainted.

All half brickwork shall be reinforced with 2 no. 6mm dia. MS round bars or equivalent reinforcement at every fourth course. The reinforcement cleaned of rust and loose flakes with wire brush, shall be embedded thoroughly in cement mortar at every fourth course. It shall be cast in or securely fixed to the adjoining columns or walls, in a manner approved by the Engineer-In-Charge.

#### **6.7.6 CURING AND REPAIR**

All brick masonry shall be water cured and shall be kept wet for least seven days by an approved method which will keep all surfaces continuously wet. Water used for curing shall meet the requirement of these specification for water used in the manufacture of bricks.

If, after the completion of any brick masonry work, the brick is not in alignment or level, or does not confirm to the lines and grades shown on drawings, or shows a defective surface, it shall be removed and replaced by the contractor at his expense unless the Engineer-In-Charge grants the permission, in writing to patch or replace the defective area.

#### **6.7.7 SCAFFOLDING**

The contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expenses. The scaffolding which is unsafe in the opinion of the Engineer-In-Charge shall not be used until it has been strengthened and made safe for use of workmen. The cost of scaffolding etc. shall be included by the contractor in the unit rate for masonry items.

Damaged, masonry from scaffolding or from any other objection shall be repaired by the contractor at his own cost.

### **6.7.8 TOLERANCE**

The brick work shall be erected plumb and true to line at level with the maximum variation in any story height of any length of wall being one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be  $\pm 3\text{mm}$ .

### **6.7.9 MEASUREMENT AND PAYMENT**

#### **6.7.9.1 General.**

Except otherwise specified herein or elsewhere in the contract documents, no measurement and payment will be made for the under maintained specified works related to the relevant items of the bill of quantities.

Cutting & chiseling of masonry whenever required.

Cement sand mortar used in laying bricks including wastage.

Curing & repairing the masonry work.

All joint reinforcing bars, reinforcing anchor bars and dove tail anchors.

#### **6.7.9.2 Measurement**

Measurement of acceptable completed works of brick masonry will be made on the basis of cubic meter for full brick or more thickness and sqm. for half brick work provided and installed in position as shown on the drawing or as directed by the Engineer-In-Charge.

#### **6.7.9.3 Payment**

Payment will be made for acceptable measured quantity of brick masonry on the basis of unit rate per cum quoted in the bill of quantities and shall be constitute full compensation for all the works related to the items.

### **6.7.10 SAMPLING TESTING AND QUALITY CONTROL**

#### **6.7.10.1 General**

The contractor shall carry out all sampling and testing in accordance with the relevant Indian standards and/or international standards and shall conduct such tests as are called for by the Engineer-In-Charge. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the direction of the Engineer-In-Charge Tests shall be done in the field and at a laboratory approved by the Engineer-In-Charge. Tests shall be done in the field and at a laboratory approved by

the Engineer-In-Charge and the contractor shall submit to the Engineer-In-Charge, the test result in triplicate within three days after completion of a test. The engineer may, at his discretion, waive off some of the stipulations given below, for small and unimportant operations.

Material/work found unsuitable for acceptance, shall be removed and replaced by the contractor. The works shall be redone as per specification requirements and to the satisfaction of the Engineer-In-Charge.

#### **6.7.11 Quality Assurance Programme**

- ❖ The contractor shall submit and finalize a detailed filed quality assurance programme within 15 days from the date of award of the contract according to the requirements of the specification. This shall include setting up to a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, field quality plan etc. on finalized field quality plan, the owner shall identify, customer hold points beyond which work shall not proceed without written approval from the Engineer-In-Charge.
- ❖ Frequency of sampling and testing including the methods for conducting the tests shall be in accordance with relevant stipulation of IS codes. The testing shall be done at site. The testing frequency set forth are the desirable minimum and the Engineer-In-Charge shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. Some of the type tests and performance tests which are not included in the specifications shall be carried out at the manufacturer's premises or at an independent Government approved.
- ❖ All masonry shall be built true and plump within the tolerances prescribed as below. Care shall be taken to keep the perpends properly aligned.
  - a. Deviation in vertically in total height of any wall of a building more than one storey in height shall not exceed  $\pm 12.5\text{mm}$ .
  - b. Deviation from vertical within a story shall not exceed  $\pm 6\text{mm}$  per 3m height.

