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TECHNICAL SPECIFICATIONS

## SPECIFICATION FOR LAND CUSTOMS STATION WORK

1. The specification for various items of work shall be same as specified for such items in the Road pavement Manual and Road Maintenance Manual, ROYAL GOVERNMENT OF BHUTAN 2005 and in addition MORT&H Specification for Road and Bridge Works, fifth revision, published in August 2013, New Delhi, India.
2. The inclusions and exclusions from quoted rates are specified in the details of each item of work in the specifications and the Bill of Quantities. In case there is no specific mention of a particular detail, the mode of specification as prescribed in MORT&H SPECIFICATIONS for such an item shall be followed.
3. In the event of contradiction between the MORT&H specifications referred to above and this Contract document, the provisions of this Contract document shall prevail.

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100 GENERAL**101 INTRODUCTION**

These specifications shall apply to Land Customs Station works as are required to be executed under the Contract or otherwise directed by the Engineer-in-Charge (herein after referred to as the Engineer). In every case, the work shall be carried out to the satisfaction of the Engineer and conform to the location, lines, dimensions, grades and cross-sections shown on the drawings or as decided by the Engineer. The quality of materials, processing of materials as may be needed at the site, salient features of the construction work and quality of finished work, measures for safety of workers and public and traffic arrangements during execution shall comply with the requirements set forth in succeeding sections. Where the drawings and specifications describe a portion of the work only in general terms, and not in complete detail, it shall be understood that only the sound engineering practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer are to be fully complied with.

A list of Indian Roads Congress (IRC) Specifications and recommended Codes of Practice which have been referred in these Specifications is given at Appendix-1. The latest edition of all Specifications/Standards/Codes of IRC till 60 (sixty) days before the final date of submission of the tender, shall be adopted.

In case of any conflict or inconsistency in the provisions of the applicable Specifications/Standards/Codes of IRC, provisions contained in these Specifications shall apply.

The Technical Specifications and Bill of Quantities shall be read in conjunction with the other Contract Documents. All the documents and drawings are to be regarded as mutually explanatory. In the event of any discrepancy or assumed discrepancy being found between them, the Contractor shall immediately inform the Engineer of the matter in writing and the Engineer will issue his instructions in the matter in accordance with the Conditions of Contract including the Environmental Codes of Practice.

As soon as possible after the letter of acceptance and before signing of the Contract Agreement, the Contractor shall submit in triplicate the Program and particulars required under Clause 25 of the General Conditions of Contract. The Contractor shall provide all information needed for fulfilment of the Program and required in accordance with the Conditions of Contract including the sequence in which the Contractor intends to work including implementation of quality assurance plan. In the Program and particulars the Contractor shall provide details of how the Contractor proposes to carry out the Works including:

- (1) The Program for the construction and completion of the works shall be established using CPM/PERT techniques or equivalent. The Program shall be



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detailed enough to give, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials, procurement/rental/leasing of equipment, progress milestones, fabrication of special products/equipment if any and their installation and testing, and for all activities of the Engineer that are likely to affect the progress of work. It shall be prepared so as to permit revisions, inclusion of additional detail and regular updates as the work progress. The Program shall also include the Contractor's general requirements for any road closures pursuant to Clause 105 of the Technical Specifications to be agreed in principle with the Engineer. Such agreement shall not relieve the Contractor of his responsibility to obtain specific approval for each closure or series of closures. In all respects the Contractor shall pay particular attention to seasonal weather pattern including rainfall and snow conditions (if any), and the construction sequencing while preparing the Program and executing the Works in accordance with this. Any proposal for night working shall also be stated in the Program.

- (2) A detailed Statement of Construction Management Procedures the Contractor proposes to adopt.

Once approved by the Engineer the Program and Statement of Construction Management Procedures shall be incorporated as per of the Contract Agreement and shall be strictly adhered to unless any alterations are found to be necessary during the construction of the Works and are confirmed in writing by the Engineer. If the Contractor requests a change in the sequence and such change is approved by the Engineer, the Contractor shall have no claim as per the Conditions of Contract for delay arising from such revisions to the Program.

The Contractor shall update all activities in accordance with the Conditions of Contract on the basis of the decision taken at the periodic site review meetings or as directed by the Engineer.

The Contractor shall furnish, at least 14 days in advance, his site work program of commencement of item of work, the method of working he intends to adopt for various items of work such as site clearance, construction for embankment, sub-base, base, surfacing, culverts, retaining walls, and such other items for which the Engineer demands the submission of the method of working. The Contractor shall provide information regarding the details of the method of working and equipment he proposes to employ and satisfy the Engineer about the adequacy and safety of the same. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will, however, rest on the Contractor, irrespective of any approval given by the Engineer.

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**102 INSURANCE**

The Contractor shall provide and maintain the insurance cover in accordance with Clause 13 of the General Conditions of Contract from an approved insurance company from the start date to the end of the Defects Liability Period.

**Measurement and Payment**

Payment for insurance cover shall be made at actual cost from provisional sum of the contract price and it shall be the full and the final compensation to the Contractor as per Clause 116 of the Technical Specifications.

**103 DEFINITIONS**

The words like Contract, Contractor, Engineer (synonymous with Engineer-in-charge), Drawings, Employer, Government, Works and Work Site used in these Specifications shall be considered to have the meaning as understood from the definitions of these terms given in the General Conditions of Contract.

The following abbreviations shall have the meaning as set forth below:-

BSB	: Bhutan Standard Bureau
BIS	: Bureau of Indian Standards
BOQ	: Bill of Quantities
CBR	: California Bearing Ratio
IRC	: Indian Roads Congress
IS	: Indian Standard published by the Bureau of Indian Standards
AASHTO	: American Association of State Highway and Transportation Officials
BSR	: Bhutan Schedule of Rate
ASTM	: American Society of Testing and Materials
QA	: Quality Assurance
QC	: Quality Control
DoR	: Department of Roads

## 104 MATERIALS AND TEST STANDARDS

The relevant standards for materials, as well as the testing procedures, have been indicated at appropriate places in the specifications. Lists of these standards with their full title are included at Appendix-1, MORT&H specification.

## 105 SUBMITALS

### 1 General Requirements

The Contractor shall maintain an approved system of recording and tracking submissions indicating dates, status (i.e. approved, not approved, approved subject to conditions), quantities, and other details as required.

Copies of all approved submissions will be retained securely and properly filed on site, available for reference by the Engineer at any time.

### 2 Contractor's Monthly Progress Report

The Contractor shall report monthly progress report to the Engineer submitted in triplicate and showing actual work done superimposed upon copies of the program. He shall furnish an explanation of any deviation from the Program stating his proposals for improving progress should this be lacking in any respect and he shall furnish the Engineer with his amended critical path analysis in triplicate. The Contractor shall comply with the reporting requirements on implementation of Environmental Management Plan in the monthly report following the guidelines provided by the Engineer.

The contractor shall submit monthly Laboratory/Field test report including cumulative number of tests done in the prescribed format. If required, the Engineer shall ask the contractor to submit quarterly Fund Projection Statement.

### 3 Samples

1. The Engineer may at his discretion request or take samples of any material or product intended for use in the Works. Where samples are requested in the Specifications, they shall be submitted in the number requested or if not specified then as directed by the Engineer
2. Samples shall be of the type and size specified and fully representative of the materials proposed to be used.
3. Samples shall be indelibly and clearly marked with the date of submission, material reference and any other data required to determine the source and kind of sample.

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4. One or more samples of each kind submitted will either be returned marked "ACCEPTED" and signed by a representative of the Engineer or the Contractor will be requested to provide new samples and be notified of deficiencies present in the submitted samples.
  5. One or more "accepted" samples will be retained by the Engineer for comparison with materials and workmanship supplied and will form the standard of acceptance.
  6. One or more "accepted" samples shall be retained at the Contractor's site office and be available for reference on request.
  7. The Engineer may reject any materials and goods which in his opinion are inferior to the samples thereof previously approved and the Contractor shall promptly remove such materials and goods from the Site.

#### 4. Copies of Orders

The Contractor shall provide the Engineer with one copy of all orders for the supply of materials and goods required in connection with the Works as the Engineer may require.

#### 5. Site Trials

Site trials/mock-up of pavement and other similar works as specified shall be prepared by the Contractor for review and acceptance of the Engineer. They shall be in a location agreed with the Engineer, and if so specified may be incorporated into the work in a clearly identified position upon approval of the Engineer. The Contractor shall carry out such changes or carry out field trials as required to obtain the Engineer's approval. Approved field trials shall form the standard of acceptance of subsequent materials and workmanship.

### 106 MAINTENANCE OF SERVICES

- (1) If any government, publicly and privately-owned service for drinking water, electricity, drainage, irrigation channels, sewers, telecommunication cables/lines and other services and structures, passing through the site is affected by the works, the Contractor shall provide a satisfactory alternative service in full working order to the satisfaction of the owner of the services and of the Engineer before terminating the existing service.
- (2) Drawings and scheduling the affected services like water pipes, sewers, cables, etc. owned by various authorities including government and public undertakings and local authorities shall be verified by the Contractor for the accuracy of the information prior to the commencement of any work.

- 
- (3) The Contractor must also allow for any effect of these services and alternations upon the works and for arranging regular meetings with the various bodies at the commencement of the contract and throughout the period of the works in order to maintain the required co-ordination.
  - (4) No clearance or alterations to the utility shall be carried out unless ordered by the Engineer.
  - (5) Any services affected by the works shall be restored immediately by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the works.
  - (6) The Contractor may be required to carry out the permanent removal or shifting or diversion of certain services/utilities on specific orders from the Engineer for which payment shall be made to him. Such works shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.

#### Measurement and Payment

No separate measurement and payment shall be made for the work of temporarily supporting; maintaining and protecting the government, publicly and privately owned services. All costs in connection with the work specified herein shall be considered to be included with other related items of the work in the Bill of Quantities.

### **107 NOTICE BOARD**

The Contractor shall erect and maintain notice boards (2m×1.2m) at each end of the site giving details of the contract in the format and wording as directed by the Engineer. These boards shall be erected within 14 days after the Contractor has been given the Possession of Site.

The Contractor shall not erect any advertisement sign board on or along the work without the written approval of the Employer.

All sign boards shall be removed by the Contractor by the end of the Defects Liability Period.

#### Measurement and Payment

Payment shall be made at the contract unit rate which shall be the full and the final payment to Contractor as per Clause 116 of the Technical Specifications.

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**108 SIEVE DESIGNATIONS**

The sieve designations referred to in the Specifications correspond to those specified by Bureau of Indian Standards in IS: 460. Table 100-1 gives the list of the commonly used IS sieves.

IS Sieves sizes (mm)

100mm

90mm

75mm

63mm

45mm

40.0mm

37.5mm

31.5mm

26.5mm

22.4mm

20.0mm

19.0mm

13.2mm

12.5mm

9.5mm

8.0mm

6.7mm

5.6mm

4.75mm

4.0mm

3.35mm

2.8mm

2.36mm

2.0mm

1.7mm

1.4mm

1.18mm

1.0mm

0.6mm

0.300mm

0.150mm

0.075mm

Note: *Only sieves with square openings shall be used.*

## 109 SCOPE OF WORK

### 109.1 GENERAL

109.1.1 The work to be carried out under the Contract shall consist of the various items as generally described in the Contract Documents as well as in the Bill of Quantities furnished in the Contract Documents.

### 109.2 CONFORMITY WITH DRAWINGS/ALLOWABLE DEVIATIONS

109.2.1 All works performed and all materials furnished shall be in conformity with the lines, grades, typical sections, dimensions, material requirements, and tolerances shown in the drawings or as indicated in the Specifications.

109.2.2 The works to be performed shall also include all general works preparatory to the construction of Land Customs Station, structures, cross drainage, drainage and all other related works. The works shall include work of any kind necessary for the due and satisfactory construction, completion and maintenance of works to the

intent and meaning of the drawings and these Specifications and further drawings and orders that may be issued by the Engineer from time to time.

109.2.3 The scope of work shall include compliance by the Contractor with all Conditions of Contract, whether specifically mentioned or not in the various Sections of these Specifications, all materials, apparatus, plant, equipment, tools, fuel, water, strutting, timbering, transport, offices, stores, workshop, staff, labour and the provision of proper and sufficient protective works, diversions, temporary fencing and lighting. It shall include all works related to safety of road user. It shall also include safety of workers at construction site, first aid equipment, suitable accommodation for the staff and workmen with adequate sanitary arrangements, the effecting and maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or other charges arising out of the erection of works and the regular clearance of rubbish, reinstatement and clearing-up of the site as may be required on completion of works, safety of the public and protection of the works and adjoining land/structures.

109.2.4 The Contractor shall ensure that all actions are taken to build in quality assurance (QA) in the planning, management and execution of works. The quality assurance shall cover all stages of work such as setting out, selection of materials, selection of construction methods, selection of equipment and plant, deployment of personnel and supervisory staff, quality control testing, etc. The QA programme shall cover the details as per IRC: SP: 47 and IRC: SP: 57. These shall broadly cover quality assurance aspects of all services rendered, all items to be supplied and all activities to be performed under the contract including temporary" structures and equipment which will influence the quality of the completed works or the progress of the contract.

As a minimum, it shall cover the following:

- i) Organization and management responsibility,
- ii) Document and data control,
- iii) Construction programme,
- iv) Method statement,
- v) Process control,
- vi) Working, inspection, testing and documentary procedures,
- vii) Arrangement for smooth and safe traffic flow during construction and maintenance
- viii) Control and documentation of purchasing and handling of materials,



- 
- ix) Maintenance of records for non-conformity and timely corrective actions,
  - x) Internal quality audit,
  - xi) Training of staff,
  - xii) Environment Management Plan (EMP).

The QA plan shall be submitted to the Engineer for approval, not later than 28 days from the date of signing of the contract agreement. The work of building in quality assurance shall be deemed to be covered in the scope of the work.

109.2.5 The Contractor shall furnish, at least 7 days in advance, unless otherwise stipulated in the contract, his programme of commencement of each item of work, including the method statement including deployment of plant and equipment for the works included in the contract and any other work for which the Engineer may demand the method statement.

He shall provide all information to the satisfaction of the Engineer to ensure its adequacy. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will, however, rest on the Contractor, irrespective of any approval given by the Engineer.

#### 109.3 INSPECTION OF MATERIALS BEFORE INCORPORATION

109.3.1 All materials shall be inspected, tested and accepted by the Engineer as per these specifications, before incorporation in the work. The frequencies and methods of sampling and testing materials, including those required for definite purpose and not covered by these specifications shall be in accordance to the relevant BSB, IRC or BIS or AASHTO/ASTMIBS Standards in order of priority.

109.3.2 All materials or work not conforming to the requirements of the Specifications shall be considered unacceptable and rejected. The unacceptable materials or work that is rejected shall be immediately removed unless the defects are corrected and approved by the Engineer. If the Contractor fails to comply promptly with any order of the Engineer made under the provisions of this Clause, the Engineer has the authority to remove and replace unacceptable materials or work and to deduct from money due to the Contractor the cost of removal-and replacement.

#### 109.4 INSPECTION OF MATERIALS AT SOURCE

The Engineer may choose to inspect material at source. In the event, the following conditions shall be met.

- 
- a) The Contractor and the manufacturer of material shall assist and co-operate with the Engineer in carrying out the inspection.
  - b) ) The Engineer shall have right to enter areas of plant where the manufacture or production of material is carried out.

#### 109.5 DELIVERY, STORAGE AND HANDLING OF MATERIALS

109.5.1 All materials shall be handled and stored in appropriate manner to preserve their quality and fitness for the work. During the handling of all aggregates or other construction materials, special care shall be taken to prevent contamination. Furthermore, aggregate shall be handled in such a manner as to prevent segregation.

109.5.2 Vehicles used in transporting construction material shall be kept clean and in proper working condition so as to prevent the loss of materials during transportation and meet the requirements of the Specifications.

109.5.3 The Contractor may be allowed to store materials and equipment within the right-of-way at location approved by the Engineer, but shall be responsible for the restoration and repair of any damage to plantation, signs, property or any assets resulting from such operations. Any additional space that may be needed for storage purposes and for placing of plant and equipment shall be provided by the Contractor at no additional cost to the Employer.

#### 109.6 MATERIALS FURNISHED BY THE EMPLOYER

When the Contract provides that certain materials required to complete the work will be supplied by the Employer, such material will be delivered or made available to the Contractor at the location(s) specified in the Contract.

The Contractor shall be responsible for all damages occurring to the materials furnished by the Employer while the materials are in his possession. Any demurrage or storage charges shall also be the responsibility of the Contractor.

The Contractor shall include the cost of handling, transportation and placing all Employer furnished materials in the Contract unit price for the relevant pay item.

#### 109.7 LAWS TO BE OBSERVED

The Contractor shall observe and comply with all Country laws, local laws and ordinance which affects those employed on the work or affect the conduct of the work.

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The Contractor shall provide all safeguards, safety devices, and protective equipment and take any other actions necessary for safety and health of employees on the project.

#### 109.8 PATENTED DEVICES, MATERIALS AND PROCESSES

If the Contractor is required or desires with the approval of the Engineer to use any design, device, material or process covered by trademark, patent or copyright, the Contractor shall obtain the right for its use by legal agreement with the patentee or owner. A copy of the agreement shall be furnished to the Engineer. Contract prices shall include all royalties and costs arising from patents, trademarks and copyrights.

### 110 CONSTRUCTION EQUIPMENT

In addition to the conditions indicated in the Contract Documents, the following conditions regarding use of equipment in works shall be satisfied:

- a) The Contractor shall be required to give a trial run of the equipment for establishing their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Engineer before commencement of the work;
- b) All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Engineer;
- c) Plants, equipment and instruments provided shall have adequate sensitivity, facility for calibration to desired level and shall be robust;
- d) Plant, equipment and instrument provided shall have data logging arrangement and control systems to enable automatic feedback control of process;
- e) Plants, equipment and instruments provided shall have adequate safety features and pollution control devices;
- f) Plant, equipment and instruments provided shall be operated by skilled and qualified operators;
- g) All the plant/equipment to be deployed on the works shall be got approved from the Engineer for ensuring their fitness and efficiency before commencement of work;

- 
- h) Any material or equipment not meeting the approval of the Engineer shall be removed from the site forthwith;
  - i) No equipment shall be removed from site without permission of the Engineer;
  - j) The Contractor shall also make available stand by equipment and spare parts; and
  - k) The Contractor shall also make available equipment for site quality control work as directed by the Engineer.

## 111 DRAWINGS

111.1 The preliminary drawings provided in the Tender Documents shall be used as reference only. The Contractor shall study the nature and type of work and ensure that the rates and price quoted by him in the Bill of Quantities have due consideration in the site and complexities of work Involved during actual execution/construction.

111.2 The Contractor based on his surveys and investigations, shall submit the detail design drawings and working drawings (hard and soft copy) to the Engineer for each activity at least 45 days in advance of the scheduled date to the start of the activity as per his approved work programme. The working drawings shall clearly show the modifications, if any, proposed with reference to corresponding tender drawings. The Engineer shall review the working drawings including the modifications proposed, if any, revise the drawings, if required, approve and issue to the Contractor two copies of Good for Construction (GFC) drawings at least 28 days in advance of the scheduled date of the start of the activity.

111.3 Examination and/or approval by the Engineer of any drawings or other documents submitted by the Contractor shall not relieve the Contractor of his responsibilities or liabilities under the Contract.

111.4 The tendered rates/prices for the work shall be deemed to include the cost of preparation, supply and delivery of all necessary drawings, prints, tracings and negatives which the Contractor is required to provide in accordance with the Contract.

### 111.5 As Built Drawings

At least one month prior to the end of the Defects Liability Period, the Contractor shall submit As Built Drawings based on Mylar print. It is advisable that the Contractor prepares the as-built drawings as the work is completed at the site to facilitate checking and verification. The following requirements will apply:

- (a) The drawings shall be prepared in latest version of auto CAD.
- (b) The drawings shall include all available information on existing conditions as well as new construction.
- (c) Site drawings shall include as in the original drawings.
- (d) Drawings shall be at a scale suitable for easy reference and as required to clearly depict all required information as directed by the Engineer.
- (e) The Contractor shall conduct such on-site checks as required to ensure the accuracy of the as-built drawings.
- (f) One original and four copies of drawings shall be submitted in bound sets subdivided by discipline. Copyright of all materials submitted will remain with the Employer without further compensation or charge.

#### Measurement and Payment

No separate measurement and payment shall be made for above items under Clause 111 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included with other related items of the work in the Bill of Quantities.

### **112 SITE INFORMATION**

112.1 The information about the site of work and site conditions in the Tender Documents is given in good faith for guidance only but it shall be the responsibility of the Contractor to satisfy him regarding all aspects of site conditions.

112.2 The location of the works and the general site particulars are as shown in the Site plan/index plan enclosed with the Tender Documents.

112.3 The Contractor shall have to make his own arrangement for the land required by him for site offices, field laboratory, site for plants and equipment, maintenance and repair workshop, construction workers' camp, stores etc.

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**113 SETTING OUT**

113.1 The Contractor shall establish working bench marks tied with the Reference bench mark in the area soon after taking possession of the site. The Reference bench mark for the area shall be as indicated in the Contract Documents and the values of the same shall be obtained by the Contractor from the Engineer. The working bench marks/levels fixed on the ground should be got approved from the Engineer. Checks must be made on these bench marks once every month and adjustments, if any, got approved from the Engineer and recorded. An up-to-date record of all bench marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Engineer for his record.

113.2 The lines and levels of formation, side slopes, drainage works, carriage ways and shoulders shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and cross-sections are obtained everywhere.

113.3 In order to facilitate the setting out of the works, the location of the structures, must be accurately established by the Contractor and approved by the Engineer. It must then be accurately referenced in a manner satisfactory to the Engineer, with marker in or near the fence line, and a schedule of reference dimensions shall be prepared and supplied by the Contractor to the Engineer. These markers shall be maintained until the works are accepted by the Engineer.

113.4 On construction reaching the formation level stage, the center line shall again be set out by the Contractor and when approved by the Engineer, shall be accurately referenced in a manner satisfactory to the Engineer by marker pegs set at the outer limits of the formation.

113.5 No reference peg or marker shall be moved or withdrawn without the approval of the Engineer and no earthwork or structural work shall commence until the center line has been referenced.

113.6 The Contractor will be the sole responsible party for safe-guarding all survey monuments, bench marks, beacons, etc. The Engineer will provide the Contractor with the data necessary for setting out the structures after verifying the detail and working drawing submitted by the contractor. All dimensions and levels shown on the drawings or mentioned in documents forming part of or issued under the Contract shall be verified by the Contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions and levels.

The construction staking shall be done by personnel who are trained and experienced in construction layout and staking of the type and kind required in the Contract.

Field notes shall be kept in standard, bound field notebooks as approved by the Engineer. Field notes shall be subject to inspection by the Engineer and shall be the property of the Employer.

The Contractor shall correct any deficient staking or construction work which resulted from inaccuracies in the staking operations or from the Contractor's failure to report inaccuracies in the plans or survey data furnished by the Department.

113.7 After obtaining approval of the Engineer, work on earthwork can commence. The profile and cross-sections as per Section 303 shall form the basis for measurements and payment. The Contractor shall be responsible for ensuring that all the basic traverse points are in place at the commencement of the contract and, if any, are missing, or appear to have been disturbed, the Contractor shall make arrangements to re-establish these points.

A "survey File" containing the necessary data will be made available for this purpose. If in the opinion of the Engineer, design modifications of the center line or grade are advisable, the Engineer will issue detailed instructions to the Contractor and the Contractor shall perform the modifications in the field, as required, and modify the ground levels on the cross-sections accordingly as many times as required.

There will be no separate payment for any survey work performed by the Contractor. The cost of these services shall be considered as being included in the rate of the items of work in the Bill of Quantities.

113.8 Precision automatic levels, having a standard deviation of  $\pm 2$  mm per km, and fitted with micrometer attachment shall be used for all double run levelling work. Setting out of the road alignment and measurement of angles shall be done by using Total Station with traversing target, having an accuracy of one second. Measurement of distances shall be done preferably using precision instruments like Distomat.

113.9 The work of setting out shall be deemed to be a part of general works preparatory to the execution of work and no separate payment shall be made for the same.

## 114 PUBLIC UTILITIES

114.1 Drawings scheduling the affected services like water pipes, sewers, oil pipe lines, cables, gas ducts etc. owned by various authorities including Public Undertakings and Local Authorities included in the Contract Documents shall be verified by the Contractor for the accuracy of the information prior to the commencement of any work.

The Contractor shall notify all utility agencies that may have installation in the work area and secure their assistance in locating and identifying all utilities before starting any work that may cause any damage to such utilities.

The Contractor shall schedule work in such a manner as to protect existing utility facilities until they are relocated, abandoned or replaced. The Contractor shall ensure that all utilities encountered within the Right of Way Le. OFC Cable,

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telephone, power, water supply, sewerage or any others, remain operational at all times. Any utility, if damaged, due to construction operation, shall be promptly repaired by the Contractor at his cost.

114.2 Notwithstanding the fact that the information on affected services may not be exhaustive, the final position of these services within the works shall be supposed to have been indicated based on the information furnished by different bodies and to the extent the bodies are familiar with the final proposals. The intermediate stages of the works are, however, unknown at the design stage, these being dictated by the Contractor's methods of working. Accordingly, the Contractor's programme must take into account the period of notice and duration of diversionary works of each body as given on the Drawings and the Contractor must also allow for any effect of these services and alterations upon the Works and for arranging regular meetings with the various bodies at the commencement of the Contract and throughout the period of the Works, the Contractor shall have no objection if the public utility bodies vary their decisions in the execution of their proposals in terms of programme and construction, provided that, in the opinion of the Engineer, the Contractor has received reasonable notice thereof before the relevant alterations are put in hand.

114.3 No removal of or alterations to the utility shall be carried out unless written instructions are issued by the Engineer

114.4 Any services affected by the Works must be temporarily supported by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the Works.

114.5 The Contractor may be required to carry out certain works for and on behalf of various bodies, which he shall provide, with the prior approval of the Engineer.

114.6 The work of temporarily supporting and protecting the public utility services during execution of the Works shall be deemed to be part of the Contract and no extra payment shall be made for the same.

114.7 The Contractor shall be responsible to co-ordinate with the service providers for cutting of trees, shifting of utilities, removal of encroachments etc. to make site unencumbered for completion of work. This will include frequent follow-up meetings. Coordination for making project site unencumbered shall be deemed to be part of the Contract and no extra payment shall be made for the same.

114.8 In some cases, the Contractor may be required to carry out the removal or shifting of certain services/utilities on specific orders from the Engineer for which payment shall be made to him. Such works, however, shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.



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**115 PRECAUTIONS FOR SAFEGUARDING THE ENVIRONMENT****115.1 GENERAL**

The Contractor shall take all precautions for safeguarding the environment during the course of the construction of the works. He shall abide by all laws, rules and regulations in force governing pollution and environmental protection that are applicable in the area where the works are situated.

**115.2 BORROW PITS FOR EMBANKMENT CONSTRUCTION**

Borrow pits shall be selected only after testing the suitability of materials for use in construction and shall not normally be dug in the right-of-way of the road. The stipulations in Section 303.4 shall govern. The borrow pits shall not be left in a condition likely to cause hazard to human and animal life. The Contractor shall seek prior approval from the concerned authorities for operating the borrow pits.

**115.3 QUARRY OPERATIONS**

The Contractor shall obtain materials from quarries only after obtaining the consent of the Mining Department or other concerned authorities. The quarry operations shall be undertaken within the purview of the rules and regulations in force.

**115.4 CONTROL OF SOIL EROSION, SEDIMENTATION AND WATER POLLUTION**

The Contractor shall carry out the works in such a manner that soil erosion is fully controlled, and sedimentation and pollution of natural water courses, ponds, tanks and reservoirs is avoided.

**115.5 POLLUTION FROM PLANTS AND BATCHING PLANTS**

Stone crushing and screening plants, bituminous hot-mix plants, concrete batching plants etc. shall be located sufficiently away from habitation, agricultural operations or industrial establishments. The locations shall be as permissible under the laws governed by local bodies/ administration of the area. The Contractor shall take every precaution to reduce the levels of noise, vibration, dust and emissions from his plants and shall be fully responsible for any claims or damages caused to the owners of property, fields and residences in the vicinity and violation of pollution control norms, if any.

#### 115.6 SUBSTANCES HAZARDOUS TO HEALTH

The Contractor shall not use or generate any materials in the works which are hazardous to the health of persons, animals or vegetation. Where it is necessary to use some substances, which can cause injury to the health of workers, the Contractor shall provide protective clothing or appliances to his workers.

#### 115.7 USE OF NUCLEAR GAUGES

Nuclear gauges shall be used only where permitted by the Engineer. The Contractor shall provide the Engineer with a copy of the regulations governing the safe use of nuclear gauges he intends to employ and shall abide by such regulations.

#### 115.8 ENVIRONMENTAL PROTECTION

115.8.1 The Contractor must take all reasonable steps to minimize dust nuisance during the construction of the works along the haul roads and the worksites by sprinkling water at a frequency specified by the Engineer. All existing highways and roads used by vehicles or equipments of the Contractor or any of his sub-contractors or suppliers of materials or plant, and similarly any new roads which are part of the works and which are being used by traffic, shall be kept clean and clear of all dust/mud or other extraneous materials dropped by the said vehicles. Similarly, all dust mud or other extraneous materials from the works spreading on these highways shall be immediately cleared by the Contractor.

Clearance shall be affected immediately by sweeping and removal of debris, and all dust, mud and other debris shall be removed entirely from the road surface. Additionally, if so directed by the Engineer, the road surface shall be hosed or watered using suitable equipment.

Damages to existing road: Any structural damage and loss of riding surface caused to the existing roads by the Contractor's construction vehicles/ equipment shall be made good without any extra cost. Compliance with the foregoing will not relieve the Contractor of any responsibility for complying with the requirements of any authority in respect of the roads used by him.

Various works defined under this item are related to provision and maintenance of camps for workmen and employees, Contractor's site offices, temporary accommodation to the supervision engineers, stores, equipment yards and workshops. These camps must be adequate, rain-proof, spacious, airy and hygienic with proper lighting and materials storage facilities. The area shall be kept neat and clean. Space allocated for storage of materials such as cement, Bricks, reinforcing wire etc. shall in general be damp-free, rain-proof and away from petroleum products storage.

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The Contractor shall ensure that proper drinking water, waste disposal and toilet facilities are provided to the camps. This arrangement shall be enforced to avoid proliferation and generation of various water borne diseases. The Contractor shall inform the Engineer regarding sources, installation and operation of supply of potable water within a week after the supply is commenced.

Provision of toilets for labour and employees and supervision engineers shall be made to avoid public nuisance as well as pollution of water courses and air. Toilets shall not be located near streams or rivers. The Contractor shall construct suitable septic tanks and/or soak pits along with room of pit-type latrines. Sufficient water must be provided and maintained in the toilets. Proper methods of sanitation and hygiene should be employed during the whole project duration. The contractor shall provide waste disposal facilities such as dustbins and waste disposal pits.

A first aid kit along with proper medical supplies must be available in the camps for treating injuries or common health problems. Services shall also include on-the-way service and other arrangements required for taking them to the nearest hospital in case of emergency. If imported laborers are required for construction, proper medical tests of the laborers shall be carried out to prevent the spread of diseases such as STD and HIV/AIDS amongst the communities near the construction sites. The scope of work shall include service of at least one part-time experienced health worker/health assistant with a minimum of once a week full time site visit as work assignment. The Contractor shall also supply and provide adequate medicines and facilities required for standard first aid. The Contractor shall inform the Engineer regarding the medical facility within a week after its establishment and operation.

All workers shall be provided with adequate safety wear such as, water boot, gloves, face masks, ear plugs, helmets, safety jackets and safety belts to prevent injuries and health hazards.

#### 115.9 AIR QUALITY

The Contractor shall device and implements methods of working to minimize dust, gaseous and other air-borne emissions and carry out the Works in such a manner as to minimize adverse impacts on the air quality.

The Contractor shall utilize effective water sprays during delivery, manufacture, processing and handling of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather. Stockpiles of friable materials shall be covered with clean tarpaulins, with applications of sprayed water during dry and windy weather. Stockpiles of materials or debris shall be dampened prior to their movement, except where this is contrary to the Specification.

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Any vehicle with open load-carrying area used for transporting potentially dust-producing material shall have properly fitting side and tail boards. Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards and shall be covered with clean tarpaulins in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tail boards.

#### 115.10 WATER SOURCES AND WATER QUALITY

The Contractor shall provide independent sources of water supply, such as bore wells, for use in the Works and for associated storage, workshop and work force compounds. Prior approval shall be obtained from the relevant State Authorities and all installations shall be in compliance with local regulations.

The Contractor shall protect watercourses, waterways, ditches, canals, drains, lakes, reservoirs and the like from pollution as a result of the execution of the Works. All water and other liquid waste products like petroleum products and chemicals arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.

The Contractor shall at all times ensure that all existing stream courses and drains within and adjacent to the Site are kept safe and free from any debris and any materials arising from the Works. The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any water course except with the permission of the Engineer and the regulatory authority concerned.

#### 115.11 CONSTRUCTION CAMPS

The construction camps shall conform to the State and National building regulations as applicable. The area for the storage of polluted materials shall be stored on impervious floors and shall be surrounded by impervious ditches in order to avoid spilling of polluted material to surrounding areas.

Construction camps shall be properly arranged to avoid noise pollution to the nearby habitants and to avoid contamination of water courses from wastewater drainage. To prevent such contamination, wastewater generated at the campsites shall be discharged into soak pits.

Human excreta shall be treated through septic tanks prior to discharge and shall conform to directives and guidelines of the State. Water accumulated in tyres, empty vessels and containers of all nature will be regularly cleaned to avoid the related health hazards. The Contractor shall provide and maintain in a neat and sanitary condition accommodations for the use of the employees and workers as may be necessary to comply with the requirements of Central, State, and local regulations.

Spilling of oil and bituminous products during construction and transport shall be avoided to reduce the chances of contamination of surface as well as ground water.

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Occupational Health and Safety of the Workforce, the Contractor shall prepare and submit to the Engineer the Occupational Health & Safety Procedures/Practices for the workforce in all quarry sites, plant sites, work sites, camp sites, etc., in accordance with the applicable laws.

#### 115.12 CONTROL AND DISPOSAL OF WASTES

The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No uncontrolled deposition or dumping shall be permitted. Wastes to be so controlled shall include, but shall not be limited to, all forms of fuels and engine oils, all types of bitumen, cement, surplus aggregates, gravels, bituminous mixtures etc. The Contractor shall make specific provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.

#### 115.13 TRANSPORT OF HAZARDOUS MATERIALS

Transport of hazardous materials, in bulk or in sealed containers, shall meet the requirements of the State regulations. Prior to ordering transport of hazardous material in bulk, the Contractor must obtain the approval of the relevant authority as well as of the Engineer. The transport of diesel, petrol, gaseous material, chemical and explosives for quarrying shall be governed by safety laws of the local authorities. Precautionary measures and conformity with regulations shall be stated in a Method Statement for the approval of the Engineer. Sealed containers of hazardous materials shall be stored in a well-ventilated room, well guarded and secured.

#### 115.14 EMERGENCY RESPONSE

The Contractor shall plan and provide remedial measures to be implemented in the event of occurrence of emergencies such as spillages of oil or bitumen or chemicals, fire. The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency, which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.

#### 115.15 MEASUREMENT FOR PAYMENT

The compliance of all provisions made in this Clause 111 shall be deemed to be incidental to the work and no separate measurement or payment shall be made. The Contractor shall be deemed to have made allowance for all such compliance with these provisions in the preparation of his bid for items of work included in the Bill of Quantities and full compensation for such compliance shall be deemed to be covered by the bid price.

**116 GENERAL RULES FOR THE MEASUREMENT OF WORKS FOR PAYMENT****116.1 GENERAL**

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant Sections read in conjunction with the General Conditions of Contract. The same shall not, however, apply in the case of lump sum contracts.

All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits:

i)	length and width	10mm
ii)	height, depth or thickness of	
	a) earthwork, subgrade,	5mm
	b) Sub-bases, bases, surfacing	5mm
iii)	Structural members	2.5mm
iv)	Areas	0.01 sq.m
v)	Volume	0.01 cu.m

In recording dimensions of work, the sequence of length, width and height or depth or thickness shall be followed.

**116.2 MEASUREMENT OF LEAD FOR MATERIALS**

Where lead is specified in the Contract for construction materials, the same shall be measured as described hereunder:

Lead shall be measured over the shortest practicable route and not the one actually taken and the decision of the Engineer in this regard shall be taken as final. Distances upto and including 100 m shall be measured in units of 50 m, exceeding 100 m but not exceeding 1 km in units of 100 m and exceeding 1 km in units of 500 m, the half and greater than half of the unit shall be reckoned as one as and less than half of the unit ignored. In this regard, the source of the material shall be divided into suitable blocks and for each block; the distance from the center of placing pertaining to that block shall be taken as the lead distance.

**116.3 MEASUREMENT OF PAVEMENT THICKNESS FOR PAYMENT ON VOLUME BASIS**

The finished thickness of sub-bases, base and concrete courses to be paid on volume basis shall be computed in the following manner:

Levels shall be taken before and after construction, at the grid of points 10 m centre-to-centre longitudinally in straight reaches and 5m centre-to-centre at curves. Suitable references for the transverse grid lines should be left in the form of embedded bricks on both ends or by other means so that it is possible to locate the grid points for level measurements after each successive course is laid.

For pavement courses laid only over widening portions, at least one line of levels shall be taken on each strip of widening, or more depending on the width of widening as decided by the Engineer.

Notwithstanding the above, the measurements may be taken at closer intervals also, if so desired by the Engineer, the need for which may arise particularly in the case of estimation of the volume of the material for profile corrective course (levelling course). The average thickness of the pavement course in any area shall be the arithmetic mean of the difference of levels before and after construction at all the grid points falling in that area, provided that the thickness of finished work shall be limited to those shown on the drawings or approved by the engineer in writing.

As supplement to level measurements, the Engineer shall have the option to take cores/make holes to check the depth of construction. The holes made and the portions cut for taking cores shall be made good by the Contractor by laying fresh mix/material including compacting as required at his-own cost immediately after the measurements are recorded.

**116.4 CHECKING OF PAVEMENT THICKNESS FOR PAYMENT ON AREA BASIS**

Where payment for any items in the base course is allowed to be made on the area basis, the Engineer may have its thickness checked with the help of a suitable penetration gauge at regular intervals or other means as he may decide.

**117 FACILITIES FOR THE ENGINEER****1) General**

The Contractor shall provide, maintain and supply services to the office for use of the Engineer's Representative and staff as described herein. The quantity is indicated in the Bill of Quantities. All facilities provided to Engineer's Representative and his staff

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shall be new unless otherwise specifically stated. The rented building/house for the office should be freshly painted and meet the requirements of the facilities, utility and services as described herein.

The full details of the facilities, which the Contractor proposes to provide for the Engineer's Representative shall be submitted for the approval of Engineer's Representative within 15 days of the Letter of Acceptance.

The Contractor shall not complete any arrangements, nor place orders for the hire/purchase of any items, nor start work on the provisions for the facilities for Engineer's Representative until he has received approval from the Engineer's Representative.

The Contractor shall complete the provision of facilities for the Engineer's Representative within 45 days of the Letter of Acceptance. During this period the Contractor shall provide such temporary facilities as may be required by the Engineer's Representative and staff in the execution of their duties under the Contract. Alternatively the Engineer's Representative and staff may make their own arrangement for temporary facilities in which case the Contractor shall reimburse the Engineer's Representative for the costs so incurred.

On completion of the Works in accordance with Conditions of Contract the Engineer's Representative will instruct the Contractor to Hand over the site offices and such other facilities not required during the Defects Liability Period to the Thromde Office P/ling if constructed . At the end of the Defects Liability Period the Contractor shall remove the remaining facilities from site in accordance with the Conditions of Contract. All furniture, furnishing, and equipment provided for the use of the Engineer's Representative, except those items provided by the Contractor for the proper maintenance of the facilities of rented items, shall become the property of the Contractor at the end of the Contract.

The contractor is required to provide, furniture, equipment, telephone, fax, support staff (Office Assistant); and to maintain office/services, equipment and communication charges as per Section 1 (General) – Bill of Quantities.

## **118 SCOPES OF RATES FOR DIFFERENT ITEMS OF WORK**

118.1 For item rate contracts, the contract unit rates for different items of work shall be payment in full for completing the work to the requirements of the Specifications including full compensation for all the operations detailed in the relevant Sections of these Specifications under "Rates". In the absence of any directions to the contrary, the rates are to be considered as the full inclusive rate for finished work covering all labour, materials, wastage, temporary work, plant, equipment, over-head charges



and profit as well as the general liabilities, performance of other obligations, insurance and risks arising out of the Conditions of Contract.

118.2 The item rates quoted by the Contractor shall, unless otherwise specified, also include compliance with/supply of the following:

- i) General works such as setting out, clearance of site before setting out and clearance of works after completion;
- ii) A detailed programme using modern project management software for the construction and completion of the work giving, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipment and their installation and testing, for all activities of the Engineer/Employer that are likely to affect the progress of work, etc., including updating of all such activities on the basis of the decisions taken at the periodic site review meetings or as directed by the Engineer;
- iii) Samples of various materials proposed to be used on the Works for conducting tests thereon as required as per the provisions of the Contract;
- iv) Design of mixes as per the relevant Sections of the Specifications giving proportions of ingredients, sources of aggregates and binder along with accompanying trial mixes as per the relevant Sections of these Specifications to be submitted to the Engineer for his approval before use on the Works;
- v) Cost of laying trial stretches;
- vi) Detailed drawings as per Clause 111.
- vii) Detailed design calculations and drawings for all Temporary Works(such as form-work, staging, centering, specialized constructional handling and launching equipment and the like);
- viii) Detailed drawings for templates, support and end anchorage, details for pre-stressing cable profiles, bar bending and cutting schedules for reinforcement, material lists for fabrication of structural steel, etc.;
- ix) Mill test reports for all mild and high tensile steel and cast steel as per the relevant provisions of the Specifications;
- x) Testing of various finished items and materials including cement, concrete, inter-locking blocks as required under these Specifications and furnishing test reports/certificates;

- xi) Inspection Reports in respect of formwork, staging, reinforcement and other items of work as per the relevant Specifications;
- xii) Any other data which may be required as per these Specifications or the Conditions of Contract or any other annexure/schedules forming part of the Contract;
- xiii) Any other item incidental to work which is necessary for complying with the provisions of the Contract;
- xiv) All temporary works, formwork and false work not included as separate item in the BOQ;
- xv) Establishing and running a laboratory with facilities for testing for various items or works as specified in Section 2015 and 2100 and other relevant Sections;
- xvi) Cost of in-built provisions for Quality Assurance;
- xvii) Cost of safeguarding the environment; and
- xviii) Cost of providing "as-built drawings" in original and two sets of prints.

Portions of road works beyond the limits and/or any other work may be got constructed by the Employer directly through other agencies. Accordingly, other agencies employed by the Employer may be working in the vicinity of the Works being executed by the Contractor. The Contractor shall liaise with such agencies and adjust his construction programme for the completion of work accordingly and no claim or compensation due to any reason what so ever will be entertained on this account. The Employer will be indemnified by the Contractor for any claims from other agencies on this account.

## **119 METHODOLOGY AND SEQUENCE OF WORK**

119.1 Prior to start of the construction activities at site, the Contractor shall, within 28 days after the date of the agreement unless otherwise stipulated in the Contract, submit to the Engineer for approval, the detailed method statement. The method statement shall be submitted in two parts.

The general part of the method statement shall describe the Contractor's proposals regarding preliminary works, common facilities and other items that require consideration at the early stage of the contract. The general part shall include information on:

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- a) Sources of materials like coarse aggregates and fine aggregates, quantity and quality of materials available in different sources;
  - b) Sources of manufactured materials like bitumen, cement, steel reinforcement, pre-stressing strands and bearings etc. He shall also submit samples/test certificates of materials for consideration of the Engineer;
  - c) Locations of the site facilities such as batching plant, hot mix plant, crushing plant, etc.;
  - d) Details of facilities available for transportation of men/material and equipment;
  - e) Information on procedure to be adopted by the Contractor for prevention and mitigation" of negative environmental impact due to construction activities;
  - f) Safety and traffic arrangement during construction;
  - g) Implementation of activities provided in the Environmental Management Plan;
  - h) Any other information required by the Engineer.

The general part of the QA programme under Section 109.3 shall accompany the method statement.

Special part of the method statement shall be submitted to the Engineer by the Contractor for each important item of work as directed by the Engineer. The statement shall be submitted at least 4 weeks in advance of the commencement of the activity of item of work unless otherwise stipulated in the contract. The statement shall give information on:

- a) Details of the personnel both for execution and quality control of the work;
- b) Equipment deployment with details of the number of units, capacity, standby arrangement;
- c) Sequence of construction and details of temporary or enabling works like diversion, cofferdam, formwork including specialized formwork for superstructure, details of borrow areas, method of construction of embankment, sub-grade and pavement, pile concreting, proprietary processes and products and equipment to be deployed. Wherever required technical literature, design calculations and drawings shall be included in the method statement;
- d) Testing and acceptance procedure including documentation;

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- e) The special part of the QA programme under Sub-Section 1 05.3 for the particular item of work shall accompany the method statement for the concerned activity.

The Engineer shall examine and approve the method statement with the required modifications. The modified method statement if required shall be submitted within 14 days of the receipt of the Engineer's approval. The sole responsibility for adequacy and safety of the method adopted by the Contractor shall rest on the Contractor irrespective of any approval given by the Engineer.

#### 119.1 APPROVAL OF PROPRIETARY PRODUCTS/PROCESSES/SYSTEMS

Within 90 days of the signing of agreement, the Contractor shall submit the following information for all proprietary products, process or any other item proposed to be used in the work, for approval of the Engineer.

- a) Name of the manufacturer and name of the product/process/ system along with authenticated copies of the license/collaboration agreement;
- b) General features of the product/process/system;
- c) Details of the product development and development testing;
- d) Acceptance test and criteria;
- e) Installation procedure;
- f) Maintenance procedure and schedule;
- g) Warranty proposal.

The Engineer may order additional test for the purpose of acceptance. Additional charges for test, if any, for the product/process/system shall be borne by the Contractor.

#### 120 CRUSHED STONE AGGREGATES

Where the terms crushed gravel/shingle, crushed stone, broken stone or stone aggregate appear in any part of the Contract Documents or Drawings issued for work, they refer to crushed gravel/crushed shingle/crushed stone aggregate obtained from integrated crushing plant having appropriate primary crusher, secondary cone crusher, vertical shaft impactor and vibratory screen unless specified otherwise. Stone retained on 4.75 mm sieve shall have at least two faces fractured.

**121 SUPPLY OF QUARRY SAMPLES**

Raw and processed samples of the mineral aggregates from the approved quarry shall be submitted by the Contractor at his cost.

**122 APPROVAL OF MATERIALS**

Approval of all sources of material for work shall be obtained in writing from the Engineer before their use on the works.

**123 USES OF SURFACES BY TRAFFIC**

123.1 Ordinarily, no construction traffic shall be allowed on pavement under construction unless authorized by the Engineer. Even in that case, the load and intensity of construction traffic should be so regulated that no damage is caused to the sub-grade or pavement layers already constructed. Where necessary, service roads shall be constructed for this purpose and the same shall be considered as incidental to the work.

123.2 The wheels or the tracks of plant moving over the various pavement courses shall be kept free of deleterious materials.

123.3 Bituminous base course shall be kept clean and uncontaminated as long as the same remains uncovered by a wearing course or surface treatment. The only traffic permitted access to the base/binder course shall be that engaged in laying and compacting the wearing course or that engaged on such surface treatment where the base/binder course is to be blinded and/or surface dressed. Should the base/binder course or tack coat on the base/binder course become contaminated, the Contractor shall make good by cleaning it to the satisfaction of the Engineer, and if this is impracticable, by removing the layer and replacing it to Specifications without any extra cost to the employer.

123.4 On Dry Lean Concrete sub-base, no heavy commercial vehicles like trucks and buses shall be permitted after its construction. Light vehicles, if unavoidable, may, however, be allowed after 7 days of its construction with prior approval of the Engineer. No vehicular traffic, shall be allowed on a finished concrete pavement for a period of 28 days of its construction and until the joints are permanently sealed and cured.

## 124 FIELD LABORATORIES

### 124.1 SCOPE

The work covers the provision and maintenance of an adequately equipped field laboratory as required for site control on the quality of materials and the works.

### 124.2 DESCRIPTION

The Contractor shall arrange to provide fully furnished and adequately equipped field laboratory, including office furniture, equipment, and stationeries. The field laboratory shall preferably be located adjacent to the site office of the Engineer and provided with amenities like water supply, electric supply etc. as for the site office of the Engineer as described in this Section.

The layout and size of the field laboratory shall be as indicated in the drawings. In case no drawings is furnished, the laboratory shall include space for the storage of samples, equipment, laboratory tables and cupboards, working space for carrying out various laboratory tests, wash basin, toilet facility and a curing tank for the curing of samples, around 4m x 2m x 1min size and a fume chamber. Wooden/concrete working table with a working platform area of about 1 m x 10 m shall be provided against the walls. Wooden cupboards above and below the working tables shall be provided to store accessories such as, sample moulds etc. At least 4 racks of slotted angles and M.S. sheets the size 1800 mm x 900 mm x 375 mm and at least 6 stools for laboratory test operators shall also be provided.

The items of laboratory equipment shall be provided in the field laboratory depending upon the items to be executed as per Table 100-2.

### 124.3 OWNERSHIP

The field laboratory building and equipment shall be the property of the Contractor. The Employer and the Engineer shall have free access to the laboratory.

### 124.4 MAINTENANCE

The Contractor shall arrange to maintain the field laboratory in a satisfactory manner until the issue of Taking over Certificate for the completed work.

### Table 100-2:List of Laboratory Equipment

SN	ITEM DESCRIPTION	NO. OF ITEMS
1.	Oven-electrically operated, thermostatically controlled (including thermometer), stainless steel interior From 0°C to 220°C Sensitivity 1 °C	1 no
2.	Grain Size Analysis (coarse sieves) 450 mm dia. perforated plate G.I. Sieves for coarse aggregates 150mm 75.0 mm 50.0 mm 37.5 mm 19.0 mm 13.2 mm 12.5 mm 9.5 mm  a) G.I. Pan (450 mm dia) b) G.I. Cover (450 mm dia) c) Wire Sieve Brushes	1 no. 1 no. 1 no. 1 no. 1 no. 1 no. 1 no. 1 no.  1 no. 1 no. As reqd.
2	Grain Size Analysis (fine aggregate)  a) 200 mm dia. Brass Wire Sieve for fine aggregate  19.0mm 9.5mm 4.75 mm 2.36 mm 1.18 mm 0.600 mm 0.425 mm 0.300 mm 0.150 mm 0.075 mm  b) Brass Pan (200 mm dia) c) Brass Cover (200 mm dia) d) Wire Sieve Brushes e) Sieve Shaker motorised, 220 V, 50 Hz, single phase supply	          1 no. 1 no. 1 no. 1 no. 1 no. 1 no. 1 no. 1 no. 1 no. 2 nos.  1 no. 1 no. As reqd 1 no.

3.	<u>Specific Gravity and Bulk Density</u> Pycnometer preferred with capillary opening 50 ml Pycnometer preferred with capillary opening 250 ml Pycnometer preferred with capillary opening 1000 ml Wire Basket (4 mm mesh size) Bucket for Immersing Aggregate Bulk Density Measures (20 ltr., 10 ltr) Tamping Rod (16 mm dia.)	1 no. 1 no. 1 no. 1 no. 1 no. 1 set 1 no.
4.	<u>Liquid Limit Device with Counter Number</u> Grooving tool and Gauge Removing Counter Kit Spatula (Flexible with round tip, 80 mm long and 20 mm wide blade) Sample Container (steel) with cover Wash bottle Glass plate (Absorbent type) [300 mm x 450 mm] Plastic Limit Rod Comparator Porcelain Dish, 120 mm dia.	1 no. 1 no. 2 nos. 20 nos. 1no. 1no. 1no. 1 no.
5.	<u>Proctor Compaction Apparatus</u> Compaction moulds 150 mm dia. Compaction moulds 100 mm dia. 4.5 kg. Rammer 2.5 kg. Rammer Gauging Trowel Straight edge (steel) Sample trays (600 mm x 600 mm x 75 mm) sample trays (450 mm x 270 mm x 45 mm) sample trays (270 mm x 210 mm x 45 mm) sample tray (220 mm x 175 mm x 45 mm) Sample extruder (Hydraulic) Rubber Gloves as required	1 no. 1 no. 1 no. 1 no. 1no. 2 nos. . 6 nos. 6 nos. 6nos. 6nos. 1nos.
6.	<u>California Bearing Ratio (CBR) Apparatus</u> Lab CBR testing equipment for conducting CBR testing, load frame with 5 Tonne capacity, electrically operated with speed control as per IS:2720 (Part 16) and consisting of following:  CBR Moulds 150mm dia, 175mm ht Spacers disc 148 mm dia 47.7 mm ht. With handle Swell Plate Tripod stand for holding dial guage holder Dial gauges 25 mm travel - 0.01 mm/division Surcharge weight 147 mm dia 2.5 kg wt. Filter Paper, Boxes Proving rings of 25KN, 50KN capacity	1 no  6 nos. 12 nos. 9 nos. 3 nos. 4 nos. 12 nos. 3 nos. 1 each



7.	<u>Field Density Test (Sand Cone Method)</u>  Sand Pouring Cylinder 150 mm dia. Pouring Cylinder 100 mm dia. Calibrating Container 150 mm dia. Calibrating Container 100 mm dia. Metal Trays (400 mm x 400 mm x 50 mm) with central hole Density Spoon (medium) Metal dibber tools Scoops Brush (different sizes) Chisel 1 Kg Hammer Trowels 1 Kg Rubber Mallets Covered Containers (moisture sampling) Standard Density Sand 850 /600	1 sets 1 sets 1 no. 1 no. 2 nos. 2 nos. 2 nos. 2 nos. 6 nos. 2 nos. 2 nos. 1 no. 14 nos. 50 kg
8.	<u>Concrete Test and Slump Cone Apparatus</u>  Cube Moulds (150 mm) Slump cone apparatus Tamping rod (16 mm dia) Steel ruler (calibrated)	20 nos. 2 nos. 2 nos. 2 nos.
9.	<u>Compression Testing Machine</u>  Compression Testing machine set (electric and hand driven), 100 t	1 set
10.	<u>Flakiness and Elongation Index</u>  Set of Flakiness and Elongation gauges	1 no.
11	Aggregate Impact Value test apparatus as per 18:2386 (Part 4) 1 963	1 no
12	Los-Angeles abrasion test apparatus a s per 18:2386 (Part 4 ) 1963	1 nos
13.	<u>Balances: (as specified)</u>  a) Electronic Balance, 500 gm nominal capacity, 0.01 g accuracy b) Electronic Balance, 2500 g nominal capacity, 0.1g accuracy c) Triple Beam Balance with carrying case, 10 kg, 0.1 g accuracy (equivalent to OHAUS) d) Heavy Duty Solution Balance, 20 kg, 1g accuracy (equivalent to OHAUS) e) Heavy Duty Balance,30 kg, 1g accuracy	1 no 1 no 2 nos. 2 nos. 1 no

14.	<u>Miscellaneous Equipment: (as specified)</u>	
	Speedy moisture meter complete with chemical	2 nos.
	Pocket type thermometer, 0-250°C	2 nos.
	Metal thermometer, 0-25°C	2 nos.
	Digital Thermometer, 0-250°C x 1°C	2 nos.
	Sample splitter, 25 mm, and 12 mm size or as specified	1 each
	Moisture can, aluminium, 50mm diameter	21 nos.
	Mixing pan 600 mm x 600 mm x 75 mm,	6 nos.
	Mixing pan 500 mm x 400 mm x 75 mm,	6 nos.
	Mixing pan 450 mm x 450 mm x 75 mm	6 nos.
	Mixing pan 300 mm x 300mm x 75mm	6 nos.
	Electric hot plates, 220/50 1000 watts	1 no
	10-20 litre buckets	2 no
	Spades	2 nos.
	Hammer 1KG,5KG	2 nos.
	Chisel 300mm long	2 nos.
	Steel calibrated ruler	2 nos.
	Plastic bowels Big size	4 nos.
	Plastic bowels small size	4 nos.
	Hand Gloves (Leather)	10 pairs
	Respiratory breathing mask	10 nos.
	Stop watches 1/5 sec. accuracy	2 nos.