- c. Deviation from the position shown on the plan of any brickwork more than one story in height shall not exceed 12.5mm.
- d. Relative displacement between load bearing walls in adjacent stories intended to be in vertical alignment shall not exceed 6mm.

Deviation of bed joint from horizontal in any length up to 12mm shall not exceed 6mm. and in any length over 12m it shall not exceed 12.5mm total.

Deviation from the specified thickness of bed-joints, cross-joints or perpends shall not exceed  $\pm 3$ mm.

## **6.8 FLOORING AND CLADDING**

### **6.8.1 METAL HARDENER FINISH**

This will consist of a sub-grade 38mm thick of cement 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate, 12.5mm nominal size) and a topping (incorporating iron particles) to bond with the sub-grade while the letter is green.

#### **1. Thickness**

The total average thickness including the finish shall be 50mm (38+12), IN case only topping is supplied to existing base PCC/RCC then the thickness of the topping shall be 12mm.

#### **2. Material**

The hardening compound shall be uniformly graded and properly treated iron particles, free from non-ferrous metal impurities, oil, grease, sand, soluble alkaline compound or other injurious materials, when desired by the Engineer, actual samples shall be tested.

#### **3. Mix**

Proportion of the metallic hardner shall be as specified or as indicated by the manufacturer. However, in absence of any such direction, 1 part of metallic hardner shall be mixed dry with 4 parts of cement by weight. To this mixture, 6mm nominal size stone chips shall be added in proportion of 1 part cement mixed with hardner to 2 parts of stone chips by volume and uniformly mixed Minimum quality of water shall be added to make it workable.

#### **4. Laying**

The concrete sub-grade floor shall be laid and leveled up to the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still green within about 3 hours of laying. Finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete sub-grade. Just when the initial setting starts the surface shall be finished smooth with a steel trowel. The finished floor shall be cured for 7 days by keeping it wet.

### **6.8.2 GLAZED/CERAMIC TILE/VITRIFIED TILE**

#### **1. General**

##### **Scope**

The work covered by this section consists of furnishing all plants, labour, equipment appliances and materials and performing all operations in connection with installation of glazed/ceramic tile walls, floor, base of kitchen, include mortar screed beds and backing.

##### **Codes and standards IS codes**

##### **Submittal**

Submit two finished sheets of ceramic wall and floor tile, each approximately 300mm square; indicating the pattern and color selected by the Engineer-In-Charge, with grouted joints.

#### **2. Product**

##### **Tile and accessories**

Manufacturer's acceptable or equivalent contingent upon product compliance with the specifications.

##### **Floor tile:**

Glazed/Ceramic Floor Tile unglazed; natural clay; 0.5 percent water absorption; as shown on drawing cushioned edges; non-slip surface where detailed or scheduled; colors to be selected by the Engineer-in Charge.

##### **Wall tile:**

Glazed/Ceramic wall Tile; glazed; natural clay; 0 percent to 0.5 percent water absorption; as shown on drawing cushioned edges;

colors to be selected by the Engineer-In-Charge supply with matching cove base.

**3. Beds and backing:**

Standard cement mortar; screeded beds and backings for tile work; mixed and proportioned by volume, as follows:

|                 |                |
|-----------------|----------------|
| Portland Cement | 1 part         |
| Sand            | 2.5 to 4 parts |
| Lime            | 0.25 parts     |

Water      Clean, fresh and free of deleterious substances.

**4. Adhesive and grout.**

Proprietary tile adhesives and joint grouts; suitable types as required and recommended by the manufacturer for specific tile work locations.

**6.8.3 Measurement and payment**

Work under this section shall be measured in square meter of wall and floor area, partition shall be measured on both faces. The rate for all item of work under this section shall cover the cost of finishing all materials, labour, scaffolding, laying, curing, finishing, and appliances at site and performing all operations at any height in accordance with drawings, Bill of Quantities and as specified. The rate shall include the cost of furnishing and installing metal fixings, providing all assistance to other trades for built in items to the satisfaction of Engineer-In-Charge.

**6.8.4 IPS FLOORING.**

It shall consist of an under bed and topping laid on an already laid and matured concrete.

It shall have thickness of 50mm for horizontal and 18mm for vertical surfaces. All junctions between vertical and horizontal work shall be rounded neatly to a uniform radius of 25mm.

**Topping Mix.**

The topping shall be floating coat of neat cement.

**Laying.**

The IPS flooring including the under bed shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has

already taken place. The maximum area of each panel shall be 1.2m x 1.2m.