*Note: The items and their numbers listed above in this Section are indicative and shall be decided by the Engineer as per requirements of the Project and modified accordingly.*

#### 124.5 SERVICEABILITY

The Contractor shall keep the laboratory in a well maintained, clean and habitable condition. The Contractor shall maintain all laboratory equipment in good working condition throughout the period of the contract at his own expense. Testing apparatus shall be maintained in serviceable condition and all measuring and control equipment will be checked and calibrated from time to time, as required by the Engineer, and immediately adjusted or replaced if it is found that correction is not possible. Any equipment, which become unserviceable during use shall be repaired or replaced by the Contractor at no extra cost to the Employer.

The Contractor shall provide all tools, accessories, services for utility, communication, consumable items for testing and operating, and all the assistance

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as may be required by the Engineer and his staff for measuring and checking the works.

#### 124.6 TESTING

Without relieving the Contractor of any of his responsibility for the testing of materials the Engineer may as and when he desires carry out any of the tests specified above using the facilities. The Engineer may order the Contractor to carry out additional laboratory tests in an independent laboratory, as deemed necessary.

For all testing which cannot be carried out in the field Laboratory, the Contractor shall be responsible for arranging for such testing to be carried out at an independent laboratory to be approved by the Engineer. The Contractor shall be responsible for all attendance on staff from these approved testing laboratories, including if necessary, the provision of transport for personnel, equipment and test specimens. No testing by external laboratories shall be carried out without the written instruction of the Engineer.

#### 124.7 RATE

Provision and maintenance of the field laboratory is not a payable item as it is incidental to the work.

### **125 SUPPLY OF PROJECT RECORD**

#### 125.1 SCOPE

The work covers the supply digital record of project events in digital format (DVD/Flash Drive) including colored photographs both in digital format as well as mounted on albums to serve as a permanent record of the work needed for an authentic documentation, as approved by the Engineer.

#### 125.2 DESCRIPTION

The Contractor shall provide the following project records in digital format (DVD/Flash Drive) as directed by the Engineer:

- i) Record of work in each work front: It shall cover the status of each work front before start of work, during various stages of construction and after completion duly including the arrangements made (day & night) for traffic during construction (This shall be need based or as directed by the Engineer);

- ii) Record of quarry sites, plant sites, camp sites including labour camps, haul roads, access roads, etc. on quarterly basis;
- iii) Record of all accidents on project road/various sites (quarry, plant, camp, etc.)

The record shall be taken by a professional with a digital camera capable of taking still as well as video images having the facility to record the date and the background commentary.

The Contractor shall keep separate discs/drives, one with the Engineer and the other with the Employer and update the data in these discs/drives on monthly basis. Separately, a video (in digital format) of maximum one-hour duration covering interesting and novel features of the work duly editing the above master disc/drive shall also be maintained, one copy each kept with the Engineer and the Employer and updated on monthly basis. All recording shall be done in the presence of the Engineer's Representative who will certify in writing the recording.

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## 200. SITE CLEARANCE

### 201 CLEARING AND GRUBBING

#### 201.1 SCOPE

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 100 mm in thickness, rubbish etc., which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

#### 201.2. Preservation of Property/Amenities

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide Clause 306. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials etc., and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3.

#### 201.3. METHODS, TOOLS AND EQUIPMENTS

Only such methods, tools and equipment as are approved by the Engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, undergrowth, grass and other deleterious matter unsuitable for incorporation in the Embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these limits, trees and stumps required to be removed

as directed by the Engineer shall be cut down to 1 m below ground level so that these do not present an unsightly appearance.

All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres, shall be suitably treated.

#### *201.4 DISPOSAL OF MATERIALS*

All materials arising from clearing and grubbing operations shall be the property of Government and shall be disposed of by the Contractor as hereinafter provided or directed by the Engineer. Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked.

Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the Engineer. Stacking of stumps, boulders, stones etc., shall be done at specified spots with all lifts and up to a lead of 1000 m.

All products of clearing and grubbing which, in the opinion of the Engineer, cannot be used or auctioned shall be cleared away from the roadside in a manner as directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed up with the materials meant for embankment, subgrade and road construction.

#### *201.5. MEASUREMENTS FOR PAYMENT*

Clearing grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting of trees up to 300 mm in girth including removal of stumps and roots, and trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots of trees of girth above 300 mm and backfilling to required compaction shall be measured in terms of number according to the sizes given below:-

- i) Above 300 mm to 600 mm

- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

For this purpose, the girth shall be measured at a height of 1 metre above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

#### 201.6. Rates

The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency, excavation and back-filling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and up to a lead of 1000 m.

The Contract unit rate for cutting (including removal of stumps and roots) of trees of girth above 300 mm shall include excavation and backfilling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

### 202 DISMANTLING OF STRUCTURES/PAVEMENTS

#### 202.1 SCOPE

This work shall consist of dismantling and removing existing culverts, bridges, pavements, kerbs and other structures like guard-rails, fences, utility services, manholes, catch basins, inlets, etc., from the right of way which in the opinion of the Engineer interfere with the construction of road or are not suitable to remain in place, disposing of the surplus/unsuitable materials and backfilling to after the required compaction as directed by the Engineer.

Existing culverts, bridges, pavements and other structures which are within the highway and which are designated for removal, shall be removed upto the limit and extent specified in the drawings or as indicated by the Engineer.

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Dismantling and removal operations shall be carried out with such equipment and in such a manner as to leave undisturbed, adjacent pavement, structures and any other work to be left in place.

All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.

#### 202.2 Dismantling Culverts and Bridges

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the part of the structure to be retained and any other properties or structures nearby.

Unless otherwise specified, the superstructure portion of culverts/bridges shall be entirely removed and other parts removed up to at least 600 mm below the sub-grade, slope face or original ground level whichever is the lowest or as necessary depending upon the interference they cause to the new construction. Removal of overlying or adjacent material, if required in connection with the dismantling of the structures, shall be incidental to this item.

Where existing culverts/b ridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as are necessary and directed by the Engineer to provide a proper connection with the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are to be left in place so as to project into the new work as dowels or ties are not injured during removal of concrete.

Pipe culverts shall be carefully removed in such a manner as to avoid damage to the pipes. Steel structures shall, unless otherwise provided, be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the drawings or directed by the Engineer that the structure is to be removed in a condition suitable for re-erection, all members shall be match-marked by the Contractor with white lead paint before dismantling; end pins, nuts, loose plates, etc. shall be similarly marked to indicate their proper location; all pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow and all parts shall be securely wired to adjacent members or packed in boxes.

Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber having salvage value as is designated by the Engineer.

#### 202.2 DISMANTLING PAVEMENTS AND OTHER STRUCTURES

In removing pavements, kerbs, gutters, and other structures like guard-rails, fences, manholes, catch basins, inlets, etc., where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing



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structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

All concrete pavements, base courses in carriageway and shoulders etc., designated for removal shall be broken to pieces whose volume shall not exceed 0.02 cu.m and used with the approval of the Engineer or disposed of.

#### *202.3 BACK-FILLING*

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density as directed by the Engineer.

#### *202.4 DISPOSAL OF MATERIALS*

All surplus materials shall be taken over by the Contractor which may either be re-used with the approval of the Engineer or disposed of with all leads and lifts.

#### *202.5 MEASUREMENTS FOR PAYMENT*

The work of dismantling shall be paid for in units indicated below by taking measurements before and after, as applicable:

- i) Dismantling brick/stone masonry/concrete
- ii) (plain and reinforced) cu.m
- iii) Dismantling flexible and cement concrete pavement in cu.m
- iv) Dismantling steel structures in tone
- v) Dismantling timber structures in cu.m
- vi) Dismantling pipes, guard rails, kerbs, gutters and fencing linear m
- vii) Utility services in No.

#### *202.6 RATES*

The Contract unit rates for the various items of dismantling shall be paid in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. The rates will include excavation and backfilling to the required compaction and for handling, giving credit towards salvage value disposing of dismantled materials with all lifts and leads.

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**300. EXCAVATION FOR STRUCTURES AND DRAINAGES****301. EXCAVATION FOR ROADWAY AND DRAINS****301.1. SCOPE**

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and waterways in accordance with requirements of these Specifications and the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and sub-grade construction, suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

**301.2 CLASSIFICATION OF EXCAVATED MATERIAL**

301.2.1. Classification: All materials involved in excavation shall be classified by the Engineer in the following manner:

**(a) Soil**

This shall comprise topsoil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having dimension in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

**(b) Rock/Boulder**

Any rock, boulder or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required for fragmentation and dispose to the disposal yard.

301.2.2. Authority for classification: The classification of excavation shall be decided by the Engineer and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

**301.3. CONSTRUCTION OPERATIONS**

301.3.1. Setting out: After the site has been cleared as per Clause 201, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as

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shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Engineer, they are required for the work.

301.3.2. Stripping and storing topsoil: When so directed by the Engineer, the topsoil existing over the sites of excavation shall be stripped to specified depths constituting Horizon "A" and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with approval of the Engineer.

301.3.3 Excavation - General: All excavations shall be carried out in conformity with the directions laid here-in-under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilized as decided upon beforehand.

While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion, water pollution etc., and take appropriate drainage measures to keep the site free of water in accordance with Clause 311, MORTH.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the specified levels/dimensions on the drawings shall be made good at the cost of the Contractor with suitable material of characteristics similar to that removed and compacted to the requirements of Clause 303.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimize erosion and ponding, allowing for natural drainage to take place. If trees were removed, new trees shall be planted, as directed by the Engineer. The cost of planting new trees shall be deemed to be incidental to the work.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

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After excavation, the sides of excavated area shall be trimmed and the area contoured to minimize erosion and ponding, allowing for natural drainage to take place. If trees were removed, new trees shall be planted, as directed by the Engineer. The cost of planting new trees shall be deemed to be incidental to the work.

301.3.4. Methods, tools and equipment: Only such methods, tools and equipment as approved by the Engineer shall be adopted/ used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

301.3.5. Excavation for surface/sub-surface drains: Where the Contract provides for construction of surface/sub-surface drains to Clause 304, excavation for these shall be carried out in proper sequence with other works as approved by the Engineer.

301.3.6 Slides: If slips, slides, over-breaks or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of Contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction. If finished slopes slide into the roadway subsequently, such slides shall be removed and paid for at the Contract rate for the class of excavation involved, provided the slides are not due to any negligence on the part of the Contractor. The classification of the debris material from the slips, slides etc. shall conform to its condition at the time of removal and payment made accordingly regardless of its condition earlier.

301.3.7 Dewatering: If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to discharge the drained water into suitable outlets as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

301.3.8 Backfilling: Backfilling of masonry/concrete/Hume pipe drain excavation shall be done with approved material after passing 75mm and down after concrete/masonry/Hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and /or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be refilled to the original surface making due allowance for settlement, in layers generally not exceeding 150 mm compacted thickness to the required density, using suitable compaction equipment such as mechanical tamper, rammer or plate compactor as directed by the Engineer.

#### **301.4 PLYING OF CONSTRUCTION TRAFFIC**

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Construction traffic shall not use the cut formation and finished sub grade without the prior permission of the Engineer. Any damage arising out of such use shall be made good by the Contractor at his own expense.

#### *301.5 PRESERVATION OF PROPERTY*

The Contractor shall undertake all reasonable precautions for the protection and preservation of any or all existing trees, drains, sewers or other sub-surface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which, in the opinion of the Engineer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect, shall be got approved from the Engineer. However, if any of these objects is damaged by reason of the Contractors negligence, it shall be replaced or restored to the original condition at his expense. If the Contractor fails to do so, within the required time as directed by the Engineer or if, in the opinion of the Engineer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Engineer shall arrange the replacement/restoration directly through any other agency at the risk and cost of the Contractor after issuing a prior notice to the effect.

#### *301.6. PREPARATION OF CUT FORMATION*

The cut formation, which serves as a sub grade, shall be prepared to receive the sub base/base course as directed by the Engineer.

Where the material in the sub grade (that is within 500 mm from the lowest level of the pavement) has a density less than specified in Table 300-2, the same shall be loosened to a depth of 500mm and compacted in layers in accordance with the requirements of Clause 303.

Any unsuitable material encountered in sub grade level shall be removed as directed by the Engineer and replaced with suitable material compacted in accordance with Clause 303.

#### *301.7. FINISHING OPERATIONS*

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces. When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock (hard or soft) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in Clause 902. Where directed, the topsoil removed earlier and conserved (Clauses 301.3.2.

and 305.3.3) shall be spread over cut slopes, where feasible, berms and other disturbed areas. Slopes may be roughened and moistened slightly, prior to the application of topsoil, in order to provide satisfactory bond. The depth of topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 100 mm.

### 301.8. MEASUREMENTS FOR PAYMENT

Excavation for roadway shall be measured by taking cross-sections at suitable intervals in the original position before the work starts and after its completion and computing the volume in cum. by the method of average end areas for each class of material encountered. Where it is not feasible to compute volumes by this method because of erratic location of isolated deposits, the volumes shall be computed by other accepted methods.

At the option of the Engineer, the Contractor shall leave depth indicators during excavations of such shape and size and in such positions as directed so as to indicate the original ground level as accurately as possible. The Contractor shall see that these remain intact till the final measurements are taken.

For rock excavation, the overburden shall be removed first so that necessary cross sections could be taken for measurement. Where cross sectional measurements could not be taken due to irregular configuration or where the rock is admixed with other classes of materials, the volumes shall be computed on the basis of stacks of excavated rubble after making 35 percent deduction there from. When volumes are calculated in this manner for excavated material other than rock, deduction made will be to the extent of 16 per cent of stacked volumes

Works involved in the preparation of cut formation shall be measured in units indicated below:

- (i) Loosening and recompacting the loosened material at sub grade .....cu. m.
- (ii) Loosening and removal of unsuitable material and replacing  
with a suitable material and compacting to required density ..... cu. m.
- (iv) Stripping including storing g and reapplication of topsoil .....cu. m.
- (v) Disposal of surplus material beyond initial 1000 m lead. ....cu. m.

### 301.9 RATES

301.9.1. The Contract unit rate for the items of roadway and drain excavation shall be payment in full for carrying out the operations required for the individual items including full compensation for:

- (i) setting out;
- (ii) transporting the excavated materials and depositing the same on sites of embankments, spoil banks or stacking as directed within all lifts and lead up to 1000m or as otherwise specified;
- (iii) trimming bottoms and slopes of excavation;
- (iv) dewatering;
- (v) Keeping the work free of water as per Clause 311; and all labour, materials, tools, equipment, safety measures, testing and incidentals necessary to complete the work to Specifications.

301.9.2. The Contract unit rate for loosening and recompacting the loosened materials at sub grade shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

301.9.3. Clause 301.9.1 and 305.8 shall apply as regards Contract unit rate for item of removal of unsuitable material and replacement with suitable material respectively.

301.9.5. The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts, but leads up to 1000 m.

301.9.6..The Contract unit for disposal of surplus earth from roadway and drain excavation shall be full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the initial lead of 1000

## **302. EXCAVATION FOR STRUCTURES**

### **302.1. SCOPE**

Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, head walls, cutoff walls, pipe culverts and other similar structures, in accordance with the requirements of these Specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer.

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The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstructions, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site and the disposal of all surplus material.

### 302.2. CLASSIFICATION OF EXCAVATION

All materials involved in excavation shall be classified in accordance with Clause 301.2.

### 302.3 CONSTRUCTION OPERATIONS

302.3.1 Setting out: After the site has been cleared according to Clause 201, the limits of excavation shall be set out true to lines, curves and slopes to Clause 301.3.1.

302.3.2. Excavation: Excavation shall be taken to the width of the lowest step of the footing and the sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench and season of the year do not permit vertical sides, the Contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontal from the bottom of the excavation.

302.3.3 Dewatering and protection: Normally, open foundations shall be laid dry. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, depression of water level by well-point system, cofferdams and other necessary works to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion or sudden rising of water level.

The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the works.



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Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipments etc., inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

302.3.4. Preparation of foundation: The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation at the cost of the Contractor. Ordinary filling shall not be used for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed of all soft loose material, cleaned and cut to a firm surface either level and stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete (1:3:6 nominal mix) upto the top level of rock.

If the depth of fill required is more than 1.5 m above the top of the footing, filling upto 1.5 m above top of footing shall be done with lean concrete (1:3:6 nominal mix) followed by boulders grouted with cement.

When foundation piles are used, the excavation of each pit shall be substantially completed before beginning pile-driving operations therein. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the elevation of the bottom of the footings.

302.3.5. Slips and slip-outs: If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

302.3.6. Public safety: Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS: 3764.

302.3.7. Backfilling: Backfilling shall be done with 75mm and down approved material after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure.

All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface in layers not exceeding 150 mm compacted thicknesses. The compaction shall be done with the help of suitable equipment such as mechanical tamper, rammer, and plate vibrator etc., after necessary watering, so as to achieve a density not less than the field density before excavation.

302.3.8. Disposal of surplus excavated materials: Clause 301.3.11 shall apply.

#### 302.4. MEASUREMENTS FOR PAYMENT

Excavation for structures shall be measured in cu. m. for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer, Excavation over increased width, cutting of slopes, shoring, shuttering and planking shall be deemed as convenience for the Contractor in executing the work and shall not be measured and paid for separately. If boulders encountered in the excavation, the sizes of the boulder shall be measured provided it required any mechanical plant/hammer/crowbar to break it for the disposal.

Foundation sealing, dewatering, including pumping shall be deemed to be incidental to the work unless separate provision is made for in the Contract. In the latter case, payment shall be on lump sum basis as provided in the Bill of Quantities.

#### 302.5 RATES

302.5.1. The Contract unit rate for the items of excavation for structures shall be payment in full for carrying out the required operations including full compensation for:

- (i) setting out;

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- (ii) construction of necessary cofferdams, cribs, sheeting, shoring and bracing and their subsequent removal;
  - (iii) removal of all logs, stumps, grubs and other deleterious matter and obstructions,
  - (iv) for placing the foundations including trimming of bottoms of excavations; foundation sealing, dewatering including pumping when no separate provision for it is made in the Contract;
  - (v) backfilling, clearing up the site and disposal of all surplus material within all lifts and leads upto 1000 m or as otherwise specified; and
  - (vi) All labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specification.

302.5.2. The Contract unit rate for preparation of rock foundation shall be full compensation for cutting, trimming and cleaning the foundation surface and filling/sealing of all seams with cement grout or mortar including all materials, labour and incidentals required for completing the work.

302.5.3. The Contract unit rate for transporting material from the excavation for structures shall be full compensation for all labour, equipment, tools, and incidentals necessary on account of the additional haul or transportation involved beyond the initial lead of 1000 m.

### 303. EMBANKMENT CONSTRUCTION

#### 303.1 GENERAL

303.1.1. Description: These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfill with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross sections shown on the drawings or as directed by the Engineer.

#### 303.2 MATERIALS AND GENERAL REQUIREMENTS

##### 303.2.1. Physical requirements:

303.2.1.1. The materials used in embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other

material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/sub-grade.

The following types of material shall be considered unsuitable for embankment:

- a) Materials from swamps, marshes and bogs;
- b) Peat, log, stump and perishable material; any soil that classifies as OL, OI, OH or Pt in accordance with IS: 1498;
- c) Materials susceptible to spontaneous combustion;
- d) Materials in a frozen condition;
- e) Clay having liquid limit exceeding 70 and plasticity index exceeding 45; and
- f) Materials with salts resulting in leaching in the embankment.

303.2.1.2. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in sub-grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

303.2.1.3. Ordinarily, only the materials satisfying the density requirements given in Table 300-1 shall be employed for the construction of the embankment and the sub-grade.

303.2.1.4 Sourcing of materials for embankment and sub-grade construction, as well as compliance with environmental requirements in respect of excavation and borrow areas under the applicable laws shall be the sole responsibility of the Concessionaire.

303.2.1.5 The material to be used in sub-grade shall satisfy the design California Bearing Ratio (CBR) at the specified density and moisture content.

### 303.3 Structural features and design of embankment

303.3.1 Embankment with height 6.0 m or more shall be designed in accordance with IRC: 75 taking into account slope stability, bearing capacity, consolidation, settlement and safety considerations based on geotechnical and investigation data. Where the embankment is to be supported on a weak stratum, appropriate remedial/ground improvement measures shall be taken.

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303.3.2 Side slopes shall not be steeper than 2H: 1 V unless soil is retained by suitable soil retaining structures.

303.3.3 The side slopes and the earthen shoulders shall be protected against erosion by providing a suitable vegetative cover, kerb channel, chute, stone/cement concrete block pitching or any other suitable protection measures depending on the height of the embankment and susceptibility of soil to erosion. In high rainfall areas and where soil is susceptible to erosion, before providing surfacing on slopes and shoulders, a coir or jute blanket shall be placed on such slopes and shoulders immediately after completion of work and in any event before onset of first monsoon after completion of work in that reach.

TABLE 300-1. DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE MATERIALS (MORTH Specification)

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SL. No	Type of Work	Maximum laboratory dry unit weight when tested as per IS : 2720 (Part 8)
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1.	Embankments up to 3 metres	Not less than 15.2 kN/cu.m. height, not subjected to extensive flooding.
2.	Embankments exceeding 3 metres	Not less than 16.0 KN/cu.m height or embankments of any height subject to long periods of inundation
3.	Sub grade and earthen shoulders/verges/backfill	Not less than 17.5 kN/cu.m

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The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

(i) The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

(ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

(iii) The Dry density-moisture content - CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the sub grade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

#### 303.4 GENERAL REQUIREMENTS:

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303.4.1 The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the sub-grade and the embankment portion just below the sub-grade.

303.4.2 Borrow materials:

Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer/the Engineer, arrangement for locating the source of supply of material for embankment and sub-grade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8m width should be left at intervals not exceeding 300m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or sitting of temporary buildings or structures.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub-grade

material when compacted to the density requirements as in Table 300-2 shall yield the design CBR value of the sub-grade.

TABLE 300-2 COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE

Type of work/material Laboratory dry density as per IS: 2720 (Part8)	Relative compaction as percentage of max.
1 Sub-grade and earthen shoulders	Not less than 97
2 Embankment	Not less than 95
3. Expansive Clays	
a) Sub-grade and 500 mm portion just below the sub-grade	Not allowed
b) Remaining portion of embankment	Not less than 90

### 303.5. CONSTRUCTION OPERATIONS

303.5.1. Setting out: After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/sub-grade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/sub-grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

303.5.2. Dewatering: If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

303.5.3. Stripping and storing topsoil: In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired.

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Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum .

303.5.4. Compacting ground supporting embankment/sub-grade: Where necessary, the original ground shall be levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table 300-2.

In case where the difference between the sub-grade level (top of the sub-grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 per cent relative compaction with respect to the dry density as given in Table 300-2, the ground shall be loosened upto a level 0.5 m below the sub-grade level, watered and compacted in layers with Clause 303.5.5 and 303.3.6 to not less than 97 per cent of dry density as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or sub-grade work shall not proceed until the foundations for embankment/sub-grade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments ,resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

#### 303.5.5 Spreading material in layers and bringing to appropriate moisture content

303.5.5.1. The embankment and sub-grade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 305.3.6. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross section of the embankment.

303.5.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but



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without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the sub grade.

303.5.5.3. Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

303.5.5.4 Compaction: Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Smooth wheeled, vibratory, pneumatic tyred, sheeps foot or pad foot rollers, etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 80 to 100 KN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction

The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of alighted category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS : 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurements reveal any soft areas in the embankment /sub grade/earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

303.5.5.5. Drainage: The surface of the embankment/sub grade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent pounding.

303.5.5.6 Repairing of damages caused by rain/spillage of water: The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

303.5.5.7. Finishing operations: Finishing operations shall include the work of shaping and dressing the shoulders/verge/roadbed and side slopes to conform to the alignment, levels, and cross sections and dimension shown on the drawings or as directed by the Engineer subject to the surface tolerance described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier (Clause 303.5.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm. When earthwork operations have been substantially completed, the construction shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

#### *303.6 PLYING OF TRAFFIC:*

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or sub grade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

#### *303.7. SURFACE FINISH AND QUALITY CONTROL OF WORK*

The surface finish of construction of sub grade shall conform to the requirements of Clause 1902. Control on the quality of materials and works shall be exercised in accordance with Clause 2100.

#### *303.8. SUB GRADE STRENGTH*

303.9.1. It shall be ensured prior to actual execution that the borrow area material to be used in the sub grade satisfies the requirements of design CBR.

303.9.2. Sub grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of construction sub grade shall be determined on undisturbed samples cut out from the compacted sub grade in CBR mould fitted with cutting shoe or on remolded samples, compacted to the field density at the field moisture content.

#### *303.9. MEASUREMENTS FOR PAYMENT*

Earth embankment/sub grade construction shall be measured separately by taking cross sections at intervals in the original position before the work starts and after its

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completion and computing the volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cu. m of suitable material brought to site from road and drainage excavation forms one cu. m. of compacted fill and all bulking or shrinkage shall be ignored. Construction of embankment under water shall be measured in cu. m.

Construction of high embankment with specified material and in specified manner shall be measured in cu. m.

Stripping including storing and reapplication of topsoil shall be measured in cu. m. Work involving loosening and recompacting of ground supporting embankment/sub grade shall be measured in cu. m.

Removal of unsuitable material at embankment/sub grade foundation and replacement with suitable material shall be measured in cu. m.

Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cu. m.

### 303.10. RATES

303.10.1. The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for:

(i) Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided otherwise in the Contract ;

(ii) Setting out;

(iii) Compacting ground supporting embankment/sub-grade except where removal and replacement of unsuitable material or loosening and recompacting is involved;

- (i) Cost of watering or drying of material in borrow areas and/or embankment and sub grade during construction as required;
- (ii) Spreading in layers, bringing to appropriate moisture content and compacting to Specification requirements;
- (iii) Shaping and dressing top and slopes of the embankment and sub grade including rounding of corners;

- (iv) Restricted working at sites of structures;
- (v) Working on narrow width of embankment and sub grade;
- (vi) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and sub grade site with all lifts and leads unless otherwise provided for in the Contract;
- (vii) All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications;
- (viii) Dewatering ; and
- (ix) Keeping the embankment/completed formation free of water as per Clause 311.

303.10.2. In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the Contract for construction of embankment and sub grade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

303.10.3. Clause 301.9.5 shall apply as regards Contract unit rates for items of stripping and storing top soil and of reapplication of topsoil.

303.10.4 Clause 301.9.2 shall apply as regards Contract unit rate for the item of loosening and recompacting the embankment/sub grade foundation.

303.10.5. Clause 301.9.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material respectively.

303.10.6. The Contract unit rate for scarifying existing granular/bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. This will also comprise of handling, salvaging, stacking and disposing of the dismantled materials within all lifts and upto a lead of 1000 m or as otherwise specified.

303.10.7 Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

303.10.8. The Contract unit rate for providing and laying filter material behind abutments shall be payment in full for carrying out the required operations including

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all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

303.10.9. Clause 305.4.6 shall apply as regards Contract unit rate for construction of embankment under water.

303.10.10 Clause 305.4.7 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

## 304 SUB GRADE

### 304.1 SCOPE

This section deals with the treatment of the upper layers of earthworks including preparation and surface treatment of the formation, the addition of layers of selected materials, the improvement of in-situ materials by addition and mixing of selected materials.

#### 304.2 DEFINITION

304.2.1 Sub-grade is that portion of the earth roadbed which after having been constructed to reasonably close conformance with the lines, grades, and cross-sections indicated on the plans, receives the base or surface material. The sub-grade whether in cut or fill should be well compacted to utilize its full strength to economize thereby on the overall thickness of pavement required. In a fill section, the sub-grade is the top of the embankment or the fill.

In a cut section the sub-grade is the bottom of the cut. The sub-grade supports the - and/or the pavement section. To ensure a stable, long-lasting, and maintenance free roadway, the sub-grade is required to be constructed using certain proven procedures that provide satisfactory results.

#### 304.2.2 Compaction requirement for sub-grade

The current MORT&H specification for Road and Bridge works recommended that the sub-grade shall be compacted to 97% of Laboratory Maximum Dry Density achieved with heavy compaction (modified proctor density) as per IS:2720 (Part 8). This density requirement is recommended for sub-grade compaction for Expressways, National Highways and other heavily trafficked roads, and Maximum laboratory dry unit weight when tested is not less than 17.5 KN/cu. m as per IS 2720 (Part 8)

#### 304.3 PREPARATION AND SURFACE TREATMENT OF FORMATION

Preparation any specific and surface treatment of the formation, shall be carried out only after completion of sub-grade drainage and unless otherwise agreed by the

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Engineer, immediately prior to laying of operation the sub-base or the road base where no sub-base is required. The sequence shall be as follows:

- a) Full formation, after reinstatement of any soft areas to the required Specifications shall be well cleaned and freed of all mud and slurry.
- b) The surface shall be compacted to the required density by a smooth Wheeled roller of 80 to 100 KN weight after spraying requisite amount of water, if required.

Materials for use in the sub grade shall not contain particles larger than 60 mm. In addition the material shall have a CBR of not less than 7% measured after a 4-day soak on a laboratory mix compacted to 97% MDD (heavy compaction), a swell of less than 1%, a plasticity index of less than 40% and an organic matter content less than 3%. In-situ material in the sub grade in cutting that does not meet these requirements shall either be spoiled or, if suitable, placed in the embankment. The spoiled material shall be replaced with material meeting the requirements for loose material in the sub grade.

304.3.1 Preparation of sub-grade: The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

If sub-grade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operations, an insulation layer of granular materials or over size brick aggregate not less than 10 cm thick of suitable thickness shall be provided for blanketing the sub-grade.

In slushy soil or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total pavement thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

304.3.2 Consolidation: The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as elastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All the undulations in the surface that developed due to rolling shall be made good with material or quarry spoils as the case may be and the sub-grade is re-rolled.

304.3.3 Surface Regularity: The finished surface shall be uniform and conform to the lines, grades and typical cross-sections shown in the drawings. When tested with the

template and straight edge, the variation shall be within the tolerances specified in the table below:

Permissible Tolerances of Surface Regularity

Longitudinal Profile	Cross Profile
Maximum permissible undulation When measured with a 3m straight	Maximum permissible Variation from specified

When the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall rectify these with fresh material or quarry spoils as the case may be, and the sub-grade re-rolled to the satisfaction of the Engineer.

**304.4 MEASUREMENT:**

The length and width shall be measured correct to a cm. the area shall be worked out in square metre, correct to two places of decimal.

**304.5 RATE:**

The rate shall include the cost of materials and labour required for all the operations mentioned above, unless specified otherwise.

**305 SURFACE/SUB-SURFACE DRAINS**

**305.1 SCOPE**

The work shall consist of constructing surface and/or sub-surface drains in accordance with the requirements of these Specifications and to the lines, grades, dimensions and other particulars shown on the drawings or as directed by the Engineer. Schedule of work shall be so arranged that the drains are completed in proper sequence with road works to ensure that no excavation of the completed road works is necessary subsequently or any damage is caused to these works due to lack of drainage.

**305.2 SURFACE DRAINS**

Surface drains shall be excavated to the specified lines, grades, levels and dimensions to the requirements of Clause 301. The excavated material shall be removed from the area adjoining the drains and if found suitable, utilized in embankment/sub-grade construction. All unsuitable material shall be disposed of as directed.

The excavated bed and sides of the drains shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes. Where so indicated,



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drains shall be lined or turfed with suitable materials in accordance with details shown on the drawings.

All works on drain construction shall be planned and executed in proper sequence with other works as approved by the Engineer, with a view to ensuring adequate drainage for the area and minimizing erosion/sedimentation.

### 305.3 SUB-SURFACE DRAINS

#### 305.3.1 Scope

Sub-surface drains shall be of close-jointed perforated pipes, open-jointed imperforated pipes, surrounded by granular material laid in a trench or aggregate drains to drain the pavement courses. Sub-surface drains designed using Geo-synthetic and approved by the Engineer can also be used.

#### 305.3.2 Materials

##### 305.3.2.1 Pipe

Perforated pipes for the drains may be metal/asbestos cement/cement concrete/Poly Vinyl Chloride (PVC)/Poly Propylene (PP)/Poly Ethylene (PE) and perforated pipes of metal vitrified clay/cement concrete/asbestos cement PVC/PP/PE. The type, size and grade of the pipe to be used shall be as specified in the Contract. In no case, however, shall the internal diameter of the pipe be less than 100 mm. Holes for perforated pipes shall be on one half of the circumference only and conform to the spacing indicated on the drawings. Size of the holes shall not ordinarily be greater than half of the size of the material surrounding the pipe, subject to being minimum 3 mm and maximum 6 mm. 085 stands for the size of the sieve that allows 85 percent of the material to pass through it.

##### 305.3.2.2 Backfill Material

Backfill material shall consist of sound, tough, hard, durable particles of free draining sand gravel material or crushed stone and shall be free of organic material, clay balls or other deleterious matter. Unless the Contract specifies any particular gradings for the backfill material or requires these to be designed on inverted filter criteria for filtration and permeability to the approval of the Engineer, the backfill material shall be provided on the following lines:

- i) Where the soil met with in the trench is of fine grained type (e.g., silt, clay or a mixture thereof), the backfill material shall conform to Class I grading set out in-Table 300-3;
- ii) Where the soil met with in the trench is of coarse silt to medium sand or sandy type, the backfill material shall correspond to Class " grading of Table 300-3; and)

- iii) Where soil met with in the trench is gravelly sand, the backfill material shall correspond to Class III grading of Table 300-3.

Geo-synthetic for use with subsurface drain shall conform to the requirements as per Section 700.

### 305.3.3 Trench Excavation

Trench for sub-surface drain shall be excavated to the specified lines, grades and dimensions shown in the drawings provided that width of trench at pipe level shall not be less than 450mm. The excavation shall begin at the outlet end of the drain and proceed towards the upper end. Where unsuitable material is met with at the trench bed, the same shall be removed to such depth as directed by the Engineer and backfilled with approved material which shall be thoroughly compacted to the specified degree.

### 305.3.4 Laying of Pipe and Backfilling

Laying of pipe in the trench shall be started at the outlet end and proceed towards the upper end, true to the lines and grades specified.

Table 300-3: Grading Requirements for Filter Material Percent Passing by Weight

Sieve Designation	Class I	Class II	Class III
53 mm	-	-	100
45 mm	-	-	97 - 100
26.5mm	-	100	-
22.4mm	-	95 - 100	58 - 100
11.2mm	100	40 - 100	40 - 60
5.6mm	92 - 100	28 - 54	4 - 32
2.8mm	83 - 100	20 - 35	0 - 10
1.4mm	59 - 96	-	0 - 5
710 micron	38 - 80	6 - 18	-
355 micron	14 - 40	2 - 9	-
180 micron	3 - 15	-	-
90 micron	0 - 5	0 - 4	0 - 3

Before placing the pipe, backfill material of the required grading(s) shall be laid for full width of the trench bed and compacted to a minimum thickness of 150 mm or as shown on the drawings. The thickness of the backfill material on the sides of the pipe shall be as shown on the drawings subject to a minimum of 150 mm. The pipe shall then be embedded firmly on the bed.

Perforated pipes, unless otherwise specified, shall be placed with their perforations down to minimize clogging. The pipe sections shall be joined securely with appropriate coupling fittings or bands.

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Non-perforated pipes shall be laid with joints as close as possible with the open joints wrapped with suitable pervious material (like suitable Geosynthetic of not less than 150 mm width) to permit entry of water but prevent fines entering the pipes. In the case of non-perforated pipes with bell end, the bell shall face upgrade.

Upgrade end sections of the pipe installation shall be tightly closed by means of concrete plugs or plugs fabricated from the same material as the pipe and securely held in place to prevent entry of soil materials.

After the pipe installation has been completed and approved, backfill material of the required grading (s) (see Clause 309.3.2.2) shall be placed over the pipe to the required level in horizontal layers not exceeding 150 mm in thickness and thoroughly compacted. The minimum thickness of material above the top of the pipe shall be 300 mm.

Unless otherwise provided, sub-surface drains not located below the road pavement shall be sealed at the top by means of 150 mm thick layer of compacted clay so as to prevent percolation of surface water.

#### 305.3.5 Use of Geo-synthetic in Laying of Pipe and Backfilling

After excavating the trench for subsurface drain, the filter fabric shall be placed, the pipe installed and the trench backfilled with permeable material according to dimensions and details shown on the drawings. Surfaces to receive filter fabric prior to placing shall be free of loose or extraneous material and sharp objects that may damage the filter fabric during installation. Adjacent rolls of the fabric shall be overlapped a minimum of 450 mm. The preceding roll shall overlap the following roll in the direction the material is being spread.

Damage to the fabric resulting from Contractor's vehicles, equipment or operations shall be replaced or repaired by the Contractor at his Cost.

#### 305.3.6 Drain Outlet

The outlet for a sub-surface drain shall not be under water or plugged with debris but should be a free outlet discharging into a stream, culvert or open ditch. The bottom of the pipe shall be kept above high water level in the ditch and the end protected with a grate or screen. For a length of 500 mm from the outlet end, the trench for pipe shall not be provided with granular material but backfilled with excavated soil and thoroughly compacted so as to stop water directly percolating from the backfill material around the pipe. The pipe in this section shall not have any perforations.

#### 305.3.7 Aggregate Drains

Aggregate drains shall be placed within the verge/shoulders after completion of the pavement. Depth, thickness and spacing of the aggregate drains shall be as shown on the drawings.

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Trenches for aggregate drains shall be excavated to a minimum width of 300 mm and to the depth shown on the drawings or ordered by the Engineer. The bottom of the trench shall be sloped to drain and shall be free from loose particles of soil. The trench shall be excavated so as to expose clearly the granular pavement courses to be drained.

Aggregate for the drains shall be durable gravel, stone or slag and shall be free from vegetable matter and other deleterious substances. The grading requirements are given in Table 300-4. Grading to be adopted shall be indicated in the drawings.

Table 300-4: Grading Requirements for Aggregate Drains

Sieve Designation	Percent passing by weight	
	Type A	Type B
63 mm	-	-
37.5mm	100	85 – 100
19 mm	-	0 – 20
9.5 mm	45 – 100	0 – 5
3.35 mm	25 - 80	-
600 micron	8 – 45	-
150 micron	0 – 10	-
75 micron	0 - 5	-

#### 305.4 MEASUREMENTS FOR PAYMENT

Measurement for surface and sub-surface drains shall be per running metre length of the drain.

#### 305.5 RATES

The Contract unit rates for surface and sub-surface drains shall be payment in full for all items such as excavation, dressing the sides and bottom; providing lining, turving, pitching, concrete and plastering; providing, laying and jointing pipes including wrapping with geo-synthetic fabric; providing, laying and compacting backfill around the pipe, granular providing, fixing and painting of cover etc. including full compensation for all materials labour, tools, equipment and other incidentals to

complete the work as shown on drawing with all leads and lifts including removal of unsuitable material.

Provision of inlets outlet, grating, sumps, outlet pipes, bedding, disbursers etc where required shall be incidental to construction of drain.

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400 SUB - BASE, BASE COURSE AND SHOULDERS

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## 401 GRANULAR SUB-BASES

## 401.1 SCOPE

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

The use of low cost natural materials is proposed for subbase and also for required capping materials and selected sub-grade. These materials can be selected from the hill-cut areas following laboratory testing to confirm that they meet the requirements of the appropriate specification. Results from the field reconnaissance and the laboratory test results indicate that there will be an abundance of suitable material at Toorsa river bed for all of the project roads. Haul distances are expected to be short – from 1 to 6kilometres. Some processing – for example to have the require sizes of material jaw crusher with excavator or using stone crusher can be made available for the production.

401.1.1 Materials: The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall be free from organic or other deleterious constituents and conform tone of the three grading given in table 400.1 below.

401.1.2. Physical requirements: The material shall have a 10 per cent fines value of 50 KN or more (for sample in soaked condition) when tested in compliance with BS: 812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which be taken as being the density relating to a uniform air voids content of 5 percent.

Table 400.1: Grading for close graded GSB materials

% by weight passing the IS sieve

IS Sieve Designation	Grading I	Grading II	Grading III
75.0mm	100		
53.0mm	80 - 100	100	
26.5mm	55 – 90	70 - 100	100
9.5mm	35 - 65	50 - 80	65 – 95
4.75mm	25 - 55	40 - 65	50 – 80
2.36mm	20 - 40	30 - 50	40 – 65
.425mm	10 - 25	15 - 25	20 – 35
0.075mm	3 - 10	3 - 10	3 – 10
Min CBR Value	30	25	20

Table 400.2: Grading for coarse graded GSB materials

% by weight passing the IS sieve

IS Sieve Designation	Grading I	Grading II	Grading III
75.0mm	100		
53.0mm	-	100	
26.5mm	55 – 75	50 - 80	100
9.5mm	-	-	-
4.75mm	10 - 30	15 - 35	25 – 45

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2.36mm	-	-	-
.425mm	-	-	-
0.075mm	<10	< 10	< 10
Min CBR Value	30	25	20

*Note: The material passing 425 micron sieve shall for all the three grading when tested shall have liquid limit and plasticity index not more than 25 and 6 % respectively*

401.1.3 Strength of sub-base: It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished. When directed by the Engineer, this shall be verified by performing CBR tests as required on specimens remolded at field dry density and moisture content and any other tests for the “quality” of the materials, as may be necessary.

#### 401.2 CONSTRUCTION OPERATIONS

Preparation of sub-grade: Immediately prior to the laying of the sub-base, the sub-grade already finished to Clause 401as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80- 100 KN smooth wheeled roller.

Spreading and Compacting: The sub-base material of grading specified in the contract shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and the grade during the operation or other means as approved by the engineer. When the sub-base materials consist of combination of materials mentioned above, mixing shall be mechanically done by the mix-in place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small sized jobs. The equipment used for mix-in-place construction shall be similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, Trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720(Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water for uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (Part 8).



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While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed mechanical or other approval means like disc harrows, rotavators until the layer is uniformly wet.

#### 401.3 ROLLING

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 225 mm the compaction shall be done with the help of a vibratory roller of a minimum 80 to 100 KN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/m<sup>2</sup> or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super-elevation and shall commence at the edges and progress towards the centre for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 Km per hour.

Rolling shall be continued till density is at least 98% of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

#### 401.4 CURING

The sub-base course shall be suitably cured for a minimum period of 7 days after which subsequent pavement courses shall be laid to prevent the surface from drying out and becoming friable. No traffic of any kind shall ply over the completed sub-base unless permitted by the Engineer.

#### 401.5 SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction shall conform to the requirements of Clause 1902.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1900.

#### 401.6 MEASUREMENTS FOR PAYMENT:

GSB shall be measured as finished work in position in cubic meters. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

#### 401.7 RATE:

The contract unit rate for granular sub-base shall be payment in full for carrying out the required operations.

### 402. WET MIX MACADAM

#### 402.1 SCOPE

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-grade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these specifications

The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the engineer. The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. when vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200mm upon approval of the engineer.

#### 402.2 MATERIALS:

##### *Aggregates:*

Physical Requirements: Coarse aggregates shall be crushed stone. If Gravel/shingle is used, not less than 90% by weight of the gravel/shingle pieces retained on 4.75mm sieve shall have at least two fractured faces. The aggregate shall conform to the physical requirements set forth in the table 400.3 given below:

Table 400.3: Physical; requirements of coarse aggregate for WMM for the sub-base base course.

Test	Test Methods	Requirements
Los Angeles abrasion value test	IS : 2386 (Part-4)	40 percent maximum
Aggregate impact value test	IS : 2386 (Part-4) or IS :	30 percent maximum

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Combined flakiness and  
elongation indices(combined) IS : 2386 (Part-1) 30 percent maximum

*\*Aggregates may satisfy the requirements of either of the two tests*

*\*\*To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone divided by weight of stone sample. Only the elongated particles be separated out from the remaining nonflaky stone metal. Elongation index is the weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added*

If the water absorption value of the coarse aggregates is greater than 2 percent, the soundness test shall be carried out on the material delivered in the site as per IS: 2386 (part 5) Grading Requirements: The aggregates shall conform to the grading given in the table 400.4 below:

Table 400.4: Grading requirements of aggregates for WMM

IS sieve Designation	% by weight passing the IS sieve
53.00mm	100
45.00mm	95 – 100
26.50mm	-
22.40mm	60 – 80
11.20mm	40 – 60
4.75mm	25 – 40
2.36mm	15 – 30
600 micron	8 – 22
75 micron	0 – 8

Materials finer than 425 micron shall have plasticity index (PI) not exceeding 6.

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The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve and vice-versa.

#### 402.3 CONSTRUCTION OPERATIONS

402.3.1 Preparation of Base: The base of the sub-grade/sub-base/base shall be prepared to the specified lines and cross fall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

402.3.2 Preparation of lateral confinement of aggregates: While constructing WMM, arrangement shall be made for the lateral confinement of wet mix. This shall be done laying materials in adjoining shoulders along with that of WMM layer.

402.3.3 Preparation of Mix: WMM shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part 8) after replacing the aggregate fraction retained on 22.4mm sieve with material of 4.75mm to 22.4mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

402.3.4 Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread by motor grader. For portions where mechanical means cannot be used, manual means as approved by the engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

402.3.5 Compaction: After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 KN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 KN or equivalent capacity roller. The speed of roller shall not exceed 5km/h.

In portions having a unidirectional cross fall/super-elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly overlapping each preceding track by at least one-third width until the entire surface had been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centerline of the road uniformly overlapping each of the preceding tracks by at least one third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good. Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching on an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling shall not be done when the subgrade is soft yielding or when it causes a wave like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceeds 123 mm when tested with a 3 m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed materials be permitted to makeup the depressions.

Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material.

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

402.3.6 Setting and Drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hrs.

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402.3.7 Opening to traffic: No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

#### *402.4 MEASUREMENT FOR PAYMENT*

WMM shall be measured as finished work in position in cubic meters.

#### *402.5 RATES:*

The unit rate for WMM shall be payment in full for carrying out all the required operations.

### 403 SHOULDERS, ISLANDS AND MEDIANS

#### *403.1 SCOPE*

The work shall consist of constructing shoulder (hard/paved/earthen with brick or stone block edging) on either side of the pavement, median in the road dividing the carriageway into separate lanes and islands for channelizing the traffic at junctions in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross sections shown on the drawings or as directed by the Engineer.

#### *403.2 MATERIALS*

Shoulder on either side of the road may be of selected earth/granular material/paved conforming to the requirements of Clause 303/400 and the median may be of selected earth conforming to the requirements of Clause 303.

Median Traffic islands shall be raised and kerbed at the perimeter and the enclosed area filled with earth and suitably covered with grass turf/shrubs.

Paved shoulders shall consist of sub-base, base and surfacing courses, as shown in the drawings and materials for the same shall conform to relevant Specifications of the corresponding items. Where paved or hard shoulders are not provided, the pavement shall be provided with brick/stone block edgings as shown in the drawings. The brick shall conform to Clause 2003 of these Specifications. Stone blocks shall conform to Clause 2004 of these Specifications and shall be of size 225 mm x 110 mm x 75 mm.

#### *403.3 SIZE OF SHOULDERS/MEDIANS/ISLANDS*

Shoulder (earthen/hard/paved)/median/traffic island dimensions shall be as shown on the drawings or as directed by the Engineer.

#### 403.4 CONSTRUCTION OPERATIONS

##### 403.4.1 Shoulders

The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved shoulder portion shall be compacted thereafter, which shall be followed by compaction of each shoulder layer.

The adjacent layers having same material shall be laid and compacted together. In all cases where paved shoulders have to be provided alongside of existing carriageway, the existing shoulders shall be excavated in full width and to the required depth as per Clause 300. Under no circumstances, box cutting shall be done for construction of shoulders.

Compaction requirement of earthen shoulder shall be as per Table 300-3. In the case of bituminous courses and concrete pavement, work on shoulder shall start only after the pavement course has been laid and compacted.

During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water. Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned.

##### 403.4.2 Median and Islands

Median and islands shall be constructed in a manner similar to shoulder up to the road level. Thereafter, the median and islands, if raised, shall be raised at least 300 mm by using kerb stones of approved material and dimensions and suitably finished and painted as directed by the Engineer. If not raised, the median and islands shall be differentiated from the shoulder/ pavement as the case may be, as directed by the Engineer.

The confined area of the median and islands shall be filled with local earth or granular material or any other approved material and compacted by plate compactor/power rammer. The confined area after filling with earth shall be turfed

with grass or planted with shrubs, or finished with tiles/slabs as provided in the drawings.

#### 403.4.3 Brick/Stone Block Edging

The brick/stone blocks shall be laid on edge, with the length parallel to the transverse direction of the road. They shall be laid on a bed of 25 mm sand, set carefully rolled into position by a light roller and made flush with the finished level of the pavement.

#### 403.5 SURFACE FINISH AND QUALITY CONTROL OF WORKS

The surface finish of construction shall conform to the requirements of Clause 1902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with section 1900.

#### 403.6 Measurements for Payment

Shoulder (earthen/hard/paved), island and median construction shall be measured as finished work in position as below:

- i) For excavation in cu.m.
- ii) For earthwork/granular fill in cu.m.
- iii) For sub-base, base, surfacing courses in units as for respective items
- iv) For kerb in running metre; length of kerb for median shall be measured for each side separately.
- v) For turfing, shrubs and tile/slab finish in sq.m.
- vi) For brick/stone block edging in running metre, the length for brick/ stone block edging for median edging shall be measured for each side separately.

#### 403.7 RATE

The Contract unit rate for shoulder (hard/paved/earthen with brick or stone block edging), island and median construction shall be payment in full for carrying out the required operations.

The rate for brick/stone block edging shall include the cost of sand cushion.



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404 FOOTPATHS / SEPARATORS

## 404.1 SCOPE

The work shall consist of constructing footpaths and/or separators at locations as specified in the drawings or as directed by the Engineer. The lines, levels and dimensions shall be as per the drawings. The scope of the work shall include provision of all drainage arrangements as shown in the drawings or as directed by the Engineer.

## 404.2 MATERIALS

The footpaths and separators shall be constructed with any of the following types:

- a) Cast-in-situ cement concrete of Grade M20 as per Section 1700 of the Specifications. The minimum size of the panels shall be as specified in the drawings
- b) Precast cement concrete blocks and interlocking blocks/tiles of grade not less than M30 as per Section 1700 of the Specifications. The thickness and size of the cement concrete blocks or interlocking blocks/tiles shall be as specified in the drawings.
- c) Natural stone slab cut and dressed from stone of good and sound quality, uniform in texture, free from defects and at least equal to a sample submitted by the Contractor and approved by the Engineer.  
The thickness and size of the natural stone slab shall be as specified in the drawings.

## 404.3 CONSTRUCTION OPERATIONS

Drainage pipes below the footpath originating from the kerbs shall be first laid in the required slope and connected to the drains/sumps/storm water drain/drainage chutes as per provisions of the drawings, or as specified.

Portion on back side of kerbs shall be filled and compacted with granular sub-base material as per Clause 401 of the Specifications in specified thickness.

The base for cast-in-situ cement concrete panels/ tiles/ nature stone slab shall be prepared and finished to the required lines, levels and dimensions as indicated in the drawings.

Over the prepared base, precast concrete interlocking blocks/tiles/natural stone slabs and/or cast-in- situ slab shall be set/laid as described as above

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**405.4 TILES/NATURAL STONE SLABS**

The blocks/tiles/slabs shall be set on a layer of average 12 mm thick cement-sand mortar (1:3) laid on prepared base in such a way that there is no rocking. The gaps between the blocks/tiles/slabs shall not be more than 12 mm and shall be filled with cement-sand mortar (1:3).

**404.5 CAST-IN-SITU CEMENT CONCRETE**

The panels of specified size shall be cast on the prepared base in panels of specified size in a staggered manner. Construction joints shall be provided as per Section 700 of the Specifications.

**404.5.1 Precast Concrete Blocks and Interlocking Concrete Block Pavements**

The precast concrete blocks and interlocking concrete block pavement shall be laid on a bedding of sand of thickness specified in the drawing. The grading of the sand layer shall be as in Table 400-4.

Table 400 – 4 Grading of Sand

IS Sieve Size	Percent passing
9.52 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	50-95
600 micron	25-60
300 micron	10-30
150 micron	0-15
75 micron	0-10

The joints shall be filled with sand passing a 2.35 mm size with the grading as in Table 400-5.

Table 400 –5 Grading of Sand

IS Sieve Size	Percent Passing
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2.36 mm	100
1.1 8 mm	90-100
600 micron	60-90
300 micron	30-60
1 50 micron	15-30
75 micron	0-10

The bedding sand slightly moist, the moisture content being about 4 percent. The bedding sand shall be compacted by vibratory plate compactor. The blocks shall be laid to the levels indicated on the drawings and to the pattern directed by the Engineer. The surface tolerance shall be  $\pm 10$  mm with respect to the design level. The blocks shall be embedded using a hammer.

#### *404.6 MEASUREMENTS FOR PAYMENT*

Footpaths and separators shall be measured in Sq.m between inside of kerbs. The edge restraint block and kerb shall be measured separately in linear meter. The items pertaining to drainage shall be measured separately.

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#### *404.7 RATE*

Contract unit rates shall be inclusive of full compensation for all labour, materials, tools equipment for footpaths including the base. Cost of providing pipes and arrangement for their discharge into appropriate drainage channels shall be incidental to the construction of footpaths.

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500 CONCRETE PAVEMENTS

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## 501. DRY LEAN CONCRETE

## 501.1 SCOPE

The work shall consist of construction of (zero slump) dry lean concrete sub-base for cement concrete pavement in accordance with the requirements of and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations, in connection with the work, as approved by the Engineer.

The design parameters of dry lean concrete sub-base, viz., width, thickness, grade of concrete, details of joints, if any, etc. shall be as stipulated in the drawings.

## 501.2 MATERIALS

## 501.2.1 Sources of Materials

The Contractor shall indicate to the Engineer the source of all materials with relevant test data to be used in the dry lean concrete work sufficiently in advance and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work in trial length. If the Contractor later proposes to obtain the materials from a different source during the execution of main work, he shall notify the Engineer with relevant test data for his approval at least 45 days before such materials are to be used.