A cement grout shall be applied and worked in to the surface to receive the finish, the under bed then laid, compacted and leveled to proper grade with a screed or float. The requisite slope as shown in the drawings of directed by the Engineer shall also be provided in under bed only maintaining a minimum thickness of 25mm at the edges. The topping shall be applied evenly on the under bed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. After the surface is sufficiently set, the finish shall be moist for 7 days.

## **6.9 FINISHES**

### **Scope**

The work covered by this section of the specifications, consists of furnishing all materials. Plant, labour, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting hollow cap, Block concrete works, gate, frames, structural steel works, steel or other drainage pipes, valves, louvers wall, ceiling and such surfaces as shown on the drawings and/or as directed by the Engineer-In-Charge. The scope of this section of specification is covered with detailed specification is covered with detailed specifications as laid down herein..

### **Code and standards**

Latest editions of relevant Indian Standards are relevant to these specifications wherever applicable

### **6.9.1 GENERAL**

Except as otherwise specified, all painting shall be applied in conformity with IS code as applicable to the work.

The contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work and structural steel work. Metal surface against which concrete is to be placed shall be furnished shop-painted and shall be cleaned prior to being embedded in Except as otherwise specified, all concrete and plastered surface are to be painted.

The Engineer-In-Charge shall furnish a Schedule of colors for each area and surface. All colors shall be mixed in accordance with the manufacturer's instructions.

Colors of priming coats (and body coats where specified) shall be lighter than those of finish coat. The Engineer-In-Charge shall have unlimited choice of colors.

Samples of all colors, stains and finishes shall be prepared in advance of requirements so as not to delay work and shall be submitted to the Engineers-In-Charge for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer-In-Charge's satisfaction, without additional expense to the Owner. Samples shall be on separate 600mm x 600mm x 3mm tempered hardboard panels.

#### **6.9.2 DELIVERY, STORAGE AND CONTAINER SIZE**

Paint shall be delivered to the site in sealed containers which plainly show the type of paint color formula of specification number, batch number, quantity, date of manufacture, name of manufacturer and instructions for use. Pigmented paints shall be supplied in containers not larger than 20 liters. All materials shall be stored under cover in a clean storage space which shall be accessible at all times to the Engineer-In-Charge. If storage is allowed inside the building floors shall be kept clean and free from paint spillage.

#### **6.9.3 MATERIAL FOR PREPARATION OF SURFACE**

These are extrudable, spreadable or sprayable compounds consisting of binders and fillers as follows.

##### **a. Glue filling Compounds**

Constituents

- \* Glue, possibly with added dispersions (i.e. very fine particles of solid pigment)

- \* Pigments

##### **b. Stoppers**

Stoppers shall be based on glazier's putty when used on general woodwork, litharge and glue for varnished timbers and wax for polished surfaces.

#### **6.9.4 SEALERS**

Masonry and Other Porous Surfaces

**a. Primer sealer**

These shall be based on an alkali-resistant substance suitable for sealing powdery residues on surfaces prior to the application of emulsions or oil paints.

**b. Fluosilicate Sealers**

These shall be Fluosilicate acid or solutions of fluosilicic acid or solutions of salts of fluosilicic acid.

- to reduce alkalinity in lime and cement plaster surfaces.
- to reduce absorbency.
- to combat efflorescence and mold formation.
- for surface consolidation of lime and cement plaster
- for sealing of smoke and water stains

### **6.9.5 DISPERSION SEALERS**

These shall be sealer based on plastic dispersions or paints for sealing surfaces containing tar or bitumen, as well as rust smoke and water stains.

### **6.9.6 PRIMERS**

**a. Masonry and other porous Surfaces Constituents:**

- Boiled linseed oil according to BS 242 (only on chemically neutral surface)
- Synthetic resin lacquers suitably thinned.

**b. Wood and Wood Based Surfaces. These shall be**

- Blue stain inhibiting primers on a synthetic resin basis
- Wood primers on a nitrocellulose basis.

**c. Steel Surfaces**

- Corrosion Protection Primers Constituents:
- Pigments (e.g. red lead , zinc chromate lead silicon chromate)
- Binders (e.g. boiled linseed oil, alkyd resin lacquers, polyurethane lacquers)
- Fillers (e.g. barrettes)

### **6.9.7 MATERIAL FOR PAINTING**

All materials shall be acceptable, proven, top grade products of reputed manufacturers as approved by the Engineer-In-Charge.