## 501.2.2 Cement

Any of the following types of cement may be used with prior approval of the Engineer:

Sl No.	Type	Confirming to
i)	Ordinary Portland Cement 43 Grade	IS:81 1 2
ii)	Portland Slag Cement	IS:455
iii)	Portland Pozzolana Cement	IS:1 489-Part I

If the sub grade soil contains soluble Sulphate in a concentration more than 0.5 percent, Sulphate resistant cement conforming to 1S:6909 shall be used.

Cement to be used may preferably be obtained in bulk form. It shall be stored in accordance with stipulations contained in Clause 2014 and shall be subjected to acceptance test prior to its immediate use.

#### 501.2.3 Aggregates

Aggregates for lean concrete shall be natural material complying with 18:383. The aggregates shall not be alkali reactive. The limits of deleterious materials shall not exceed the requirements set forth in Table 600-2. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching, or as directed by the Engineer.

#### 501.2.4 Coarse Aggregates

Coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 31.5 mm for pavement concrete. No aggregate which has water absorption more than 2 percent shall be used in the concrete mix. The aggregates shall be tested for soundness in accordance with 18:2386 (Part-5). After 5 cycles of testing, the loss shall not be more than 12 percent if sodium sulphate solution is used or 18 percent if magnesium sulphate solution is used. The Los Angeles Abrasion value shall not exceed 35. The combined flakiness and elongation index of aggregate shall not be more than 35 percent.

Coarse aggregates shall comply with Clause 602.2.6.2, of MORTH Specification, except that the maximum size of the coarse aggregate shall be 26.5 mm, and aggregate gradation shall comply with Table 500-1 as below:

Table 500-1: Aggregate Gradation for Dry Lean Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
26.50 mm	100
19.0 mm	75 – 95
9.50 mm	50 – 70
4.75 mm	30 – 55

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2.36 mm	17 – 42
600 micron	8 – 22
300 micron	7 – 17
150 micron	2 – 12
75 micron	0 - 10

### 501.2.5 Fine Aggregates

The fine aggregates shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS: 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregates shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37).

Gradation table of Fine Aggregates as per IS 383 – 1970, Table 4

Table 500.2

Percentage passing for

IS Sieve Designation	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90 – 100	90 – 100	90 – 100	95 – 100
2.36mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18 mm	30 – 70	55 – 90	75 – 100	90 – 100
600 micron	15 – 34	35 – 59	60 – 79	80 – 100
300 micron	5 - 20	8 – 30	12 – 40	15 – 50
170 micron	0 - 10	0 – 10	0 - 10	0 – 15

The coarse material after blending shall conform to the grading as indicated in Table 500-1.

### 501.3 WATER

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. Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456. Potable water is generally considered satisfactory for mixing concrete. The pH value of water shall be not less than 6.

#### *501.4. STORAGE OF MATERIALS*

All materials shall be stored in accordance with the provisions of Clause 2014 of these Specifications and other relevant IS Specifications. All efforts must be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for use in the work. The storage place must also permit easy inspection, removal and storage of materials. All such materials even though stored in approved godowns must be subjected to acceptance test immediately prior to their use.

#### *501.5 PROPORTIONING OF MATERIALS FOR THE MIX*

The mix shall be proportioned with a maximum aggregate cement ratio of 15:1. The water content shall be adjusted to the optimum as per Clause 501.5.1 for facilitating compaction by rolling. The strength and density requirements of concrete shall be determined in accordance with Clause 501.7 by making trial mixes.

501.5.1. Moisture content: The right amount of water for the lean concrete in the main work shall be decided so as to ensure full compaction under rolling and shall be assessed at the time of rolling the trial length. Too much water will cause the lean concrete to be heaving up before the wheels and picked up on the wheels of the roller and too little will lead to inadequate compaction, a low in-situ strength and an open-textured surface.

The optimum water content shall be determined and demonstrated by rolling during trial length construction and the optimum moisture content and degree of compaction shall be got approved from the Engineer. While laying in the main work, the lean concrete shall have moisture content between the optimum and optimum +2 per cent, keeping in view the effectiveness of compaction achieved and to compensate for evaporation losses.

501.5.2 Cement content: The minimum cement content in the lean concrete shall not be less than 150 kg/cu.m. of concrete. If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary without additional cost compensation to the Contractor.

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501.5.3 Concrete strength: The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 501.8 shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

#### 501.6 SUB-GRADE

The sub-grade shall conform to the grades and cross sections shown on the drawings and shall be uniformly compacted to the design strength in accordance with these Specifications and Specification stipulated in the Contract. The lean concrete sub-base shall not be laid on a sub-grade softened by rain after its final preparation; surface trenches and soft spots, if any, must be properly back-filled and compacted to avoid any weak or soft spot. As far as possible, the construction traffic shall be avoided on the prepared sub-grade. A day before placing of the sub-base, the sub-grade surface shall be given a fine spray of water and rolled with one or two passes of a smooth wheeled roller after a lapse of 2-3 hours in order to stabilize loose surface. If Engineer feels it necessary, another fine spray of water may be applied just before placing sub-base.

#### 501.7 CONSTRUCTION

501.7.1. General: The pace and programme of the lean concrete sub base construction shall be matching suitably with the programme of construction of the cement concrete pavement over it. The sub-base shall be overlaid with cement concrete pavement only after 7 days after sub base construction.

501.7.2. Batching and mixing: The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clause 700. The cement from the bulk stock shall be weighed separately from the aggregates. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity for the laying arrangements.

The batching and mixing shall be carried out preferably in a forced action central batching and mixing plant having necessary automatic controls to ensure accurate proportioning and mixing. Other types of mixers shall be permitted subject to demonstration of their satisfactory performance during the trial length. The type and capacity of the plant shall be got approved by the Engineer before commencement of the trial length. The weighing balances shall be calibrated by weighing the aggregates, cement, water and admixtures physically either by weighing in the large weighing machine or in a weigh bridge. The accuracy of weighing scales of the batching plant shall be within  $\pm 2$  per cent in the case of aggregates and  $\pm 1$  per cent in the case of cement and water.



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The design features of Batching Plant should be such that the shifting operations of the plant will not take very long time when they are to be shifted from place to place with the progress of the work.

501.7.3. Transporting: Plant mix lean concrete shall be discharged immediately from the mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tippers/dumpers with tarpaulin during transit. The concrete shall be transported by tipping trucks, sufficient in number to ensure a continuous supply of material to feed the laying equipment to work at a uniform speed and in an uninterrupted manner. The lead of the batching plant to paving site shall be such that the travel time available from mixing to paving as specified in Clause 501.7.5 will be adhered to.

501.7.4. Placing: Lean concrete shall be laid/placed by a paver with electronic sensor. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. The paving machine shall have high amplitude tamping bars to give good initial compaction to the sub-base. The laying of the two-lane road sub-base done either in full width or lane by lane. Preferably the lean concrete shall be placed and compacted across the full width of the road, by constructing it in one go or in two lanes running forward simultaneously. Transverse and longitudinal construction joints shall be staggered by 500-1000 mm and 200-400 mm respectively from the corresponding joints in the overlaying concrete slabs.

#### 501.7.5. Compaction

The compaction shall be carried out immediately after the material is laid and leveled. In order to ensure thorough compaction which is essential, rolling shall be continued on the full width till there is no further visible movement under the roller and the surface is closed. The minimum dry density obtained shall be 97 per cent of that achieved during the trial length construction vide Clause 501.11. The densities achieved at the edges i.e 0.5 m from the edge shall not be less than 95 percent of that achieved during the trial construction vide Clause 501.11.

The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possible and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the layer and the final finishing of the same shall not exceed 90 minutes when the concrete temperature is above 25 and below 30 degree Celsius and 120 minutes if less than 25 degree Celsius.

This period may be reviewed by the Engineer in the light of the results of the trial run but in no case shall it exceed 2 hours. Work shall not proceed when the temperature of the concrete exceeds 30 degree Celsius. If necessary, chilled water or addition of ice may be resorted to for bringing down the temperature. It is desirable to stop concreting when the ambient temperature is above 35° C. After compaction has been completed, roller shall not stand on the compacted surface for the duration of

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the curing period except during commencement of next day's work near the location where work was terminated the previous day.

Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 KN static weight are considered to be suitable for rolling dry lean concrete. In case any other roller is proposed, the same shall be got approved from the Engineer, after demonstrating its performance.

The number of passes required to obtain maximum compaction depends on the thickness of the lean concrete, the compatibility of the mix, and the weight and type of the roller etc., and the same as well as the total requirement of rollers for the job shall be determined during trial run by measuring the in-situ density and the scale of the work to be undertaken.

In addition to the number of passes required for compaction there shall be a preliminary pass without vibration to bed the lean concrete down and again a final pass without vibration to remove roller marks and to smoothen the surface.

Special care and attention shall be exercised during compaction near joints, kerbs, channels, side forms and around gullies and manholes. In case adequate compaction is not achieved by the roller at these points, use of plate vibrator shall be made, if so directed by the Engineer.

The final lean concrete surface on completion of compaction and immediately before overlaying shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects. The final surface shall be inspected immediately on completion and all loose, segregated or defective areas shall be corrected by using fresh lean concrete material laid and compacted as per Specification. For repairing honey combed surface, concrete with aggregates of size 10 mm and below shall be spread and compacted.

It is necessary to check the level of the rolled surface for compliance. Any level/thickness deficiency should be corrected after applying concrete with aggregates of size 10 mm and below after roughening the surface. Similarly the surface regularity also should be checked with 3 m straightedge. The deficiency should be made up with concrete with aggregates of size 10 mm and below.

Segregation of concrete in the dumpers shall be controlled by premixing each fraction of the aggregates before loading in the bin of the batching plant, by moving the dumper back and forth while discharging the mix on it and other means. Even paving operation shall be such that the mix does not segregate.

#### *501.8 SAMPLING AND TESTING OF CUBES*

Samples of dry lean concrete for making cubes shall be taken from the uncompacted material from different locations immediately before compaction at the rate of 3 samples for each 1000 sq.m or part thereof laid each day. The sampling of mix shall

be done from the paving site shall be made for each type of mix from the concrete delivered to the paving plant. Each pair shall be from a different delivery of concrete and tested at a place to be designated by the Engineer in accordance with the testing procedure as outlined in Clause 700.

Groups of four consecutive results from single specimens tested at 28 days shall be used for assessing the strength for compliance with the strength requirements. The specimens shall be transported in an approved manner to prevent sudden impact causing fractures or damage to the specimen. The flexural strength test results shall prevail over compressive strength tests for compliance.

501.8.1 A quality control chart indicating the strength values of individual specimens shall be maintained for continuous quality assurance. Where the requirements are not met with, or where the quality of the concrete or its compaction is suspect, the actual strength of the concrete in the slab shall be ascertained by carrying out tests on cores cut at the rate of 2 cores for every 150 cu.m of concrete. The average of the results of crushing strength tests on these cores shall not be less than 0.8 x 0.85 times the corresponding characteristic compressive strength of cubes, where the height to diameter ratio of the cores is two. Where height to diameter ratio is not two, necessary corrections shall be made in calculating the crushing strength of cubes in the following manner.

#### *501.9 JOINTS*

Contraction and longitudinal joints shall be provided as per the drawing. At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical face where the correct thickness of the properly compacted material has been obtained.

#### *501.10 CURING*

As soon as the lean concrete surface is compacted, curing shall commence. One of the following two methods shall be adopted:

- (a) The initial curing shall be done by spraying with liquid curing compound. The curing compound shall be white pigmented or transparent type with water retention index of 90 per cent when tested in accordance with BS 7542. Curing compound shall be sprayed immediately after rolling is complete. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days.
- (b) Curing shall be done by covering the surface by gunny bags/hessian, which shall be kept continuously moist for 7 days by sprinkling water.

#### *501.11 TRIAL MIXES*

The Contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 per cent using cement content specified and the specified aggregate grading but without violating the requirement of aggregate-cement ratio specified in Clause 704.

Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix shall be done in three layers with vibratory hammer fitted with a square or rectangular foot as described in Clause 501.8. After establishing the optimum moisture, a set of six cubes shall be cast at that moisture for the determination of compressive strength on the 3rd and the seventh day. Trial mixes shall be repeated if the strength is not satisfactory either by increasing cement content or using higher grade of cement. After the mix design is approved, the Contractor shall construct a trial section.

If during the construction of the trial length, the optimum moisture content determined as above is found to be unsatisfactory, the Contractor may make suitable changes in the moisture content to achieve a satisfactory mix. The cube specimens prepared with the changed moisture content should satisfy the strength requirement. Before production of the mix, natural moisture content of the aggregate should be determined on a day-to-day basis so that the moisture content could be adjusted. The mix finally designed should neither stick to the rollers nor become too dry resulting in raveling of surface.

#### 501.11.1 Trial Length

The trial length shall be constructed at least 14 days in advance of the proposed date of commencement of work. At least 30 days prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a "Method Statement" giving detailed description of the proposed materials, plant, equipment, mix proportion, and procedure for batching, mixing, laying, compaction and other construction procedures. The Engineer shall also approve the location and length of trial construction which shall be a minimum of 60 m length and for full width of the pavement. The trial length shall contain the construction of at least one transverse construction joint involving hardened concrete and freshly laid sub-base. The construction of trial length will be repeated till the Contractor proves his ability to satisfactorily construct the sub-base.

In order to determine and demonstrate the optimum moisture content which results in the maximum dry density of the mix compacted by the rolling equipment and the minimum cement content that is necessary to achieve the strength stipulated in the drawing, trial mixes shall be prepared as per Clause 501.7.

After the construction of the trial length, the in-situ density of the freshly laid material shall be determined by sand replacement method with 20 cm dia density cone. Three density holes shall be made at locations equally spaced along a diagonal that bisects the trial length; average of these densities shall be determined. These main density holes shall not be made in the strip 50 cm from the edges. The average

density obtained from the three samples collected shall be the reference density and is considered as 100 per cent. The field density of regular work will be compared with this reference density in accordance with Clause 501.7. A few cores may be cut as per the instructions of the Engineer to check segregation or any other deficiency.

The hardened concrete shall be cut over 3 m width and reversed to inspect the bottom surface for any segregation taking place. The trial length shall be constructed after making necessary changes in the gradation of the mix to eliminate segregation of the mix. The lower surface shall not have honey-combing and the aggregates shall not be held loosely at the edges.

The trial length shall be outside the main works. The main work shall not start until the trial length has been approved by the Engineer. After approval has been given the materials, mix proportions, moisture content, mixing, laying, compaction plant and construction procedures shall not be changed without the approval of the Engineer.

#### *501.12 TOLERANCES FOR SURFACE REGULARITY, LEVEL, THICKNESS, DENSITY AND STRENGTH*

The tolerances for surface regularity, level, thickness, density and strength shall conform to the requirements given in Clause 1900. Control of quality of materials and works shall be exercised by the Engineer in accordance with section 1900.

#### *501.13 TRAFFIC*

No heavy commercial vehicles like trucks and buses shall be permitted on the lean concrete sub-base after its construction. Light vehicles if unavoidable may, however, be allowed after 7 days of its construction with prior approval of the Engineer.

#### *501.14 MEASUREMENTS FOR PAYMENT*

The unit of measurement for dry lean concrete pavement shall be the cubic metre of concrete placed, based on the net plan areas for the specified thickness shown on the drawings or as directed by the Engineer.

#### *501.15 RATE*

The Contract unit rate payable for dry lean concrete sub-base shall be payment in full for carrying out the required operations including full compensation for all labour, materials and equipment, mixing, transport, placing, compacting, finishing, curing, testing and incidentals to complete the work as per Specifications, all royalties, fees, storage and rents where necessary and all leads and lifts.

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502. PLAIN CEMENT CONCRETE PAVEMENT (*RIGID PAVEMENT*)502.1. *SCOPE*

The work shall consist of construction of unreinforced, dowel jointed, plain cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross sections shown on the drawings. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations in connection with the work, as approved by the Engineer.

The design parameters, viz., thickness of pavement slab, grade of concrete, joint details etc. shall be as stipulated in the drawings.

502.2. *MATERIALS*

502.2.1. Source of materials: The Contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work. If the Contractor later proposes to obtain materials from a different source, he shall notify the Engineer for his approval, at least 45 days before such materials are to be used with relevant test data.

502.2.2. Cement: Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer, but the preference should be to use at least the 43 Grade or higher.

- i) Ordinary Portland cement, 33 Grade IS: 269.
- ii) Ordinary Portland cement, 43 Grade IS: 8112.
- iii) Ordinary Portland cement, 53 Grade IS: 12269.

If the soil around has soluble salts like sulphate in excess of 0.5 per cent, the cement used shall be sulphate resistant and shall conform to IS : 12330.

Guidance may be taken from IS: SP: 23, Handbook for Concrete Mixes for ascertaining the minimum 7 days strength of cement required to match with the design concrete strength. Cement to be used may preferably be obtained in bulk form. If cement in paper bags are proposed to be used, there shall be bag-splitters with the facility to separate pieces of paper bags and dispose them of suitably. No paper pieces shall enter the concrete mix. Bulk cement shall be stored in accordance with Clause 2014. The cement shall be subjected to acceptance test just prior to its use.

502.2.3. Admixtures: Admixtures conforming to IS: 6925 and IS: 9103 shall be permitted to improve workability of the concrete or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious

effect on steel bars. The particulars of the admixture and the quantity to be used must be furnished to the Engineer in advance to obtain his approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in trial paving works. If air entraining admixture is used, the total quantity of air in air-entrained concrete as a percentage of the volume of the mix shall be  $5 \pm 1.5$  per cent for 25 mm nominal size aggregate.

#### 502.2.4. Aggregates

Aggregates for pavement concrete shall be natural material complying with IS: 383 but with a Los Angeles Abrasion Test result not more than 35 per cent. The limits of deleterious materials shall not exceed the requirements set out in IS: 383.

The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalis in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 per cent by weight and the total sulphate content expressed as sulphuric anhydride (SO<sub>3</sub>) shall not exceed 0.25 per cent by weight.

502.2.4.1. Coarse aggregate: Coarse aggregate shall consist of clean, hard, strong, dense, nonporous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 25 mm for pavement concrete. Continuously graded or gap graded aggregates may be used, depending on the grading of the fine aggregate. No aggregate which has water absorption more than 2 per cent shall be used in the concrete mix. The aggregates shall be tested for soundness in accordance with IS: 2386 (Part-5). After 5 cycles of testing the loss shall not be more than 12 per cent if sodium sulphate solution is used or 18 percent if magnesium sulphate solution is used.

Dumping and stacking of aggregates shall be done in an approved manner. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hrs before batching as directed by the Engineer.

502.2.4.2. Fine aggregate: The fine aggregate shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS: 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregate shall not contain deleterious substances more than the following:

#### 502.2.4.3 Separation layer between sub base and pavement

Foundation layer below concrete slabs should be smooth to reduce inter layer friction. A separation membrane of minimum 25 micron Polythene is recommended to reduce the friction (ref: IRC -15- 2002) between concrete slabs and dry lean concrete sub base (DLC)

Clay lumps 4.0 percent

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Coal and lignite 1.0 percent

Material passing IS Sieve No. 75 micron 4.0 percent

502.2.5. Water: Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

502.2.6. Mild steel bars for dowels and tie bars: These shall conform to the requirements of IS:

432, IS: 1139 and IS: 1786 as relevant. The dowel bars shall conform to Grade S 240 and tie bars to Grade S 415 of I.S.

502.2.7. Premoulded joint filler: Joint filler board for expansion joints which are proposed for use only at some abutting structures like bridges and culverts shall be of 20-25 mm thickness within a tolerance of  $\pm 1.5$  mm and of a firm compressible material and complying with the requirements of IS: 1838, or BS Specification Clause No. 2630 or Specification for Highway Works, Vol .I Clause 1015. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of  $\pm 3$  mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit in the dowel bars.

502.2.8. Joint sealing compound: The joint sealing compound shall be of hot poured, elastomeric type or cold poly sulphide type having flexibility, resistance to age hardening and durability. If the sealant is of hot poured type it shall conform to AASHTO M282 and cold applied sealant shall be in accordance with BS 5212 (Part 2).

502.2.9. Storage of materials: All materials shall be stored in accordance with the provisions of Clause 2014 of the Specifications and other relevant IS Specifications. All effort must be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for the work.

The platform where aggregates are stock piled shall be levelled with 15 cm of watered, mixed and compacted granular sub-base material. The area shall have slope and drain to drain off rain water. The storage space must also permit easy inspection, removal and storage of the materials. Aggregates of different sizes shall be stored in partitioned stack-yards. All such materials even though stored in approved godowns must be subjected to acceptance test as per Clause 1900 of these Specifications immediately prior to their use.

### 502.3. PROPORTION OF CONCRETE

. After approval by the Engineer of all the materials to be used in the concrete, the Contractor shall submit the mix design based on weighed proportions of all ingredients for the approval of the Engineer. The mix design shall be submitted at least 30 days prior to the paving of trial length and the design shall be based on



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laboratory trial mixes using the approved materials and methods as per IS : 10262 (Recommended Guidelines for Mix Design) or on the basis of any other rational method agreed to by the Engineer. Guidance in this regard can also be obtained from IS: SP: 23 Handbook on Concrete Mixes. The target mean strength for the design mix shall be determined as indicated in Clause 704.2.1. The mix design shall be based on the flexural strength of concrete.

502.3.1. Cement content: The cement content shall not be less than 350 kg per cu.m. of concrete. If this minimum cement content is not sufficient to produce in the field, concrete of the strength specified in the drawings/design, it shall be increased as necessary without additional compensation under the Contract. The cement content shall, however, not exceed 425 kg per cu.m. of concrete.

#### 502.3.2. Concrete strength

While designing the mix in the laboratory, correlation between flexural and compressive strengths of concrete shall be established on the basis of at least thirty tests on samples. However, quality control in the field shall be exercised on the basis of flexural strength. It may, however, be sure that the materials and mix proportions remain substantially unaltered during the daily concrete production. The water content shall be the minimum required to provide the agreed workability for full compaction of the concrete to the required density as determined by the trial mixes or other means approved by the Engineer and the maximum free water cement ratio shall be 0.50.

The ratio between the 7 and 28 day strengths shall be established for mix to be used in the slab in advance, by testing pairs of beams and cubes at each stage on at least six batches of trial mix. The average strength of the 7 day cured specimens shall be divided by the average strength of the 28 day specimens for each batch, and the ratio 'R' shall be determined. The ratio 'R' shall be expressed to three decimal places.

If during the construction of the trial length or during normal working, the average value of any four consecutive 7 day test results falls below the required 7 day strength as derived from the value of 'R', then the cement content of the concrete shall, without extra payment, be increased by 5 per cent by weight or by an amount agreed by the Engineer. The increased cement content shall be maintained at least until the four corresponding 28 day strengths have been assessed for its conformity with the requirements as per Clause 704. Whenever the cement content is increased, the concrete mix shall be adjusted to maintain the required workability.

#### 502.3.3 Workability

The workability of the concrete at the point of placing shall be adequate for the concrete to be fully compacted and finished without undue flow. The optimum workability for the mix to suit the paving plant being used shall be determined by the

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Contractor and approved by the Engineer. The control of workability in the field shall be exercised by the slump test as per IS: 1199.

The workability requirement at the Batching Plant and paving site shall be established slump tests carried during trial paving. These requirements shall be established from season to season and also when the lead from Batching plant site to the paving site changes. The workability shall be established for the type of paving equipment available. A slump value in the range of  $30 \pm 15$  mm is reasonable for paving works but this may be modified depending upon the site requirement and got approved by the Engineer. These tests shall be carried out on every truck/dumper at Plant site and paving site initially when the work commences but subsequently the frequency can be reduced to alternate trucks or as per the instructions of the Engineer.

#### 502.3.4. Design mix

. The Contractor shall carry out laboratory trials of design mixes with the materials from the approved sources to be used. Trial mixes shall be made in presence of the Engineer or his representative and the design mix shall be subject to the approval of the Engineer. They shall be repeated if necessary until the proportions that will produce a concrete which compiles in all respects with this Specification, and conforms to the design/drawings have been determined.

The proportions determined as a result of the laboratory trial mixes may be adjusted if necessary during the construction of the trial length. Thereafter, neither the materials nor the mix proportions shall be varied in any way except with the written approval of the Engineer.

Any change in the source of materials or mix proportions proposed by the Contractor during the course of work shall be assessed by making laboratory trial mixes and the construction of a further trial length unless approval is given by the Engineer for minor adjustments like compensation for moisture content in aggregates or minor fluctuations in the grading of aggregate.

#### 502.3.5 Water

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS:456.

#### 502.4. SUB-BASE

The cement concrete pavement shall be laid over the sub-base constructed in accordance with the relevant drawings and Specifications contained in Clause 501. If the sub-base is found damaged at some places or it has cracks wider than 10mm, it shall be repaired with fine cement concrete or bituminous concrete laying separation

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layer. Prior to laying of concrete it shall be sure that the separation membrane as per Clause 2012 is placed in position and the same is clean of dirt or other extraneous materials and free from any damage.

#### 502.5. SEPARATION MEMBRANE

A separation membrane shall be used between the concrete slab and the sub-base. Separation membrane shall be impermeable plastic sheeting 125 microns thick laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheeting shall be replaced at the Contractor's expense. The separation membrane may be nailed to the lower layer with concrete nails.

#### 502.6. JOINTS

The location and type of joints shall be as shown in the drawing. Joint shall be constructed depending upon their functional requirement as detailed in the following paragraphs.

The location of the joints should be transferred accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It should be ensured that the full required depth of cut is made from edge to edge of the pavement. Transverse and longitudinal joints in the pavement and sub-base shall be staggered so that they are not coincident vertically and are at least 1 m and 0.3 m apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and personnel without damaging the texture of the pavement. Sawing operation could start as early as 6-8 hours depending upon the season.

##### 502.6.1. Transverse joints

Transverse joints shall be contraction and expansion joints constructed at the spacing described in the Drawings. Transverse joints shall be straight within the following tolerances along the intended line of joints which is the straight line transverse to the longitudinal axis of the carriageway at the position proposed by the Contractor and agreed to by the Engineer, except at road junctions or roundabouts where the position shall be as described in the drawings:

- (i) Deviations of the filler board in the case of expansion joints from the intended line of the joint shall not be greater than  $\pm 10$  mm.
- (ii) The best fit straight line through the joint grooves as constructed shall be not more than 25 mm from the intended line of the joint.

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- (iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.
  - (iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 502.11

502.6.2 Contraction joints: Contraction joints shall consist of a mechanical sawn joint groove, 3 to 5 mm wide and 1/4 to 1/3 depth of the slab  $\pm$  5 mm or as stipulated in the drawings and dowel bars complying with Clause 502.6.7 and as detailed in the drawings.

The contraction joints shall be cut as soon as the concrete has undergone initial hardening and is hard enough to take the load of joint sawing machine without causing damage to the slab

502.6.3 Expansion joints: The expansion joints shall consist of a joint filler board complying with Clause 502.2.7 and dowel bars complying with Clause 502.6.7 and as detailed in the drawings. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within the tolerances given in Clause 502.6.1 and at such depth below the surface as will not impede the passage of the finishing straight edges or oscillating beams of the paving machines. The adjacent slabs shall be completely separated from each other by providing joint filler board. Space around the dowel bars, between the sub-base and the filler board shall be packed with a suitable compressible material to block the flow of cement slurry.

502.6.4. Transverse construction joint: Transverse construction joints shall be placed whenever concreting is completed after a day's work or is suspended for more than 30 minutes. These joints shall be provided at the regular location of contraction joints using dowel bars. The joint shall be made butt type. At all construction joints, steel bulk heads shall be used to retain the concrete while the surface is finished. The surface of the concrete laid subsequently shall conform to the grade and cross sections of the previously laid pavement. When positioning of bulkhead/stop-end is not possible, concreting to an additional 1 or 2 m length may be carried out to enable the movement of joint cutting machine so that joint grooves may be formed and the extra 1 or 2 m length is cut out and removed subsequently after concrete has hardened.

#### 502.6.5. Longitudinal joint

The longitudinal joints shall be saw cut as per details of the joints shown in the drawing. The groove may be cut after the final set of the concrete. Joints should be sawn to at least 1/3 the depth of the slab  $\pm$  5 mm as indicated in the drawing.

Tie bars shall be provided at the longitudinal joints as per dimensions and spacing shown in the drawing and in accordance with Clause 502.6.8.

## 502.6.6 Steel for Dowels and Tie Bars

Steel shall conform to the requirements of IS: 432 and IS: 1786 as relevant. The dowel bars shall conform to IS: 432 of Grade I. Tie bars shall be either High yield Strength Deformed bars conforming to IS: 1786 and grade of Fe 500 or plain bars conforming to IS: 432 of Grade I. The steel shall be coated with epoxy paint for protection against corrosion.

## 502.6.7 Dowel bars

Dowel bars shall be mild steel rounds in accordance with Clause 502.6.6 with details/dimensions as indicated in the drawing and free from oil, dirt, loose rust or scale. They shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. The dowel bar shall be supported on cradles/dowel chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full re-compaction of the concrete around the dowel bars.

Unless shown otherwise on the drawings, dowel bars shall be positioned at mid depth of the slab within a tolerance of  $\pm 20$  mm, and centered equally about intended lines of the joint within a tolerance of  $\pm 25$  mm. They shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given hereunder, the compliance of which shall be checked.

- (i) For bars supported on cradles prior to the laying of the slab:
  - (a) All bars in a joint shall be within  $\pm 3$  mm per 300 mm length of bar
  - (b) 2/3rd of the bars shall be within  $\pm 2$ mm per 300 mm length of bar
  - (c) No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical planeCradles supporting dowel bar shall not extend across the line of joint i.e.no steel bar of the cradle assembly shall be continuous across the joint.

- (ii) For all bars inserted after laying of the slab:

- (a) Twice the tolerance for alignment as indicated in (i) above

Dowel bars, supported on cradles in assemblies, when subject to a load of 110 N applied at either end and in either the vertical or horizontal direction (upwards and downwards and both directions horizontally) shall conform to be within the following limits:

- (i) Two-thirds of the number of bars of any assembly tested shall not deflect more than 2 mm per 300 mm length of bar

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- (ii) The remainder of the bars in that assembly shall not deflect more than 3 mm per 300 mm length of bar.

The assembly of dowel bars and supporting cradles, including the joint filler board in the case of expansion joints, shall have the following degree of rigidity when fixed in position:-

- (i) For expansion joints, the deflection of the top edge of the filler board shall be not greater than 13 mm, when a load of 1.3 KN is applied perpendicular to the vertical face of the joint filler board and distributed over a length of 600 mm by means of a bar or timber packing, at mid depth and midway between individual fixings, or 300mm from either end of any length of filler board, if a continuous fixing, is used. The residual deflection after removal of the load shall be not more than 3 mm.
- (ii) The joint assembly fixings to sub-base shall not fail under the 1.3 KN load applied for testing the rigidity of the assembly but shall fail before the load reaches 2.6 KN.
- (iii) The fixings for contraction joint shall not fail under 1.3 KN load and shall fail before the load reaches 2.6 KN when applied over a length of 600 mm by means of a bar or timber packing placed as near to the level of the line of fixings as practicable.
- (iv) Fixings shall be deemed to fail when there is displacement of the assemblies by more than 3mm with any form of fixing, under the test load. The displacement shall be measured at the nearest part of the assembly to the centre of the bar or timber packing.

Dowel bars shall be covered by a thin plastic sheath for at least two-thirds of the length from one end for dowel bars in contraction joints or half the length plus 50 mm for expansion joints.

The sheath shall be tough, durable and of an average thickness not greater than 1.25 mm. The sheathed bar shall comply with the following pull-out tests:

Four bars shall be taken at random from stock and without any special preparation shall be covered by sheaths as required in this Clause. The ends of the dowel bars which have been sheathed shall be cast centrally into concrete specimens 150 x 150 x 600 mm, made of the same mix proportions to be used in the pavement, but with a maximum nominal aggregate size of 20 mm and cured in accordance with IS:516. At 7 days a tensile load shall be applied to achieve a movement of the bar of at least 0.25 mm. The average bond stress to achieve this movement shall not be greater than 0.14 MPa.

For expansion joints, a closely fitting cap 100 mm long consisting of waterproofed cardboard or an approved synthetic material like PVC or GI pipe shall be placed over

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the sheathed end of each dowel bar. An expansion space at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of cement slurry between dowels and cap it may be taped.

#### 502.6.8 Tie bars

Tie bars in longitudinal joints shall be deformed steel bars of strength 415 Mpa complying with IS: 1786 and in accordance with the requirements given below. The bars shall be free from oil, dirt, loose rust and scale.

Tie bars projecting across the longitudinal joint shall be protected from corrosion for 75mm on each side of the joint by a protective coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used.

Tie bars in longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of the slab. Alternatively, tie bars at longitudinal joint may be mechanically or manually inserted into the plastic concrete from above by vibration using a method which ensures correct placement of the bars and re compaction of the concrete around the tie bars.

Tie bars shall be positioned to remain within the middle third of the slab depth as indicated in the drawings and approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of  $\pm 50$  mm, and with a minimum cover of 30 mm below the joint groove.

#### 502.7. WEATHER AND SEASONAL LIMITATIONS

502.7.1. Concrete during monsoon months: When concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulin or other water proof cloth shall be provided along the line of the work. Any time when it rains, all freshly laid concrete which had not been covered for curing purposes shall be adequately protected. Any concrete damaged by rain shall be removed and replaced. If the damage is limited to texture, it shall be retextured in accordance with the directives of the Engineer.

502.7.2. Concreting in hot weather: No concreting shall be done when the concrete temperature is above 30 degree Centigrade. Besides, in adverse conditions like high temperature, low relative humidity, excessive wind velocity, imminence of rains etc., if so desired by the Engineer, tents on mobile trusses may be provided over the freshly laid concrete for a minimum period of 3 hours as directed by the Engineer. The temperature of the concrete mix on reaching the paving site shall not be more than 30°C. To bring down the temperature, if necessary, chilled water or ice flakes should be made use of. No concreting shall be done when the concrete temperature is below 5 degree Centigrade and the temperature is descending.

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**502.8. SIDE FORMS, RAILS AND GUIDE WIRES**

502.8.1 Side forms and rails: All side forms shall be of mild steel of depth equal to the thickness of pavement or slightly less to accommodate the surface regularity of the sub-base. The forms can be placed on series of steel packing plates or shims to take care of irregularity of sub-base. They shall be sufficiently robust and rigid to support the weight and pressure caused by paving equipment. Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below the top of the forms. The forms and rail shall be firmly secured in position by not less than 3 stakes/pins for each 3m length so as to prevent movement in any direction. Forms and rails shall be straight within a tolerance of 3 mm in 3m and when in place shall not settle excess of 1.5 mm in 3 m while paving is being done. Forms shall be cleaned and oiled immediately before each use. The forms shall be bedded on a continuous bed of low moisture content lean cement mortar or concrete and set to the line and levels shown on the drawings within tolerances  $\pm 10$  mm and  $\pm 3$  mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 3 mm. The forms shall be got inspected from the Engineer for his approval before 12 hours on the day before the construction of the slab and shall not be removed until at least 12 hours afterwards.

At all times sufficient forms shall be used and set to the required alignment for at least 200 m length of pavement immediately in advance of the paving operations, or anticipated length of pavement to be laid within the next 24 hrs whichever is more.

**502.8.2. Use of guide wires**

502.8.2.1. Where slip form paving is proposed, a guide wire shall be provided along both sides of the slab. Each guide wire shall be at a constant height above and parallel to the required edges of the slab as described in the contract/drawing within a vertical tolerance of  $\pm 3$  mm. Additionally, one of the wires shall be kept at a constant horizontal distance from the required edge of the pavement as indicated in the contract/drawing within a lateral tolerance of  $\pm 10$  mm.

The guide wires shall be supported on stakes not more than 8 m apart by connectors capable of fine horizontal and vertical adjustment. The guide wire shall be tensioned on the stakes so that a 500 gram weight shall produce a deflection of not more than 20 mm when suspended at the midpoint between any pair of stakes. The ends of the guide wires shall be anchored to fixing point or winch and not on the stacks.

The stack shall be positioned and the connectors maintained at their correct height and alignment from 12 hours on the day before concreting takes place until 12 hours after finishing of the concrete. The guide wire shall be erected and tensioned the connectors at any section for at least 2 hours before concreting that section.

The Contractor shall submit to the Engineer for his approval of line and level, the stakes and connectors which are ready for use in the length of road to be



constructed by 12 hours on the working day before the day of construction of slab. Any deficiencies noted by the Engineer shall be rectified by the Contractor who shall then re-apply for approval of the affected stakes. Work shall not proceed until the Engineer has given his approval. It shall be ensured that the stakes and guide wires are not affected by the construction equipment when concreting is in progress.

#### 502.9. CONSTRUCTION

502.9.1 General: A systems approach may be adopted for construction of the pavement, and the Method Statement for carrying out the work, detailing all the activities including indication of time cycle, equipment, personnel etc., shall be got approved from the Engineer before the commencement of the work. The above shall include the type, capacity and make of the batching and mixing plant besides the hauling arrangement and paving equipment. The capacity of paving equipment, batching plant as well as all the ancillary equipment shall be adequate for a paving rate of at least 300 m in one day.

502.9.2. Batching and mixing: Batching and mixing of the concrete shall be done at a central batching and mixing plant with automatic controls, located at a suitable place which takes into account sufficient space for stockpiling of cement, aggregates and stationary water tanks. This shall be, however, situated at an approved distance, duly considering the properties of the mix and the transporting arrangements available with the Contractor

#### 502.9.3. Equipment for proportioning of materials and paving

Proportioning of materials shall be done in the batching plant by weight, each type of material being weighed separately. The cement from the bulk stock may be weighed separately from the aggregates and water shall be measured by volume. Wherever properly graded aggregate of uniform quality cannot be maintained as envisaged in the mix design, the grading of aggregates shall be controlled by appropriate blending techniques. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity of the laying/paving equipment.

#### 502.9.4 Batching plant and equipment:

(1) General- The batching plant shall include minimum four bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant operation, inspection and testing. The batch plant shall be equipped with suitable non-resettable batch counter which will correctly indicate the number of batches proportioned.

(2) Bins and hoppers- Bins with minimum number of four adequate separate compartments shall be provided in the batching plant.

(3) Automatic weighing devices- Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells.

(4) Mixers- Mixers shall be pan type, reversible type or any other mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specific mixing period, and of discharging the mixture, without segregation. Each stationary mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed 90 seconds or as per the manufacturer's recommendation. The mixer shall be equipped with a suitable non-resettable batch counter which shall correctly indicate the number of batches mixed.

The mixers shall be cleared at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 20 mm or more. The Contractor shall

- (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or
- (2) Provide permanent marks on blade to show points of 20 mm wear from new conditions. Drilled holes of 5 mm diameter near each end and at midpoint of each blade are recommended. Batching Plant shall be calibrated in the beginning and thereafter at suitable interval not exceeding 1 month

(5) Control cabin- An air-conditioned centralized control cabin shall be provided for automatic operation of the equipment.

502.9.5 Paving equipment: The concrete shall be placed with an approved fixed form or slip paver with independent units designed to (i) spread, (ii) consolidate, screed and float-finish, (iii) texture and cure the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary and so as to provide a dense and homogeneous pavement in conformity with the plans and Specifications. The paver shall be equipped with electronic controls to control/sensor line and grade from either or both sides of the machine.

Vibrators shall operate at a frequency of 8300 to 9600 impulses per minute under load at a maximum spacing of 60 cm. The variable vibration setting shall be provided in the machine.

502.9.6 Concrete saw: The Contractor shall provide adequate number of concrete saws with sufficient number of diamond-edge saw blades. The saw machine shall be either electric or petrol/diesel driven type. A water tank with flexible hoses and pump shall be made available in this activity on priority basis. The Contractor shall have at

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least one standby saw in good working condition. The concreting work shall not commence if the saws are not in working condition.

#### 502.9.7 Hauling and placing of concrete

Freshly mixed concrete from the central batching and mixing plant shall be transported to the paver site by means of trucks/tippers of sufficient capacity and approved design in sufficient numbers to ensure a constant supply of concrete. Covers shall be used for protection of concrete against the weather. The trucks/tippers shall be capable of maintaining the mixed concrete in a homogeneous state and discharging the same without segregation and loss of cement slurry. The feeding to the paver is to be regulated in such a way that the paving is done in an uninterrupted manner with a uniform speed throughout the days work.

##### 502.9.7.1 Placing of concrete

Concrete mixed in central mixing plant shall be transported to the site without delay and the concrete which, in the opinion of the Engineer, has been mixed too long before laying will be rejected and shall be removed from the site. The total time taken from the addition of the water to the mix, until the completion of the surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when the concrete temperature is between 25°C to 30°C. Trucks/tippers delivering concrete shall not run on plastic sheeting nor shall they run on completed slabs until after 28 days of placing the concrete. The Paver shall be capable of paving the carriageway as shown in the drawings, in a single pass and lift.

Where fixed form pavers are to be used, forms shall be fixed in advance as per Clause 502.8 of the Specifications. Before any paving is done, the site shall be shown to the Engineer, in order to verify the arrangement for paving besides placing of dowels, tie-bars etc., as per there levant Clauses of this Specification. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement.

In all cases, the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.

The addition of water to the surface of the concrete to facilitate the finishing operations will not be permitted except with the approval of the Engineer when it shall be applied as a mist by means of approved equipment.

If considered necessary by the Engineer, the paving machines shall be provided with approved covers to protect the surface of the slab under construction from direct sunlight and rain or hot wind.

While the concrete is still plastic, its surface shall be brush textured in compliance with Clause 502.10 and the surface and edges of the slab cured by the application of a sprayed liquid curing membrane in compliance with Clause 502.10.1. After the

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surface texturing, but before the curing compound is applied, the concrete slab shall be marked with the chain age at every 100 m interval.

As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of one part of cement to 3 parts of fine chips and fine aggregate under the supervision of the Engineer.

If the requirement of surface regularity fails to be achieved on two consecutive working days, then normal working shall cease until the cause of the excessive irregularity has been identified and remedied.

#### 502.9.8. Construction by fixed form paver

The fixed form paving train shall consist of separate powered machines which spread, compact and finish the concrete in a continuous operation.

The concrete shall be discharged without segregation into a hopper spreader which is equipped with means for controlling its rate of deposition on to the subbase. The spreader shall be operated to strike off concrete upto a level requiring a small amount of cutting down by the distributor of the spreader. The distributor of spreader shall strike off the concrete to the surcharge adequate to ensure that the vibratory compactor thoroughly compacts the layer. If necessary, poker vibrators shall be used adjacent to the side forms and edges of the previously constructed slab. The vibratory compactor shall be set to strike off the surface slightly high so that it is cut down to the required level by the oscillating beam. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or cross fall. The final finisher shall be able to finish the surface to the required level and smoothness as specified, care being taken to avoid bringing up of excessive mortar to the surface by overworking.

#### 502.9.9. Construction by slip form paver

The slip form paving train shall consist of power machine which spreads compacts and finishes the concrete in a continuous operation. The slip form paving machine shall compact the concrete by internal vibration and shape it between the sides forms with either a conforming plate or by vibrating and oscillating finishing beams. The concrete shall be deposited without segregation in front of slip form paver across the whole width and to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of the strike off plate or a screw auger device extending across the whole width of the slab. The equipment for striking-off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by change in slab thickness or cross fall.

The level of the conforming plate and finishing beams shall be controlled automatically from the guide wires installed as per Clause 502.8 by sensors attached

at the four corners of the slip form paving machine. The alignment of the paver shall be controlled automatically from the guide wire by at least one set of sensors attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of the slab.

Slip-form paving machines shall have vibrators of variable output, with a maximum energy output of not less than 2.5 KW per metre width of slab per 300 mm depth of slab for a laying speed upto 1.5 m per minute or pro-rata for higher speeds. The machines shall be of sufficient mass to provide adequate reaction during spreading and paving operations on the traction units to maintain forward movements during the placing of concrete in all situations.

If the edges of the slip formed slab slump to the extent that the surface of the top edge of the slab does not comply with the requirements, then special measures approved by the Engineer shall be taken to support the edges to the required levels and work shall be stopped until such time as the Contractor can demonstrate his ability to slip form the edges to the required levels.

502.9.9.1. Construction by hand-guided method: Areas in which hand-guided methods of construction become indispensable shall be got approved by the Engineer in writing in advance. Work may be permitted only in restricted areas in small lengths. Work shall be carried out by skilled personnel as per methods approved by the Engineer. The acceptance criteria regarding level, thickness, surface regularity, texture, finish, strength of concrete and all other quality control measures shall be the same as in the case of machine laid work.

#### 502.10 SURFACE TEXTURE

After the final regulation of the slab and before the application of the curing membrane, the surface of concrete slab shall be brush-textured in a direction at right angles to the longitudinal axis of the carriageway.

The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450 mm wide but longer brushes are preferred. The brush is made of 32 gauge tape wires grouped together in tufts spaced at 10 mm centers. The tufts shall contain an average of 14 wires and initially be 100 mm long. The brush shall have two rows tufts. The rows shall be 20 mm apart and the tufts in one row shall be opposite the centre of the gap between tufts in the other row. The brush shall be replaced when the shortest tuft wears down 90 mm long.

The texture depth shall be determined by the Sand Patch Test as described in clause 502.12. This test shall be performed at least once for each day's paving and wherever the Engineer considers it necessary at times after construction as under:

Five individual measurements of the texture depth shall be taken at least 2 m apart along a diagonal line across a lane width between points 50 m apart along the pavement.

No measurement shall be taken within 300 mm of the longitudinal edges of a concrete slab constructed in one pass.

Texture depths shall not be less than the minimum required when measurements areas given in Table 500-3 nor greater than a maximum average 1.25 mm.

TABLE: 500-3 Texture Depth

Time of Test	Number of Measurements	Required Texture Depth (mm)	
		Specified Value	Tolerance
1 Between 24 hours and 7 days after the constn. of the slab or until the slab is first used by vehicles.	An average of 5 Measurements	1.00	0.25
2 Not later than 6 weeks before the road is opened to public traffic.	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall good the texture across the full lane width over length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

#### 502.10.1 Curing

Immediately after the surface texturing, the surface and sides of the slab shall be cured by the application of approved resin-based aluminized reflective curing compound which hardens into an impervious film or membrane with the help of a mechanical sprayer. Compounds shall contain sufficient flake aluminum in finely

divided dispersion to complete coverage of the sprayed surface with a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have water retention efficiency index of 90 per cent in accordance with BS Specification No. 7542.

The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks after application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of application is 2.5 - 5m<sup>2</sup>/litre or shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall efficient mechanical device for continuous agitation and mixing of the compound during spraying.

In addition to spraying of curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavement with tents as described in Clause 710, during adverse weather conditions as directed by the Engineer. After three hours, the pavement shall be covered by moist hessian and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. The hessian shall be kept continuously moist. All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

The Contractor shall be liable at his expense to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint.

#### 502.11. TRIAL LENGTH

The trial length shall be constructed at least one month in advance of the proposed start of concrete paving work. At least one month prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a detailed method statement giving description of the proposed materials, plant, equipment and construction methods. All the major equipment like paving train, batching plant, tippers etc., proposed in the construction are to be approved by the Engineer before their procurement. No trials of new materials, plant, equipment or construction methods, nor any development of them shall be permitted either during the construction of trial length or in any subsequent paving work, unless they form part of further, approved trials. These trial lengths shall be constructed away from the carriageway but with at least a subbase layer below it.

The Contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, at least 60 m but not more than 300 m long for mechanized construction and at least 30 m long for hand guided methods. If the first trial is unsatisfactory, the Contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

The trial length shall be constructed in two parts over a period comprising at least part of two separate working days, with a minimum of 30 m constructed each day for mechanized construction and a minimum of 15 m on each day for hand guided construction. The trial length shall be constructed at a similar rate (speed, around 1m/hr) to that which is proposed for the main work.

Transverse joints and longitudinal joints of each type that are proposed for dowel-jointed unreinforced concrete slabs in the main work shall be constructed and assessed in the trial length. If in the trial length the construction of expansion joint and longitudinal joint is not demonstrated, the first 2 expansion joints and at least the first 150 m of longitudinal construction joint form enchained paving in the main work, shall be considered as the trial length for these joints.

The trial length shall comply with the Specification in all respects, with the following additions and exceptions:

#### 502.11.1 Surface levels and regularity

- (i) In checking for compliance with Clause 2100 the levels shall be taken at intervals at the locations specified in this Clause along any line or lines parallel to the longitudinal centre line of the trial length.
- (ii) Maximum number of permitted irregularities of pavement surface shall comply with the requirements of Clause 502.14. Shorter trial lengths shall be assessed prorata based on values for a 300 m length.

#### 502.11.2 Joints

- (iii) Alignment of dowel bars shall be inspected as described in Clause 502.11.6 in any two consecutive transverse joints. If the position or alignment of the dowel bars alone of these joints does not comply with Clause 502.6.7, if that joint remains the only one that does not comply after the next 3 consecutive joints of the same type have been inspected, then the method of placing dowels shall be deemed to be satisfactory. In order to check sufficient joints for dowel bar alignment without extending the trial length unduly, the Contractor may, by agreement with the Engineer, construct joints at more frequent joint intervals than the normal spacing required in the Contract.
- (iv) If there are deficiencies in the first expansion joint that is constructed as a trial, the next expansion joint shall be a trial joint. Should this also be deficient, further trial expansion joints shall be made as part of the trial length which shall not form part of the permanent works, unless agreed by the Engineer.

#### 502.11.3 Density



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- (v) Density shall be assessed as described in Clause 502.3.2 from at least 3 cores drilled from each part of the trial length.

#### 502.11.4 Position of tie bars

- (vi) Compliance with Clause 502.6.8 for the position and alignment of tie bars shall be checked by drilling additional cores from the slab unless they can be determined from cores taken for density.

#### 502.11.5 Approval and acceptance

Approval of the materials, plant, equipment and construction methods shall be given when a trial length complies with the Specification. The Contractor shall not proceed with normal working until the trial length has been approved and any earlier defective trial lengths have been removed, unless that can be remedied to the satisfaction of the Engineer. If the Engineer does not notify the Contractor of any deficiencies in any trial length within 10 days after the completion of that trial length, the Contractor may assume that the trial length, and the materials, plant, equipment and construction methods adopted are acceptable.

When approval has been given, the materials, plant, equipment and construction methods shall not thereafter be changed, except for normal adjustments and maintenance of plant, without the approval of the Engineer. Any changes in material, plant, equipment and construction methods shall entitle the Engineer to require the Contractor to lay a further trial length as described in this Clause to demonstrate that the changes will not adversely affect the permanent works.

Trial lengths which do not comply with the Specification, with the exception of areas which are deficient only in surface texture and which can be remedied in accordance with Clause 502.1 shall be removed immediately upon notification of deficiencies by the Engineer and the Contractor shall construct a further trial length.

#### 502.11.6 Inspection of dowel bars

Compliance with Clause 502.6.7 for the position and alignment of dowel bars at construction and expansion joints shall be checked by measurements relative to the side forms or guide wires.

When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them in the plastic concrete across the whole width of the slab. When the joint is an expansion joint, the top of the filler board shall first be exposed sufficiently in the plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working, these measurements shall be carried out in the pavement section at the end of day's work by extending slab length by 2 m.

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After sawing the transverse joint groove, the extended 2 m slab shall be removed carefully soon after concrete has set to expose dowels over half the length. These dowels can be tested for tolerances.

If the position and alignment of the bars in a single joint in the slab is un-satisfactory then the next two joints shall be inspected. If only one joint of the three is defective, the rate of checking shall be increased to one joint per day until the Engineer is satisfied that compliance is being achieved. In the event of non-compliance in two or more successive joints, the Contractor shall revert to the construction of fresh trial lengths and make any necessary alteration to concrete mix, paving plant or methods until the dowel bar position and alignment are satisfactory.

After the dowel bars have been examined, the remainder of the concrete shall be removed over a width of 500 mm on each side of the line of the joint and reinstated to the satisfaction of the Engineer. The dowels shall be inserted on both sides of the 1 m wide slab by drilling holes and grouting with epoxy mortar. Plastic sheath as per Clause 502.6.7 shall be provided on dowels on one of the joints. The joint groove shall be widened and sealed as per Clause 502.11.7.

#### 502.11.7 Preparation and Sealing of Joint Grooves

##### 502.11.7.1 General

All transverse joints in surface slabs shall be sealed using sealants described in Clause 502.11.8. Joints shall not be sealed before 14 days after construction.

##### 502.11.7.2. Preparation of joint grooves for sealing

Joint grooves usually are not constructed to provide the minimum width specified in the drawings when saw cut joints are adopted. They shall be widened subsequently by sawing before sealing. Depth/width gauges shall be used to control the dimension of the groove.

If rough arises develop when grooves are made, they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle up to 10 degree from the perpendicular to the surface, the overhanging edge of the sealing groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10 degrees, the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects up to a maximum width, including any chamfer, of 20mm for transverse joints and 10mm for longitudinal joints. If the spalling cannot be so eliminated then arises shall be repaired by an approved thin bonded arise repair using cementations' materials.

All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. If need arises the Engineer may instruct cleaning by pressurized water jets. Depending upon the requirement of the sealant manufacture, the sides of the grooves may have to be sand blasted to increase the bondage between sealant and concrete.

The groove shall be cleaned and dried at the time of priming and sealing.

Before sealing the temporary seal provided for blocking the ingress of dirt, soil etc., shall be removed. A highly compressible heat resistant paper-backed debonding strip as per drawing shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove so that the sealant may not leak through the cracks. The width of debonding strip shall be more than the joint groove width so that it is held tightly in the groove. In the case of longitudinal joints, heat resistant tapes may be inserted to block the leakage through bottom of the joint.

#### 502.11.8. Sealing with sealants

When sealants are applied, an appropriate primer shall also be used if recommended by the manufacturer and it shall be applied in accordance with their recommendation. The sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed is below 7°C.

. If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculation pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturers' recommendations and reheated material shall not be used.

Cold applied sealants with chemical formulation like poly sulphide may be used. These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended they shall be applied neatly with an appropriate brush. The Movement Accommodation Factor (MAF) shall be more than 10 per cent

The sealants applied at contraction phase of the slabs would result in bulging of the sealant over and above the slab. Therefore, the Contractor in consultation with the Engineer shall establish the right temperature and time for applying the sealant. Thermometer shall be hung on a pole in the site for facilitating control during the sealing operation.

Sealant shall be applied, slightly to a lower level than the slab with a tolerance of 5 - 2mm.

During sealing operation, it shall be seen that no air bubbles are introduced in the sealant either by vapors or by the sealing process.

502.11.9 Testing of applied sealants: Manufacturer's certificate shall be produced by the Contractor for establishing that the sealant is not more than six months old and stating that the sealant complies with the relevant standard as in Clause 502.11.8. The samples shall meet the requirement of AASHTO M 282 for hot applied sealant or BS 5212: (Part- 2) for cold applied sealant.

#### *502.12. MEASUREMENT OF TEXTURE DEPTH - SAND PATCH METHOD*

502.12.1. The following apparatus shall be used:

- (i) A cylindrical container of 25 ml internal capacity
- (ii) A flat wooden disc 64 mm diameter with a hard rubber disc, 1.5 mm thick, stuck to one face, the reverse face being provided with a handle.
- (iii) Dry natural sand with a rounded particle shape passing a 300 micron IS sieve and retained on a 150 micron IS sieve.

502.12.2. Method: The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylindrical container shall be filled with the sand, tapping the base 3 times on the surface to ensure compaction, and striking off the sand level with the top of the cylinder.