Colors shall be pure, non- fading pigment, mildew-proof, sun-proof, finely ground in approve medium. Colors used on plaster and

concrete surfaces shall be lime- proof. All materials shall be subject to the Engineer-In-Charge's approval.

All non-corrosive durable coating and primers for structural steel, metal work shall be the best available of its type and shall be approved by the Engineer-In-Charge.

Plastic paint of specified finish shall be used as shown on drawings and shall be of the best quality. Prior approval of the paint quality, shade and color shall be obtained from the Engineer-In-Charge.

Materials for wax polish shall be subject to approval of the Engineer-In-Charge prior to use in the works.

Approved quality cement wash paint shall be used for painting the exterior of the structures or other surfaces as directed by the Engineer-In-Charge.

Bitumen painting shall consists of bitumen grade 10/12 and it shall be used in foundations where specified 2 coats of painting shall be applied.

Fire resistant painting shall be proprietary painting material to be applied in conformity with the recommendations and instructions of the manufacturers. Where mentioned on drawings exposed steel structure members shall have a spray-on asbestos fire coating on the interior, the coating shall have 90 minute rating and shall be applied as per the manufacturer's recommendations and instructions after the Engineer-In-Charge's approval.

#### **6.9.8 SURFACE PREPARATION**

All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted and polished by the use of a clean wiping material following the solvent cleaning , the surface shall be cleaned by scraping, chipping, blasting, wire brushing or other effective means as approved –by Engineer-In-Charge.

In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, re- cleaning shall be done by the contractor at no additional cost.

Surfaces of stainless steel, aluminum, bronze, and machined surfaces adjacent to metalwork being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.

All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust dirt etc., by scraping, wire brushing as directed by the Engineer-In-Charge. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 5 liters per 32.81 sft./10sqm. No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer-In-Charge.

### **6.9.9 Execution**

#### **6.9.9.1 General**

##### **a. Preparation of Materials**

The manufacturer's instructions are to be followed when tinning paints and in no case shall thinners exceed 5% by volume. Paints shall be stirred regularly unless otherwise recommended by the manufacturer.

Most paints are provided in a condition ready for use. It is important that only those additions or admixtures are made which are expressly permitted on the container labels or in the manufacturer's literature. Materials shall not be used when either the shelf-life or the pot-life has been exceeded. All partially used paint packages, such as kegs, drums and tins shall always be properly resealed so as to avoid deterioration of the remaining material.

##### **b. Cleanliness**

In all painting operations, including preparatory work, cleanliness is essential. Completed works shall be protected by rags or polythene sheeting during painting operations. Rags and waste which have become saturated with drying oil or paint e.g., when cleaning utensils, are liable to ignite spontaneously. They shall not be left about, but shall be taken away immediately. Paint containers shall be emptied and cleaned with a suitable solvent each day after use. Brushes, knives and other utensils shall be cleaned after use and be appropriately stored so as to be maintained in clean condition.

Paste or size left on pails or in brush stocks can prove fertile ground for the propagation of molds and woodwork when the contaminated articles are again used.

##### **c. Weather Conditions**

No exterior or interior painting, finishing or sealing shall be carried out during periods of rain, sandstorm or high winds unless the areas concerned can be protected until the paint has dried.

#### 6.9.10 Application

Materials covered by processing instructions provided by the manufacturer are to be used according to these instructions. Paint, lacquer and varnish applications and coatings may be applied by hand or mechanically.

Paint, lacquer and varnish application and coatings must adhere firmly and appear as a uniform finish and proper flow in the case of varnish paints, using the specified materials in accordance with the following performance instructions. Varnish & lacquer applications are to have a high gloss finish as satin finish or matt. If filling is necessary, the surfaces are to be covered all over with filling compound and smoothed down. When two or more coats must be dry before the following coat is applied. This does not apply to wet-on-wet techniques.

Dry times stated by the manufacturer must be observed. Standing time must not be exceeded. In doors, windows and skirting, work must be finished off with sharps and straight lines. Coating materials containing solvents which are flammable or are injurious to health must be stored and applied in a manner which befits their special properties.

Remainders of coating materials are to be disposed of in such a manner that they can not cause any damage, they must not be emptied into sinks, closet, pans and the like. All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workmanlike manner, leaving the finished surface free from drips, ridges, waves, laps and brush mark. All paints shall be applied under dry and dust free conditions. Unless approved by the Engineer-In-Charge paint shall not be applied when the temperature of the metal or of the surrounding air is below 45 degrees Fahrenheit. Surfaces shall be free from moisture at the time of painting.

All primary paint shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measure shall be taken to prevent aggregation of the paint in the container during painting operation.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of spraying equipment.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that

shall be inaccessible after installation shall be completely painted prior to installation.

Two coats of cement wash shall be applied to exterior surfaces where shown on drawings in accordance with the manufacturer's instructions or as directed by the Engineer– In–Charge.

Only as much material shall be mixed as can be used up in one hour. Over thinning shall not be permitted. After the first coat the surfaces shall be soaked evenly four or five times and the second coat shall be applied after leaving for at least over night.

All steel works including steel doors, windows and ventilators shall be painted as follows:

- a. Internal surfaces of door frames and double shin shutter shall be given one coat epoxy.
- b. All other external surfaces of door frames and shutter shall be given two coats epoxy primer and finished with two coats of epoxy enamel paint.
- c. External surfaces in contract or embedded in concrete shall not be painted, greased or oiled at all. However, these surfaces shall be given a cement wash after blast cleaning.
- d. Film thickness of each coat of paint and other relevant installation regarding its application shall be as specified by the paint manufacturer.

Three coats of plastic emulsion paint of the approved make and shade shall be applied to all specified interior surfaces as per manufacturer's instructions or as directed by the Engineer–In–Charge.

Where specified on the drawings, three coats of polyvinyl distemper of approved make shade and color shall be applied to interior surfaces as per manufacturer's instructions and directions of the Engineer–In–Charge.

### **6.9.11 Polishing**

#### **6.9.11.1 Polishing and Waxing**

After fine sanding by a skilled operator, one coat of polish shall be rubbed in by hand using a cloth or pad, be allowed to dry and buffed up with worn fine sandpaper or steel wool to remove raised

grain. A second coat of polish shall then be applied. When this is dry a paste wax shall be applied sparingly, be allowed to dry and then buffed up by machine or by hand. Subsequent coats of wax may be applied as necessary.

#### **6.9.11.2 False Ceiling:**

##### **a) Aluminium panel/ lineal false ceiling system**

Aluminium panel (coil coated) lineal / panel ceiling system shall consist of rolled formed, coil coated aluminium pre-coated magnesium alloy (Al-Mg AA 5050) carrier and panels of minimum 0.9 mm and 0.5 mm thickness respectively. The ceiling system shall be of approved pattern. The system shall be complete with edge cover profile, special panels, carrier splice, etc. The carrier shall be suspended from roof by MS flats, angles or 4g or heavier galvanized tie wire hangers having special height adjustment clips made from spring steel at maximum spacing of 1.2 m c/c both ways as per manufacturer's specification.

##### **b) False ceiling with Mineral Fiber Tiles**

False ceiling shall consist of regular or tapered edge lightweight mineral fiber tiles of size of 600 x 600 or 600 x 1200 or as per architecture design with minimum tile thickness of 15 mm. Exposed surface shall be semi perforated (fine fissured) with nominal depth of perforation as 4 mm. The material shall be humid resistance up to 95% RH with fire performance of class 0/class 1 (as per BS 476) and shall not sag for 10 years under 95% RH.

Metal suspension system shall conform to ASTM C-635 and shall be hot dipped M.S. galvanized (grade 180 as per IS: 277). Nominal size

of T-section shall be 24 x 38 mm for main runners and 24 x 30 mm or 24 x 25 mm cross runners. 24 mm wide exposed flange surfaces shall be permanently colour coated. Suspension system shall be as per manufacturer's specification.

##### **c) Gypsum plasterboard, used for false ceiling, shall be minimum 12mm thick conforming to IS: 2095.**

Suitable cutouts shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc. Illumination and A.C. ventilation grills in these areas shall match with the overall aesthetics.

False ceiling used shall have good impact resistance, durability, high humidity resistance, fire performance shall be in accordance to British Standards BS: 476 as well as aesthetic.

Glass wool insulation shall be laid on top of false ceiling panels in Main Control room, Administrative areas where good acoustic is required.

Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.

#### **6.9.12 Acid-proof tiling material**

Acid-proof tiles shall be of ceramic unglazed vitreous tiles 20 mm thick as per IS-4457, mortar conforming to IS-4832 (Part I). The tiles shall be scored or dovetailed at the back for improving the bonding properties and to give a good key.