The sand shall be poured into a heap on the surface to be treated. The sand shall be spread over the surface, working the disc with its face kept flat in a circular motion so that the sand is spread into a circular patch with the surface depressions filled with sand to the level of peaks.

The diameter of the patch shall be measured to the nearest 5 mm. The texture depth of concrete surface shall be calculated from  $31000/(D \times D)$  mm where D is the diameter of the patch in mm.

#### *502.13. OPENING TO TRAFFIC*

No vehicular traffic shall be allowed to run on the finished surface of a concrete pavement within a period of 28 days of its construction and until the joints are permanently sealed. The road may be opened to regular traffic after completion of the curing period of 28 days and after sealing of joints is completed including the construction of shoulder, with the written permission of the Engineer.

#### *502.14. TOLERANCE FOR SURFACE REGULARITY, LEVEL, THICKNESS AND STRENGTH*

The tolerances for surface regularity, level, thickness and strength shall conform to the requirements given in Clause 2101.5 Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 2100.

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502.15 MEASUREMENTS FOR PAYMENT

Cement Concrete pavement shall be measured as a finished work in square metres with specified thickness. The volume to be paid for will be calculated on the basis of thickness and plans shown on the project drawings and adjusted for the deficiency in thickness. No additional payment shall be made for extra thickness of the slab. The full payment will be made to this item after 28 days strength of the concrete is found to be satisfactory.

The unit for measurement for concrete pavement shall be the cubic metre of concrete placed, based on the net plan areas for the specified thickness shown on the Drawings or directed by the Engineer. The rate shall include all provisions of this Specification and shall include the provision of all materials including polythene film, concrete, stock piling, mixing, transport, placing, compacting, finishing, curing together with all formwork, and including testing and submission of test certificates and records. No deduction shall be made in measurement for openings provided that the area of each is less than 0.5 sq.m. The unit rate as entered in the Bill of Quantities shall also include the full costs of contraction, expansion, construction, and longitudinal joints. It shall also include joint filler, keys, caulking rod, debonding strip, sealant primer, joint sealant, dowel bar and tie rod.

## 502.15.1. Pavement thickness

All precautions and care shall be taken to construct pavement having uniform thickness as called for on the plans.

Thickness of the cement concrete pavement shall be calculated on the basis of level data of the cement concrete pavement and the underlying sub-base taken on a grid of 5m x 3.5m or 6.25m x 3.5m, the former measurement being in longitudinal direction. A day=s work is considered as a 'lot' for calculating the average thickness of the slab. In calculating the average thickness, individual measurements which are in excess of the specified thickness by more than 10 mm shall be considered as the specified as thickness plus 10 mm.

Individual areas deficient by more than 25 mm shall be verified by the Engineer by ordering core cutting and if in his opinion the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans. When the average thickness for the lot is deficient by the extent shown in Table 500-4, the Contract unit price will be adjust as per this Table.

TABLE 500-4 PAYMENT ADJUSTMENT FOR DEFICIENCY IN THICKNESS

Deficiency in the average thickness of payable day=s work	Percent of Contract unit price
Up to 5mm	100
6 –10 mm	87

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11-15 mm	81
16 – 20 mm	75
21 –25 mm	70

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In the stretch where deficiency of average thickness is more than 25 mm, the section whose thickness is deficient by 26 mm or more is identified with the help of cores. Such slabs shall be removed and reconstructed at the cost of the Contractor. During such rectification work, care shall be taken to replace full slab and to the full depth.

#### 502.16. RATE

The Contract unit rate for the construction of the cement concrete shall be payment in full for carrying out the operations required for the different items of the work as per these Specifications including full compensation for all labour, tools, plant, equipment, testing and incidentals to complete the work as per Specifications, providing all materials to be incorporated in the work including all royalties, fees, storage, rents where necessary and all leads and lifts.

#### 503. PAVER BLOCKS ON PARKING PAVEMENT

##### 503.1 MATERIALS

The paving blocks shall be made with cement concrete having a minimum compressive strength of 40 Mpa. The quantity of cement in the mix shall not be less than 350 kg/cum. The coarse aggregate shall have a size of 5-12 mm. The blocks shall be manufactured in a plant capable of producing the blocks of required quality, strength, finish and dimensional tolerance. The thickness of the blocks shall be 85 mm for the parking pavement. The following dimensional tolerances shall be observed:

- Plan dimension: 2 mm
- Thickness: 3 mm

The block shall be laid over 50 mm thick sand bedding. The gradation of the bedding sand shall be as under:

Gradation Table 500 - 5

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Sieves Size (mm)	Percent
9.50 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	50-95

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600 micron	25-60
300 micron	10-30
150 micron	0-15
75 micron	0-15

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**503.2 MATERIALS**

The block pavement shall be laid over a prepared base. Suitable edge restraints in plain cement concrete M-40 grade shall be provided to confine the bedding sand and to provide support against the horizontal thrust that can develop between blocks while under traffic.

The bedding sand shall be spread manually to a uniform thickness of 200 mm. The sand shall have moisture content of 6-8 percent. The sand shall then be screed by a mechanical screed and compacted.

The pre-cast blocks shall be laid manually or by suitable machines. Block laying shall start at or near an edge restraint and proceed continuously to terminate at another edge restraint. The blocks shall be laid to any standard pattern such as herring bond, structure bond or basket weave. The joint shall be 2-4 mm.

The blocks shall be compacted with vibratory plate compactors. The joints shall be filled with sand by spreading a thin layer of sand working it into the joints.

Following this, one or two further passes by a plate compactor shall be made. If necessary, sand can be washed by sprinkling water. The pavement shall be opened to traffic after the joints are fully filled in. the finished pavement shall confirm to the following:

- Plan deviation

From any 3 m line	10 mm (max)
From any 10 m line	20 mm (max)

- □ Vertical deviation

From designated level □ 10 mm

**503.3 MEASUREMENT FOR PAYMENT**

The works shall be measured in square meters.

**503.4 RATE**

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The contact unit rate for interlocking pre-cast block shall include the cost of all materials, labour, tools and plants and all over incidental works and expenses all complete as per specifications.



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**600 ROAD MARKINGS****601.1. GENERAL**

The colour, width and layout of road marking shall be in accordance with the Code of Practice for Road Markings with paints, IRC: 35, and as specified in the drawings or as directed by the Engineer.

**601.2. MATERIALS**

Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorised paint as specified in the item and the material shall meet the requirements as specified below.

**601.3. ORDINARY ROAD MARKING PAINT**

Ordinary paint used for road marking shall conform to Grade I as per IS: 164.

The road marking shall preferably be laid with appropriate road marking machinery.

Laying thickness of road marking paint shall be as specified by the Engineer.

**601.4. HOT APPLIED THERMOPLASTIC ROAD MARKING****601.4.1. General:**

- (i) The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
- (ii) The thermoplastic compound shall be screened /extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (iii) The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.
- (iv) Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper

bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

#### 601.4.2. Thermoplastic Material

601.4.2.1. General: The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads.

#### 601.4.2.2 Requirements:

(i) Composition: The pigment, beads, and aggregates shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 600-3.

TABLE 600-1. PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL  
(Percentage by weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30 - 40	30 - 40
Titanium Dioxide	10.0 min.	-
Calcium Carbonate and Inert Fillers	42.0 max.	See
Yellow Pigments	-	Note

Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met.

(ii) Properties: The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262-(Part I), shall be as below:

#### (a) Luminance:

White: Daylight luminance at 45 degrees – 65 per cent min. as per AASHTO M 249

Yellow: Daylight luminance at 45 degrees - 45 per cent min. as per AASHTO M 249

(b) Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

(c) Skid resistance: not less than 45 as per BS 6044.

(d) Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

(e) Softening point:  $102.5 \pm 9.5$ °C as per ASTM D 36.

- (f) Flow resistance: Not more than 25 per cent as per AASHTO M 249.
- (g) Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M 249

iii) Storage life: The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.

- iv) Reflectorisation: Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 602.4.3.

Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

1. The name, trade mark or other means of identification of manufacturer
2. Batch number
3. Date of manufacture
4. Colour (white or yellow)
5. Maximum application temperature and maximum safe heating temperature.

iv) Sampling and testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM /BS method. The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

#### 601.4.3. Reflectorising glass beads

601.4.3.1 General: This Specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 600-3 and Type 2 beads are those which are to be sprayed on the surface vide clause 602.6.

The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in clause 803.4.3.3.

#### 601.4.3.2 Specific requirements

- A.** Gradation: The glass beads shall meet the gradation requirements for the two types as given in Table 600-4.

Table 600-2. GRADATION REQUIREMENTS FOR GLASS BEADS

Sieve Size	Percentage retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 –do-	-	5 to 20
600 –do-	5 to 20	-
300 –do-	-	30 to 75
180 –do-	0 to 10	10 to 30
Below 180 micron	-	0 to 15

- B.** Roundness: The glass beads shall have a minimum of 70 per cent true spheres.
- C.** Refractive index: The glass beads shall have a minimum refractive index of 1.50
- D.** Free flowing properties: The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

#### 601.4.4. Application properties of thermoplastic material

The thermoplastic material shall readily get screeded/extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

#### 601.4.5. Preparation:

- i. The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The

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temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.

- ii. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

#### 601.4.6. Properties of finished road marking:

- a) The stripe shall not be slippery when wet.
- b) The marking shall not lift from the pavement in freezing weather.
- c) After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures upto 60°C.
- d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS: 164.

#### 601.5. REFLECTORISED PAINT

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorizing glass beads for reflectorizing paints where used shall conform to the requirement of Clause 803.4.3.

#### 601.6. APPLICATION

Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a monolayer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

. The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS -3262 (Part 3).

. The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

#### 601.7 MEASUREMENTS FOR PAYMENT

The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any).

In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers.

#### 601.8 RATE

The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications.

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700 STRUCTURAL CONCRETE

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## 701 DESCRIPTIONS

The work shall consist of producing, transporting, placing and compacting of structural concrete including fixing formwork and temporary works etc" and incidental construction in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Engineer.

## 702 MATERIALS

All materials shall conform to Section 2000 of these Specifications"

## 703 GRADES OF CONCRETE

The grades of concrete shall be designated by the characteristic strength as given in Table 700-1, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Table 700-1: Grades of Concrete

Nominal Mix Concrete	Type of Concrete/Grade Designation		Characteristic of Concrete in Mpa(N/mm <sup>2</sup> )
	Standard Concrete	High Performance Concrete	
M15	M15		15
M20	M20		20
	M25		25
	M30	M30	30
	M35	M35	35
	M40	M40	40
	M45	M45	45
	M50	M50	50
		M55	55

M60

60

1) Normal Mix Concrete is made on the basis of nominal mix proportioned by weight of its main ingredients - cement, coarse and fine aggregates and water.

2) Standard concrete is made on the basis of design mix proportioned by weight of its ingredients, which in addition to cement, aggregates and water, may contain chemical admixtures to achieve certain target values of various properties in fresh condition, achievement of which is monitored and controlled during production by suitable tests. Generally, concrete of grades up to M50 are included in this type.

3) High Performance Concrete is similar to standard concrete but contains additional one or more mineral admixtures providing binding characteristics and partly acting as inert filler material which increases its strength, reduces its porosity and modifies its other properties in fresh as well as hardened condition. Concrete of grades upto M90 are included in this type.

4) For concrete of grades higher than M90, the design parameters may be obtained from specialized literature and experimental results.

The minimum grades of concrete and corresponding minimum cement content and maximum water/cement ratios for different exposure conditions shall be as indicated in Table 700-2.

For concrete subjected to sulphate attack the minimum grades of concrete, minimum cement content and maximum water/cement ratios and types of cement for different concentration of sulphate content shall be as indicated in Table 700-2.

Table 700-2: Requirement of Concrete for Different Exposure Condition  
Using 20 mm Aggregate

Exposure Condition	Maximum Water Cement Ratio	Minimum Cement Content, kg/m <sup>3</sup>	Minimum Grade of Concrete
Moderate	0.45	350	M25
Severe	0.45	360	M30
Very Severe	0.40	380	M40

Note:

- i) All three provisions given in the above table for a particular exposure condition, shall be satisfied.
- ii) The term cement for maximum w/c ratio and minimum cement content shown in Table includes all cementitious materials mentioned in Clause 1715.2. The maximum limit of fly ash and ground granulated blast furnace slag in the



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*blended cement shall be as specified in IS: 1489 (Part 1) and IS: 455 respectively.*

- iii) *For plain cement concrete, with or without surface reinforcement, the minimum grade of concrete can be lowered by 5 MPa and maximum water/cement ratio exceeded by 0.05.*

Cement content shown in the above table shall be increased by 40 kg/m<sup>3</sup> for use of 12.50 mm nominal size aggregates and decreased by 30 kg/m<sup>3</sup> for use of 40 mm nominal size aggregates.

## 704 PROPORTIONING OF CONCRETE

Prior to the-start of construction, the Contractor shall design the mix in case of design mix concrete or propose nominal mix in case of nominal mix concrete, and submit to the Engineer for approval, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticizers or super-plasticizers) may be used at the Contractor's option, subject to the approval of the Engineer.

### 704.1 REQUIREMENTS OF CONSISTENCY

The mix shall have the consistency which will allow proper placement and compaction in the required position. Every attempt shall be made to obtain uniform consistency. Slump test shall be used to measure consistency of the concrete.

The optimum consistency for various types of structures shall be as indicated in Table 700-3, or as directed by the Engineer. The slump of concrete shall be checked as per IS: 516.

Table 700-3: Requirements of Consistency

Sl No	Type	Slump (mm) (at the Time of Placing of Concrete)
1	a) Structure with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40 - 50

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	RCC structure with fair degree of congestion of	
3	reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm	50 - 75
4	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75 - 125
5	Underwater concreting through tremie e.g. bottom plug, cast in-situ piling	150 - 200

Notwithstanding the optimum consistency indicated against Sl. No. 1 to 3, the situation should be properly assessed to arrive at the desired workability with the adjustment of admixture in each case, where the concrete is to be transported through transit mixer and placed using concrete pump.

Under these circumstances, the optimum consistency during placement for the items of work of Sl. No. 1 to 3 can be considered ranging from 75 mm to 150 mm. This is, however, subject to satisfying the other essential criteria of strength, durability etc. and approval of the Engineer.

#### 704.2 REQUIREMENTS FOR DESIGN MIXES

##### 704.2.1 Target Mean Strength

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the current margin.

- i) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.64 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

##### 704.2.2 Trial Mixes

The Contractor shall give notice to the Engineer to enable him to be present at the time of carrying out trial mixes and preliminary testing of the cubes. Prior to commencement of trial mix design, all materials forming constituents of proposed design mix should have been tested and approval obtained in writing from the Engineer. Based on test results of material, draft mix design calculation for all grades

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of concrete to be used in the works, shall be prepared after taking into account the provisions in the Contract Technical Specifications, Guidelines of IS: 10262, IS:SP:23 and IRC: 112 and submitted to the Engineer for approval.

Prior to commencement of concreting, trial mix design shall be performed for all grades of concrete and trial mix which has been found successful, shall be submitted by the Contractor and approval obtained. During concreting with the approved trial mix design, if source of any constituents is changed, the mix design shall be revised and tested for satisfying the strength requirements.

The initial trial mixes shall be carried out in a laboratory approved by the Engineer. However, Engineer may permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a fully-fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. Sampling and testing procedures shall be in accordance with these Specifications.

When the site laboratory is utilized for preparing initial mix design, the concrete production plant and means of transport employed to make the trial mixes shall be similar to those proposed to be used in the works.

For each trial mix, a set of six cubes shall be made from each of three consecutive batches for purposes of testing. Three cubes from each set of six shall be tested at an age of 7 days and three at an age of 28 days as approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these Specifications. The mean strength of the six cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

#### 704.2.3 Control of Strength of Design Mixes

##### a) Adjustment to Mix Proportions

Adjustment to mix proportions arrived at in the trial mixes, shall be made subject to the Engineer's approval, in order to minimize the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

##### b) Change of Current Margin

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with Clause 704.2.1. The recalculated value shall be adopted as directed by the Engineer, and it shall become the current margin for concrete produced thereafter.

##### c) Additional Trial Mixes

In case any changes are observed in the properties of fresh concrete and/or strength of hardened concrete on the basis of early age tests, additional mixes and tests shall be carried out during production, so as to control and bring the quality of concrete

within acceptable limits. In case of any change in the source or properties of materials, the design of mix shall be established afresh.

#### 704.2.4 Requirements of Nominal Mix Concrete

Requirements for nominal mix concrete unless otherwise specified shall be as given in Table 700-4.

Table 700-4: Requirements for Nominal Mix Concrete

Concrete Grade	Total quantity of Dry Aggregate by mass per 50 kg of cement to be taken as pa sum of individual masses of fine and course aggregate (Kg)	Proportion of fine to course aggregate (by Mass)	Maximum quantity of water for 50 kg of cement ( liters)	
			PCC	RCC
M15	350	Generally, 1:2, subject to upper limit	25	
M20	250	1:1.5 and lower limit of 1:2.5	25	22

#### 704.3 SUITABILITY OF PROPOSED MIX PROPORTIONS

The Contractor shall submit the following information for the Engineer's approval:

- a) Nature and source of each material
  - c) Quantities of each material per cubic metre of fully compacted concrete
  - d) Either of the following:
    - i) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement (s) as specified.
    - ii) Full details of tests on trial mixes.
  - e) Statement giving the proposed mix proportions for nominal mix concrete

Any change in the source of material or in the mix proportions shall be subject to the Engineer's prior approval.

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*704.4 CHECKING OF MIX PROPORTIONS AND WATER/CEMENT RATIO*

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement per bag as given by the manufacturer is accepted, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stock at site and not by bag, it shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed.

All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked. The specified water/cement ratio shall always be kept constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined as frequently as possible, the frequency for a given job being determined by the Engineer according to the weather conditions. The amount of water to be added shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates IS: 2386 (Part III) shall be referred. Suitable adjustments shall also be made in the weight of aggregates to allow for their variation in weight due to variation in their moisture content.

*704.5 GRADING OF AGGREGATES FOR PUMPED CONCRETE*

Materials for pumped, concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe. The grading of aggregates shall be continuous and shall have sufficient ultra fine materials (material finer than 0.25 mm). Proportion of fine aggregates passing through 0.25 mm shall be between 15 and 30 percent and that passing through 0.125 mm sieve shall not be less than 5 percent of the total volume of aggregate. Admixtures to increase workability can be added.

When pumping long distances and in hot weather, set-retarding admixtures can be used. Fluid mixes can be pumped satisfactorily after adding plasticizers and super plasticizers. Suitability of concrete shall be verified by trial mixes and by performing pumping test.

*705 ADMIXTURES**705.1 CHEMICAL ADMIXTURES*

Chemical admixtures such as superplasticisers, or air entraining, water reducing, accelerating and retarding agents for concrete, may be used with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of their products only

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after obtaining complete information of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the work.

Admixtures/additives conforming to IS: 9103 may be used subject to approval of the Engineer. However, admixtures/additives generating hydrogen or nitrogen and containing chlorides, nitrates, sulphides, sulphates or any other material likely to adversely affect the steel or concrete, shall not be permitted.

Compatibility of the admixtures with the cement and any other Pozzolana or hydraulic addition shall be ensured by for avoiding the following problems

- i) Requirement of large dosage of superplasticisers for achieving the desired workability,
- ii) Excessive retardation of setting
- iii) Excessive entrainment of large air bubbles,
- iv) Unusually rapid stiffening of concrete,
- v) Rapid loss of slump
- vi) Excessive segregation and bleeding.

#### 706 SIZES OF COARSE AGGREGATES

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as given in Table 700-5.

Table 700-5: Maximum Nominal Size of Coarse Aggregates

Components	Maximum Nominal Size of Coarse Aggregate (mm)
1. RCC well curb	20

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2. RCC/PCC well steining	40
3. Well cap or Pile Cap Solid type piers and abutments	40
4. RCC work in girder, slabs wearing coat, kerb, approach slab, hollow piers and abutments, pier/abutment caps, piles	20
5. PSC Work	20
6. Any other item	As specified by the Engineer

Maximum nominal size of aggregates shall also be restricted to the smaller of the following values:

- a. 10 mm less than the minimum lateral clear distance between individual reinforcements
- b. 10 mm less than the minimum clear cover to the reinforcement
- c. One quarter of minimum thickness of member

The proportions of the various individual sizes of aggregates shall be so adjusted that the grading produces the densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

#### 707 EQUIPMENT

Unless specified otherwise, equipment for production, transportation and compaction of concrete shall be as under:

- a) Production of Concrete:
  - i) For overall bridge length of less than 200 m - batch type concrete mixer, diesel or electric operated, with a minimum size of 200litres automatic water measuring system and integral weigher (hydraulic/pneumatic type).
  - ii) For overall bridge length of 200 m or more - concrete batching and mixing plant fully automatic, with minimum capacity of 1 5 cum per hour.

All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be checked over the range in use, when set up at each site and thereafter, periodically as directed by the Engineer.

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The accuracy of the measuring devices shall fall within the following limits:

Measurement of Cement :  $\pm 3$  percent of the quantity of cement in each batch

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Measurement of Water :  $\pm 3$  percent of the quantity of water in each batch

Measurement of Aggregate:  $\pm 3$  percent of the quantity of aggregate in each batch

Measurement of Admixture :  $\pm 3$  percent of the quantity of admixture in each batch

b) Transportation of Concrete:

i) Concrete dumpers : minimum 2 tonnes capacity

ii) Powered hoists : minimum 0.5 tonne capacity

iii) Chutes

iv) Buckets handled by cranes

v) Transit truck mixer

vi) Concrete pump

vii) Concrete distributor booms

viii) Belt conveyor

ix) Cranes with skips

x) Tremies

c) For Compaction of Concrete :

i) Internal vibrators : size 25 mm to 70 mm

ii) Form vibrators : minimum 500 watts :

iii) Screed vibrators : full width of carriageway(upto two lanes)

## 708 BATC HING, MIXING, TRANSPORTING, PLACING AND COMPACTION

### 708.1 GENERAL



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Prior to start of concreting, the Contractor shall submit for approval of the Engineer, his programme along with list of equipment proposed to be used by him for batching, mixing, transporting and placing concrete.

#### 708.2 BATCHING OF CONCRETE

In batching concrete:

- The quantity of cement, aggregate and mineral admixtures, if used, shall be determined by mass.
- Chemical admixtures, if solid, shall be determined by mass
- Liquid admixtures may be measured in volume or mass, and
- Water shall be weighed or measured by volume in a calibrated tank.

The concrete shall be sourced from on-site or off-site batching and mixing plants, or from approved Ready Mixed Concrete plants, preferably having quality certification. Except where supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock piles. The materials should be stock piled several hours, preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible to ensure that the specified grading is maintained.

The water/cement ratio shall always be maintained constant at its correct value. To this end, determination of moisture content in both fine and coarse aggregates shall be made as frequently as possible, depending on weather conditions. The amount of added water shall be adjusted to compensate for any observed variations in the moisture content. To allow for the variation in mass of aggregate due to variation in moisture content, suitable adjustment in the mass of aggregate shall also be made. Accurate control shall be kept on the quantity of mixing water, which when specified, shall not be changed without approval.

#### 708.3 MIXING CONCRETE

##### 708.3.1 Mixing at Site

All concrete shall be machine mixed. In order to ensure uniformity and good quality of concrete the ingredients shall be mixed in a power driven batch mixer with hopper and suitable weigh batching arrangement or in a central mix plant. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering

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the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall be continued till materials are uniformly distributed, a uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall mixing be done for less than 2 minutes. It shall be ensured that the mixers are not loaded above their rated capacities and are operated at a speed recommended by the manufacturer. When mineral admixtures are added at the mixing stage, their thorough and uniform blending with cement shall be ensured, if necessary by longer mixing time. The addition of water after the completion of the initial mixing operation shall not be permitted.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch and also before changing from one type of cement to another.

#### 708.3.2 Ready Mix Concrete

Use of ready mix concrete proportioned and mixed off the project site and delivered to site in a freshly mixed and unhardened state conforming to IS: 4926, shall be allowed with the approval of the Engineer.

#### 708.4 TRANSPORTING CONCRETE

Mixed concrete shall be transported from the place of mixing to the place of final deposit as rapidly as possible by methods which will prevent the segregation or loss of the ingredients.

The method of transporting or placing of concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position so that no contamination, segregation or loss of its constituents' materials take place.

Concrete may be transported by transit mixers or properly designed buckets or by pumping. Transit mixers or other hauling equipment when used should be equipped with the means of discharge of concrete without segregation. During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to be reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

In case concrete is to be transported by pumping; the fresh concrete should have adequate fluidity and cohesiveness to be pumpable. Proper concrete mix proportioning and initial trials should ensure this. The conduit shall be primed by pumping a batch of mortar through the line to lubricate it. Once the pumping is started, it shall not be interrupted, as concrete standing idle in the line is liable to cause plug. The operator shall ensure that some concrete is always there in the pump's receiving hopper during operation. The lines shall always be maintained clean and free of dents.

Pipelines from the pump to the placing area shall be laid with minimum bends. For large quantity placements, standby pumps shall be available. Suitable air release valves, shut off valves etc. shall be provided as per site requirements. The pumping of priming mix i.e. rich mix of creamy consistency, to lubricate the concrete pump and pipelines, shall precede the pumping of concrete. Continuous pumping shall be done to the extent possible. After concreting, the pipelines and accessories shall be cleaned immediately. The pipes for pumping shall not be made of material which has adverse effect on concrete. Aluminum alloy pipelines shall not be used.

#### *708.5 PLACING OF CONCRETE*

All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete.

No concrete shall be placed in any part of the structure until the approval of the Engineer has been obtained. If concreting is not started within 24 hours of the approval being given, the approval shall have to be obtained again from the Engineer. Concreting shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes, unless a proper construction joint is formed.

The concrete shall be deposited as nearly as practicable in its original position to avoid re-handling. Methods of placing should be such as to preclude segregation. Care should be taken to avoid displacement of reinforcement or movement of formwork. To achieve this, concrete should be lowered vertically in the form and horizontal movement of concrete inside the forms should, as far as practicable, be minimized.

The concrete shall be placed and compacted before its initial setting so that it is amenable to compaction by vibration. The workability of concrete at the time of placement shall be adequate for the compaction equipment to be used. If there is considerable time gap between mixing and placing of concrete, as in the case of ready mixed concrete plants or off-site batching and mixing plants, concrete mix shall be designed to have appropriately higher workability at the time of discharge from the mixer, in order to compensate the loss of workability during transit.

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This is generally achieved by suitable chemical admixtures. Keeping these considerations in view, the general requirement for ready mixed concrete plants or off-site batching and mixing plants, is that concrete shall be discharged from the truck mixer within two hours of the time of loading. A longer period may be permitted if suitable retarding admixtures are used.

In wall forms, drop chutes attached to hoppers at the top should preferably be used to lower concrete to the bottom of the form. As a general guidance, the permissible free fall of concrete may not exceed 1.5 metres and under no circumstances shall it be more than 2 metres. When free fall of larger height is involved, self compacting concrete having adequate fluidity, cohesiveness and Viscosity and which uniformly and completely fills every corner of the formwork by its own weight without segregation, shall be used.

Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not more than 300 mm in all other cases.

Concrete when deposited shall have temperature of not less than 5°C and preferably not more than 30°C and in no case more than 40°C. In case of site mixing, fresh concrete shall be placed and compacted in its final position within 30 minutes of its discharge from the mixer. When the concrete is carried in properly designed agitator operating continuously, the concrete shall be placed and compacted within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete, if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

#### 708.6 COMPACTION OF CONCRETE

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over-vibration shall be avoided to minimize the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided.

When internal vibrators are used, they shall be inserted vertically to the full depth of the layer being placed and ordinarily shall penetrate the layer below for a few centimeters. The vibrator should be kept in place until air bubbles cease escaping from the surface and then withdrawn slowly to ensure that no hole is left in the concrete, care being taken to see that it remains in continued operation while being

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withdrawn. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdown.