The tiles shall be jointed with synthetic resin cement such as –

- i) Polyester resin
- ii) Phenolic resin
- iii) Furanic resin.

The finished tile when fractured shall appear fine-grained in texture, dense and homogeneous. Tile shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in the dimensions shall be within the limits specified in the respective IS Code.

The size and thickness of tiles for use in the flooring/retaining walls shall be as specified /approved by Engineer.

## **7.0 DISMANTLING OF WORK**

This specification covers the general requirements, procedure, application of tools and safety precautions for demolition and dismantling work for Renovation and Maintenance work. It deals with dismantling of RCC equipment foundation, floor slab, grade slab, rammed morum/brick & boulders under grade slab, columns, pedestals, structural steel and earth work, pipes etc as per requirement. It also covers supply, delivery of all necessary materials, labour, scaffolding, tools, tackles, equipment and everything that is necessary for the satisfactory completion of the job on schedule.

**Note–:**

**Dismantling/ Demolishing / removal of mechanical and electrical equipment is not included in the scope of work.**

### **7.1 GENERAL**

**7.1.1** The contractor should visit the site and acquaint himself about site conditions and thoroughly understand the scope and nature of the work. The contractor is also required to submit the proposed execution plan and schedule of demolishing and dismantling and list of all available tools (manual & power tools) along with his quotation.

**7.1.2** Dismantling/Demolishing needs to be vibration-less or with minimum vibrations so that adjacent structure is not affected. Use of chemical like crackamite is desirable. Crackamite chemical is used for expanding and splitting RCC by drilling holes and putting chemical in the holes thereby facilitating breaking and splitting.

**7.1.3** Dismantling/Demolishing shall also requires power driven concrete saw, diamond wire saw, concrete splitting m/c and other such tools as may be required for successful & safe execution of work.

**7.1.4** Entire work of demolishing and dismantling shall be meticulously planned. Prior to start of work, the Contractor shall examine all the drawings, locations, adjoining structures, available working space etc. and then prepare his action/execution plan for demolishing and dismantling and submit to the Engineer-in-charge for his review. Comments, if any, shall be taken care by the

Contractor and execution of the work shall be done based on the approved execution plan.

**7.1.5 The contractor is required to submit complete proposal with sequence-wise operations.**

**7.1.6** The term Dismantling implies carefully taking up or down and removing without damage to adjoining parts of the structures. Apart from this specification, the demolition and dismantling of structures (part or whole) shall be in compliance with all statutory safety regulations. This shall consist of dismantling one or more part of the structures as specified or shown on the drawings. Prior consent and approval of the Engineer-in-charge shall be obtained in writing before starting any dismantling work. Any restriction imposed regarding working hours shall also be followed by the Contractor.

**7.1.7** All materials obtained from dismantling/demolition operations shall be the property of Owner and shall be kept in safe custody until handed over to the owner.

**7.1.8** Alternate arrangement is to be made by contractor to maintain continuity and proper functioning of the service line to the satisfaction of customer and immediately bring to the knowledge of Engineer-In-Charge.

**7.1.9** Before the start of dismantling work, the contractor shall ensure that all the mechanical & electrical equipment's or parts are removed from the foundation/structure planned for dismantling.

## **7.2 SAFETY PRECAUTIONS**

**7.2.1** The contractor shall adopt standard practices and procedures, use appropriate tools and workmen at all stages of work to guard against accidents to ensure complete safety.

**7.2.2** CONTRACTOR shall provide necessary passageways as may be required, safety belts, helmets, safety shoes, lights and other safety equipment's/gadgets as per standard rules of local authorities and for protection to his men and materials.

**7.2.3** Necessary propping, shoring and/or underpinning shall be provided for the safety of the adjoining structure which is to be left intact before dismantling and demolishing is taken up. The work shall be carried out in such a way that no damage is caused to the adjoining property/structure.

**7.2.4** Wherever required and/or instructed by Engineer-in-charge temporary enclosures made out of GI sheet, fencing, including danger lights etc. shall be provided by the Contractor and got approved by the Engineer-in-charge before start of work to prevent accidents and to restricts entries.

**7.2.5** Necessary precautions shall be taken to keep the dust -nuisance down as and when necessary.

**7.2.6** Contractor must ensure the availability of adequate fire fighting equipment / arrangements before starting actual demolishing/dismantling works. These facilities shall be made available throughout the entire operation of demolition and dismantling of structures.

**7.2.7** All equipment's, pipes, fittings and instruments, underground utilities etc. located in the vicinity shall be protected by suitable means, as directed by the Engineer-in-charge, during demolishing & dismantling operations.

**7.2.8** Roads and working spaces shall be kept free of any debris/dismantled materials at the end of day's work.

**7.2.9** Dismantled elements/components shall not be dropped from a height or thrown from a distance. Dismantling of elements fixed by screws/bolts/hooks etc. shall be done by taking out the fixtures with proper tools only. Such fixtures may be allowed to be cut by sawing or flame cutting, in the event of their being struck up due to corrosion etc. however the decision of Engineer-in-charge in this regard shall be final and binding. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any condition.

**7.2.10** A large part of demolition safety involves proper dress and the use of appropriate safety accessories, especially when using power tools.

- Do not wear loose clothing that can get caught in machinery

- Wear safety helmet all the time during work.
- Remove any jewelry that can interfere with safe machinery operation
- Wear safety goggles or glasses with side protection
- Use a face mask in dusty applications, ear plugs when the site is especially noisy or for extended periods of work
- Heavy work gloves should be worn to protect against the steady vibration of power tools and the heat that can be generated, especially in the bit
- Wear steel-toed safety shoes or boots.

### **7.3 PROCEDURE**

**7.3.1** The contractor shall plan appropriate application of tools and machinery as per requirement of work with consent of the Engineer-in-charge. It is expected that the contractor shall employ the required power operated tools like concrete saw, Diamond wire saw, chemicals like crackamite for dismantling of RCC. Reinforcing steel shall also be recovered from dismantled RCC and shall be cleaned, stacked and be handed over to the Engineer-In-Charge.

**7.3.2** Demolition and dismantling shall be restricted to the extent shown on drawings and as directed by the Engineer-in-charge.

**7.3.3** Dismantling shall be commenced in a systematic manner. All elements shall be carefully removed without causing any damage. All materials which are likely to be damaged by dropping from a height shall be carefully dismantled first. The dismantling articles shall be passed by hands or proper tools depending upon requirements where necessary and lowered to the ground and not thrown or torn off by force. The materials then properly stacked as directed by the Engineer -in-charge.

**7.3.4** Demolition of any structure shall be carried out in a proper sequence, as approved by the Engineer -in-charge.

**7.3.5** Blasting in any form shall not be permitted.

### **7.4 STACKING & DISPOSAL**

**7.4.1** Any serviceable material, obtained during dismantling or demolition such as bricks, stones, reinforcement bars, structural steel, sheeting etc. shall be separated out, cleaned

and stacked properly in separate lots with in the plant boundary as directed by the Engineer-in-charge.

**7.4.2** Contractor will make his own arrangements for dumping/ disposal of unserviceable materials outside the plant boundary.

## **7.5 MEASUREMENT & PAYMENT**

**7.5.1** Measurement of all works shall be taken prior to start of demolishing/ dismantling works.

**7.5.2** Payment for dismantling of reinforced and Plain Cement Concrete shall be made on the basis of actual volume in cubic meters (cu.m.) so demolished. Thickness of flooring & plaster shall be included in measurement.

**7.5.3** Payment shall also be made for reinforcement removed, cleaned and stacked as per specifications on basis of weight of reinforcement steel.

**7.5.4** Payment for demolishing of rammed morum, boulders & excavation of earthwork shall be made on the basis of actual volume in cubic meters (cu.m.) as existing.

**7.5.5** Payment of dismantling of structural steel shall be made on the basis of weight (MT) of the structure/components being dismantled. Assessment of weight shall be done as per the standard structural handbook specifications or as per the direction of Engineer-in-charge.

**7.5.5** Incase a parallel lump sum proposal is submitted, the payment schedule shall be worked out based on item wise progress of work.

**7.5.6** In all cases the rate for demolishing/dismantling shall include:

Necessary safety measures, Supply of all labour, tools & tackles, propping, underpinning, scaffolding, handling, cutting, straightening, scraping and cleaning of reinforcement bars and other embedment, equipment, consumables, unbolting, cutting (by sawing or flame cutting) of gussets/plates/bolts/hooks/welds, including cleaning, sorting out and stacking of all serviceable materials & handling over to OWNER, disposal of all unserviceable material, clearing the site, etc. all complete as specified and directed by the Engineer-in-charge.