Mechanical vibrators used shall comply with IS: 2502, IS: 2506, IS: 2514 and IS: 4656.

## 709 CONSTRUCTION JOINTS

Construction joints shall be avoided as far as possible. In no case shall the locations of such joints be changed or increased from those shown on the drawings except with the express approval of the Engineer.

Joints should be positioned where they are readily accessible for preparation and concreting. Construction joints should be positioned to minimize the effects of the discontinuity of the durability, structural integrity and appearance of the structure. As far as possible, joints should be provided in non-aggressive zones, but if joints in aggressive zones cannot be avoided, they should be sealed. Joints should be located away from the regions of maximum stress caused by loading; particularly where shear and bond stresses are high.

In beams and slabs joints should not be near the supports. Construction joints between slabs and ribs in composite beams shall be avoided. For box girders, there shall be no construction joint between the soffit and webs.

Joints should be either vertical or horizontal. For a vertical construction joint, the lifts of concrete shall finish level or at right angles to the axis of the member. Concreting shall be continued right up to the joint.

Before resuming work at a construction joint when concrete has not yet fully hardened, all laitance shall be removed thoroughly. The surface shall be roughened, taking care to avoid dislodgement of coarse aggregates. Concrete shall be brushed with a stiff brush soon after casting, while the concrete has only slightly stiffened. If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed. Fully hardened concrete shall be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles.

The practice of first placing a layer of mortar or grout when concreting joints shall be avoided. The old surface shall be soaked with water, without leaving puddles, immediately before starting concreting. The new concrete shall be thoroughly compacted against it.

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Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement shall be protected. In all cases, where construction joints are made, the joint surface shall not be contaminated with release agents, dust, or sprayed curing membrane and reinforcement shall be firmly fixed in position at the correct cover.

The sequence of concreting, striking of forms and positioning of construction joints for every individual structure, shall be decided well in advance of the commencement of work.

## 710 CONCRETING IN HOT WEATHER

When depositing concrete in hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 30°C while placing. This shall be achieved by using chilled mixing water, using crushed ice as a part of mixing water, shading stock piles of aggregates from direct rays of the sun, sprinkling the stock piles of coarse aggregate with water to keep them moist, limiting temperature of cement below 30°C at the time of use, starting curing before concrete dries out and restricting time of concreting as far as possible to early mornings and late evenings.

When ice is used to cool mixing water, it will be considered as part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted. The Contractor will be required to state his methodology for the Engineer's approval when temperatures of concrete are likely to exceed 30°C during the work.

## 711 PROTECTIONS AND CURING

### 711.1 GENERAL

Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor. Curing and protection of concrete shall start immediately after compaction of the concrete.

The concrete shall be protected from:

- a) Premature drying out particularly by solar radiation and wind
- b) High internal thermal gradients
- c) Leaching out by rain and flowing water

- d) Rapid cooling during the first few days after placing
- e) Low temperature or frost
- f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.
- g) Vibration caused by traffic including construction traffic.

Concrete shall be protected, without allowing ingress of external water, by means of wet (not dripping) gunny bags, hessian etc. Once the concrete has attained some degree of hardening (approximate 12 hrs after mixing), moist curing shall commence and be continued through the requisite period. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

#### 711.2 WATER CURING

Water for curing shall be as specified in Section 2000 of these specifications. Sea water shall not be used for curing. Sea water shall not come into contact with concrete members before they have attained adequate strength.

The concrete should be kept constantly wet by ponding or covering or use of sprinklers/ Perforated pipes for a minimum period of 14 days after concreting, except in the case of concrete with rapid hardening cement, where it can be reduced to 5 days. Water should be applied on surfaces after the final set. Curing through watering shall not be done on green concrete. On formed surfaces, curing shall start immediately after the forms are stripped.

The concrete shall be kept constantly wet with a layer of sacking, canvas, hessian or similar absorbent material.

#### 712 FINISHING

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or comers, and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar.

The mortar shall be of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as possible. Considerable pressure shall be applied in filling and pointing to ensure thorough

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filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance of the member shall be rejected. Surface defects of a minor nature may be accepted. On acceptance of such work, the same shall be rectified as directed by the Engineer.

### 713 FREQUENCIES

The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 700-6.

Table 700-6: Minimum Frequency of Sampling

Quantity of Concrete in Work, m3	No. of Samples
1 - 5	1
6 - 15	2
16 - 30	3
31 - 50	4
51 and above	4 plus one additional sample for each additional 50 m3 or part thereof



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714 MEASUREMENTS FOR PAYMENT

Structural concrete shall be measured in cubic metres. In reinforced or pre-stressed concrete, the volume occupied by reinforcement or pre-stressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

## 715 RATE

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. Unless mentioned separately as an item in the contract, the contract unit rate for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per Section 800 of these Specifications.

If the concrete is found to be acceptable by the Engineer as sub-standard work, the Contractor shall be subjected to reduction in his contract unit rate. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under:

$$\% \text{ reduction in rate} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

## 716 TRADITIONAL CORNICES

## 716.1 BHUTAN CORNICE

The profile of the cornice shall conform in all respects to the approved design and the work carried out as directed by the Engineer. Care shall be taken to see that cornice at each floor level is as per the design for that level, and to maintain proper line and level.

Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20mm aggregate including cost of formwork, finishing, 6mm thick plaster on the exposed surface with cement mortar 1:3, excluding reinforcement & decorative painting cost.

- i. Single Storied building, including cost of Phana and
- ii. Multi Storied building at floor two level or other floors where Lhanglag is provided including cost of Lhanglag

**716.2 MEASUREMENT:**

Bhutan cornice shall be measured by length correct to 10mm, along the junction of the cornice and wall.

**716.3 RATE:**

The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering unless otherwise mentioned in the item.

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**800 FORMWORK****801 DESCRIPTION**

Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish, as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support.

**802 MATERIALS**

All materials shall comply with the requirements of IRC: 87. Materials and components used for formwork shall be examined for damage or excessive deterioration before use/re-use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits.

Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Other materials conforming to the requirements of IRC: 87 may also be used if approved by the Engineer.

**803 DESIGN OF FORMWORK**

The design, erection and removal of formwork shall conform to IRC: 87 "Guidelines for Formwork, False work and Temporary Structures" and these specifications. The forms shall be such as to ensure that they can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection.

The Contractor shall furnish the design and drawing of complete formwork (i.e. the forms as well as their supports) for approval of the Engineer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information as per Appendix 1500/1, to the Engineer for approval.

Notwithstanding any approval or review of drawing and design by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety of formwork.

In the case of pre-stressed concrete superstructure; careful consideration shall be given to redistribution of loads on props due to pre-stressing.

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804 WORKMANSHIP

The formwork shall be robust and strong and the joints shall be leak-proof. Ballies shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

The number of joints in the formwork shall be kept to a minimum by using large sized panels. The design shall provide for proper "soldiers" to facilitate alignment. All joints shall be leak proof and must be properly sealed. Use of PVC joint sealing tapes, foam rubber or PVC T-section, is essential to prevent leakage of grout.

As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable, minimum number of nails shall be used and these shall be of the double-headed type. Alternatively, if the nails are of the normal type, they shall be left partially projecting without being driven to their full length, so that they can be withdrawn easily.

Use of ties shall be restricted, as far as practicable. Wherever ties are used they shall be used with HOPE sheathing so that they can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.

Unless otherwise specified, or directed, chamfers or fillets of size 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp comers. The chamfers, beveled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as directed by the Engineer.

Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.

The formwork shall be constructed with pre-camber to the soffit to allow for (deflection of the formwork. This shall be in addition to the pre-camber for the permanent structure as shown on the drawings.

Where centering trusses or launching trusses are adopted for casting of super structure, the joints of the centering trusses, whether welded, riveted or bolted shall be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion. Launching truss, casting truss of span more than 40 m and travelling forms, shall be load tested before they are put to use.

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The formwork shall be so made as to produce a finished concrete true to shape, line and levels and dimensions as shown on the drawings, subject to the tolerances specified in respective Sections of these specifications, or as directed by the Engineer.

Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.

The formwork shall ensure the correct final shape of the structure, with the calculated amount of positive or negative camber. The deformation of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes arising in pre-stressed structures shall be properly accounted for.

Suitable camber shall be provided to horizontal members of structure, especially in long spans, to counteract the effects of deflection. The formwork shall be so fixed as to provide for such camber.

The formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating oils (machine oils) shall be prohibited for use as coating.

#### 805 LINING OF FORMWORK

The formwork shall be lined with material approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and shall be so fixed to its backing as not to impart any blemishes. It shall be of the same type and obtained from only one source throughout for the construction of any one structure.

The contractor shall make good any imperfections in the resulting finish as required by the Engineer. Internal ties and embedded metal parts shall be carefully detailed and their use shall be subject to the approval of the Engineer.

#### 806 PREPARATION OF FORMWORK BEFORE CONCRETING

The inside surfaces of forms shall, except in the case of permanent formwork or where otherwise agreed to by the Engineer, be coated with a release agent supplied

by approved manufacturer or of an approved material to prevent adhesion of concrete to the formwork.

Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come in contact with any reinforcement or pre-stressing tendons and anchorages. Different release agents shall not be used in formwork for exposed concrete.

Before re-use of forms, the following actions shall be taken:

- i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.
- iii) It should be ensured that the release agent is appropriate to the surface to be coated. The same type and make of release agent shall be used throughout on similar formwork materials and different types should not be mixed.
- iv) The form surfaces shall be evenly and thinly coated with release agent. The vertical surface shall be treated before horizontal surface and any excess wiped out.
- v) It shall be ensured that the reinforcement or the surface of the hardened concrete shall not come in contact with the release agent.

All forms shall be thoroughly cleaned immediately before concreting.

The Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork. However, such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

## 807 REMOVAL OF FORMWORK

The scheme for removal of formwork (Le. de-shuttering and de-centering) shall be planned in advance and furnished to the Engineer for scrutiny and approval. No formwork or any part there of shall be removed without prior approval of the Engineer.

The formwork shall be so removed as not to cause any damage to concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

Form work shall not be released unless the concrete has achieved strength of at least twice the stress the concrete may be subjected at the time of the removal of formwork. When no test is conducted for determination of strength of concrete and where the time of removal of formwork is not specified, the same shall be as under:

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a)	Walls, piers, abutments, columns and vertical faces of structural members	12 to 48 hours as may be decided by the Engineer
b)	Soffits of Slabs (with props left under)	3 days
c)	Props left under slabs	14 days
d)	Soffits of Girders (with props left under)	7 days
e)	Props (left under girders)	21 days

The above time schedule is applicable when ordinary Portland cement is used without any admixtures at an ambient temperature exceeding 10°C.

For concrete made with Portland Pozzolana cement, Portland slag cement or mineral admixtures, additional cube samples shall be taken for verifying the strength of concrete to decide the time of de shuttering

Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

#### 808 RE-USE OF FORMWORK

When the formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before their use again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning.

All bent steel props shall be straightened before re-use. The maximum permissible deviation from straightness is 1/600 of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

During the use of Formwork, the Contractor is advised to apply Formwork-Oil to the entire surface in contact with the Concrete for smooth finishing.

#### 809 MEASUREMENTS FOR PAYMENT

Unless stated otherwise, the rate for concrete in plain concrete or reinforced concrete or pre-stressed concrete, shall be deemed to include all formwork required in accordance with this Section, which shall not be measured separately.

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Where it is specifically stipulated in the Contract, the formwork shall be paid separately, and the measurement of formwork shall be taken in square meters ( $M^2$ ) of the surface area in contact with concrete. The payment to the Contractor shall be **only one-third (1/3)** of total measurement (total area of formwork).

Note: The same formwork shall be used three times for any similar work.

#### 810 RATE

The unit rate of plain concrete or reinforced concrete or prestressed concrete as defined in respective Sections of these Specifications, shall be deemed to cover the costs of all formwork and staging, including cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured, set and hardened as required.

Where the contract unit rate for formwork is specially provided as a separate item in the contract, it shall include the cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured; set and hardened as required.



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**900 STEEL REINFORCEMENT****901 DESCRIPTION**

This work shall consist of furnishing and placing coated or uncoated mild steel or high strength deformed reinforcement bars of the shape and dimensions shown on the drawings and conforming to these Specifications or as approved by the Engineer.

**902 GENERAL**

Steel for reinforcement shall meet the requirements of Section 2000 of these Specifications. Reinforcements may be either mild steel or high strength deformed bars. They may be uncoated or coated with epoxy.

**903 PROTECTION OF REINFORCEMENT**

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or by thoroughly cleaning it using any suitable method such as sand blasting, mechanical wire brushing etc., as directed by the Engineer. Reinforcements shall be stored above the ground in a clean and dry condition, on blocks, racks or platforms and shall be suitably marked to facilitate inspection and identification.

Portions of uncoated reinforcing steel and dowels projecting from concrete, shall be protected within one week after initial placing of concrete, with a brush coat of neat cement mixed with water to a consistency of thick paint. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete. Coated reinforcing steel shall be protected against damage to the coating. If the coating on the bars is damaged during transportation or handling and cannot be repaired, the same shall be rejected.

In case of fusion bonded epoxy coated reinforcement or hot dipped galvanized bars used, reference Section 2000 of these specifications.

**904 BENDING OF REINFORCEMENT**

Bar bending schedule shall be furnished by the Contractor and got approved by the Engineer before start of work.

Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.

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Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer using a proper bar bender, operated by hand or power to obtain the correct shape and radii of bends.

Bars shall not be bent or straightened in a manner that will damage the parent material or the coating.

Bars bent during transport or handling shall be straightened before being used on work. They shall not be heated to facilitate straightening.

#### 905 PLACING OF REINFORCEMENT

- a) The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcement and casting of concrete, which may result in rust formation on the surface of the bars, shall not be permitted.
- b) Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS: 280 to make the skeleton of the reinforcement rigid such that there in for cement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1 mm.
- c) Bars shall be kept in position usually by the following methods:
  - i) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover, shall be placed between the bars and formwork, subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer, provided they have the same strength and specification as those of the member.
  - ii) In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed upto a level just below their location.
  - iii) Layers of reinforcements shall be separated by spacer bars at approximately one metre intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or

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maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.

- iv) Necessary stays, blocks, metal chairs, spacers, metal hangers, supporting wires etc. or other subsidiary reinforcement shall be provided to fix the reinforcement firmly in its correct position.
  - v) Use of pebbles, broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.
- C) Bars coated with epoxy shall be placed on supports that do not damage the coating. Supports shall be installed in a manner such that planes of weakness are not created in hardened concrete. The coated reinforcing steel shall be held in place by use of plastic or plastic coated binding wires especially manufactured for the purpose. Refer Section 1000 of these Specifications for other requirements.
- d) Placing and fixing of reinforcement shall be inspected and approved by the Engineer before concreting is commenced.

## 906 BAR SPLICES

### 906.1 LAPPING

All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, shall be permitted without approval of the Engineer. The lengths of the splice shall be as indicated on drawing or as approved by the Engineer. Where practicable, overlapping bars shall not touch each other, and shall be kept apart by 25mm or 1.25 times the maximum size of coarse aggregate, whichever is greater. If this is not feasible, overlapping bars shall be bound with annealed steel binding wire not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points along the span where stresses are low.

### 906.2 WELDING

Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Engineer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

While welding may be permitted for mild steel reinforcing bars conforming to IS: 432, welding of deformed bars conforming to IS: 1786 shall in general be prohibited.

The method of welding shall conform to IS: 2751 and IS: 9417, any supplemental specifications and Clause 1904.8 of these Specifications to the satisfaction of the Engineer.

Welding may be carried out by metal arc welding process. Oxy-acetylene welding shall not be permissible. Any other process may be used subject to the approval of the Engineer and necessary additional requirements to ensure satisfactory joint performance. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed.

All bars shall be butt welded except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded. Single-V or Double-V butt joints may generally be used. For vertical bars single bevel or double bevel joints may be used. Welded joints shall be located well away from bends and shall be not less than twice the bar diameter away from a bend.

Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary shall, however, be permitted when the facilities, equipment, process, consumables, operators and welding procedure, are adequate to produce and maintain uniform quality at par with that attainable in shop welding, to the satisfaction of the Engineer.

Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall be qualified by tests prescribed in IS: 2751. Inspection of welds shall conform to IS: 822 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not be accepted.

Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding. When welding is done in two or three stages, the surface shall be cleaned properly after each stage. Bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before carrying out welding. Only competent and experienced welders shall be employed on the work with the approval of the Engineer. No welding shall be done on coated bars.

M.S. electrodes used for welding shall conform to IS: 814.

Welded joints shall preferably be located at points where steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that at any one section, not more than 20 percent of the bars are welded.

Specimens of welded pieces of reinforcement taken from the site shall be tested. The number and frequency of tests shall be as directed by the Engineer.

### 906.3 MECHANICAL COUPLERS AND ANCHORAGES

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906.3.1 Mechanical Couplers

Bars may be joined with approved patented mechanical devices as indicated on the drawing or as approved by the Engineer e.g. by special grade steel sleeves swaged on to bars in end to end contact or by screwed couplers. In case such devices are permitted by the Engineer, they shall develop at least 125 percent of the characteristic strength of the reinforcement bar.

## 906.3.2 Anchorages

Bars may be anchored with approved patented mechanical anchorages as indicated on the drawing or as approved by the Engineer. The anchorages shall be connected to the reinforcing bar by the use of taper thread system. The anchorage shall be capable of developing the characteristic strength of reinforcement without damage to concrete and shall have sufficient diameter and width to develop adequate shear cone strength. The connection shall develop 125% of the characteristic strength of reinforcement bar.

## 907 TESTING AND ACCEPTANCE

The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, will be got carried out by the Contractor at his own cost.

The supply, fabrication and placing of reinforcement shall be in accordance with these Specifications and shall be as checked and accepted by the Engineer. Manufacturer's test certificate regarding compliance with Indian Standards for each lot of steel, shall be obtained and submitted to the Engineer. If required by the Engineer, the Contractor shall carry out confirmatory tests in the presence of a person authorized by the Engineer.

Cost of these tests shall be borne by the Contractor. The sampling and testing procedure shall be as laid down in IS: 1786. If any test piece selected from a lot fails, no re-testing shall be done and the lot shall be rejected.

## 908 MEASUREMENT FOR PAYMENT

Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of IS: 1732. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing, shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

## 909 RATE

The contract unit rate for coated/uncoated reinforcement shall cover the cost of material, royalty, fabricating, transporting, storing, bending, placing, binding and fixing in position as shown on the drawings and as per these Specifications and as directed by the Engineer, including all labour, equipment, supplies, incidentals, sampling, testing and supervision.

The unit rate for coated reinforcement shall be deemed to also include cost of all material, labour, tools and plant, royalty, transportation and expertise required to carry out the coating work as well as sampling, testing and supervision required for the work.

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**1000 STRUCTURAL STEEL WORK****1000.1 GENERAL**

As much fabrication work as is reasonably practicable, shall be completed in shops, where steel work is fabricated.

Structural steel shall be procured from reputed manufacturers as approved by the employer. All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Tolerances for fabrication of steel structures conform BIS 7215. Tolerances for erection of steel structures shall conform to BIS 12843.

**1000.2 MINIMUM THICKNESS OF METAL - CORROSION PROTECTION**

Unless, otherwise specified, the thickness of steel section shall be governed as below:

a) Steel work exposed to weather

Where steel work is directly exposed to weather and is fully accessible for clearing and repairing the thickness shall not be less than 6 mm. Where steel is exposed to weather and is not accessible for cleaning and painting, the thickness shall not be less than 8 mm. This shall not apply for hot rolled sections covered by Indian Standards.

b) Steel work not directly exposed to weather

The thickness of steel work not directly exposed to the weather, shall be not less than 6 mm. The thickness of steel in secondary members shall be not less than 6 mm. For hot rolled sections to Indian Standards, the mean thickness of flange be considered and not the web thickness.

c) The requirements (a) and (b) above does not apply to light structural work or sealed box section or to steel work in which special provision against corrosion has been made.

d) In case of steel work exposed to highly corrosive fumes or vapour the thickness shall be as approved by the Employer's Representative.

**1000.3 DRAWINGS PREPARED BY THE CONTRACTOR**

The contractor shall prepare all fabrication working and erection drawings for the entire work. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

All fabrication drawings shall be submitted to the Employer's Representative for approval.

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No fabrication drawings will be accepted for Employer's Representative's approval unless checked and approved by the contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The contractor shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the contractor only after Employer's Representative's approval of fabrication drawings. Approval by the Employer's Representative of any of the drawing shall not relieve the contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon.

The drawings prepared by the contractor and all subsequent revisions etc. shall be at the cost of the contractor for which no separate payment will be made.

#### 1000.4 CONNECTIONS

Shop/field connections shall be as per approved fabrication drawings.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers shall be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All members, likely to collect rain water shall have drain holes provided.

#### 1000.5 RIVETING

Rivets shall be heated uniformly throughout their length without burning or excessive scaling and shall be of sufficient length to provide a head of standard dimensions. They shall, when driven, completely fill the holes and if counter sunk, the counter sinking shall be fully filled by the rivet; any protrusion of the countersunk head being dressed off flush if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted



connections. For multiple riveted connections, a service bolt shall be provided for every third or fourth hole.

Wherever practicable, machine riveting shall be carried out by using machines of the steady pressure type. All loose bored or otherwise defective rivets shall be cut out and replaced before the structure is loaded and special care shall be taken to inspect all single riveted connections.

Special care shall be taken in heating and riveting long rivets.

#### 1000.6 INSPECTION

##### 1000.6.1 GENERAL

The Contractor shall give due notice to the Employer's Representative in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Employer's Representative's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Employer's Representative if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the employer may make because of defective or unsatisfactory materials and /or workmanship.

No materials shall be painted or dispatched to site without inspection and approval by the Employer's Representative unless such inspection is waived in writing by the Employer's Representative. Cost of such inspections shall be borne by the contractor.

The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Employer's Representative.

Inspection and tests on structural steel members shall be as set forth below.

##### 1000.6.2 MATERIAL TESTING

If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

#### 1000.7 TESTS ON WELDS

##### (a) Non Destructive Test

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All full strength butt welds shall be tested in accordance with the recommended practice for non destructive test as per relevant BIS code.

*(b) Dimensions, Workmanship & Cleanliness*

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings.

**1000.8 TEST FAILURE**

In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the Employer's Representative. The Contractor must obtain permission from the Employer's Representative before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Employer's Representative.

The Employer's Representative has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the contractor.

The Contractor shall maintain records of all inspection and testing which shall be made available to the Employer's Representative.

**1000.8 SHOP MATCHING**

For structures like, bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Employer's Representative. All these shop assemblies shall be carried out by the Contractor.

**1000.9.1 SHOP ASSEMBLY**

- a) The steel work shall temporarily shop assembled complete or as arranged with the Authority so that accuracy of fit may be checked before dispatched. The parts shall be shop assembled with sufficient numbers of parallel drifts to bring and keep the parts in place.
- b) In case of parts drilled or punched, through steel jigs with bushes resulting in all similar parts being interchangeable the steel work may be shop erected in such position as arranged with the Authority.

**1000.9.2 PACKING**

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All projecting plates or bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed; and all rivets, bolts, nuts, washers and small loose parts shall be packed separately in cases so as to prevent damage or distortion during transit.

#### 1000.9.3 INSPECTION AND TESTING

- a) The Employer's Representative shall have free access at all reasonable times to those parts of the manufacturers' works which are concerned with the fabrication of steel work and shall be afforded all reasonable facilities to satisfy that the fabrication is being undertaken in accordance with the specifications.
- b) Unless specified otherwise, inspection prior to dispatch shall not interfere with the operation of the work.

#### 1000.10 SITE ERECTION

- a) Plant and Equipment

The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Employer's Representative.

- b) Storing and Handling

All structural steel should be so stored and handled at the site that the members are not subject to excessive stresses and damage.

- c) Setting Out

The positioning and leveling of all steelwork, the plumbing of stanchions and the placing of every part of the structure with accuracy shall be in accordance with approved drawings and to the satisfaction of Employer's Representative.

- d) Security during Erection

Safety precaution during erection shall conform to BIS 7205:1974. During erection, the steel work shall be securely bolted or otherwise fastened and, when necessary, temporarily braced to provide for all load to be carried by the structure during erection including those due to erection equipment and its operation.

No riveting, permanent bolting or welding should be done until proper alignment has been obtained.

#### 1000.11 FIELD CONNECTIONS

All field assembly by bolts, rivets and welding shall be executed in accordance with the requirements of shop fabrication excepting such as manifestly apply to shop conditions only. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of 50 mm at least on either side of the joint.

#### 1000.11.1 PAINTING AFTER ERECTION

- a) All the surfaces of structural steel shall be cleaned by sand blasting.
- b) Before painting of such steel which is delivered, all surfaces to be painted shall be dry and thoroughly cleaned from all loose scale and rust.
- c) The specified protective treatment shall be completed after erection. All rivet and bolt heads and site welds after de-slugging shall be cleaned. Damaged or deteriorated paint surfaces shall be cleaned. Damaged or deteriorated paint surfaces shall be first made good with the same type of paint as the shop coat. Where specified, surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while paint is still wet.
- d) Where the steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds and site rivets and bolts; but subject to the approval of Authority, protection may be completed by painting on site. Bolts which have been galvanized or similarly treated are exempted from this requirement.
- e) Surfaces which will be inaccessible after site assembly shall receive the full specified treatment before assembly.
- f) Site painting should not be done in frosty or foggy weather, or when humidity is such as to cause condensation on the surfaces to be painted.
- g) It is essential to ensure that immediately after preparation of the surfaces; the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'. After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the Aluminum paint of optimum thickness shall be applied by brushing with minimum of brush marks.

The first finishing coat of Aluminum paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing if required by the Engineers representatives.

#### 1000.12 MATERIALS

- Zinc chrome primer shall conform to BIS : 2074

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- Synthetic enamel paint shall conform to BIS : 2932
  - Aluminium paint shall conform to BIS : 2339

All the materials shall be of the best quality from an approved manufacturer. Bidder shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/ shade. All the materials shall be brought to the site in sealed containers.

#### 1000.13 MARKING OF MEMBERS

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

#### 1000.14 ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Employer's Representative as defective workmanship. Where the Employer's Representative rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to the Specifications by the Contractor, at no additional cost to the employer.

#### 1000.15 TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with relevant IS Specifications and necessary test certificates shall be furnished. Additional tests, if required, shall be got carried out by the Contractor at his own cost.

The fabrication, furnishing, erection and painting of structural steel work shall be in accordance with these Specifications and shall be checked and accepted by the Engineer.

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1000.16 MEASUREMENTS FOR PAYMENT

The measurements of this item shall be in tonnes based on the net weight of metal in the fabricated structure, computed on the basis of nominal weight of materials.

The weight of rolled and cast steel and cast iron shall be determined from the dimensions shown on the drawings on the following basis:

Rolled or cast steel:  $7.84 \times 10^{-3}$  kg/cu.cm.

Cast Iron:  $7.21 \times 10^{-3}$  kg/cu.cm.

Weight of structural sections shall be nominal weight.

Weight of castings shall be computed from the dimensions shown on the drawings with an addition of 5 percent for fillets and over-runs.

The Contractor shall supply detailed calculation sheets for the weight of the metal in the fabricated structure.

No additions shall be made for the weight of protective coatings, weld fillets, bolts, nuts and washers.

Where computed weight forms the basis for payment, the weight shall be calculated for exact cut sizes of members used in the structure, deductions being made for all cuts, except for rivet holes. Additions shall be made for the rivet heads as mentioned above.

When specially agreed upon, the basis for payment may be the bridge weight complete, according to specifications included in special provisions of the contract.

## 1000.17 RATE

The contract unit rate for the completed structural steel work shall include the cost of all materials, labour, tools, plant and equipment required for fabrication, connections, oiling, painting, temporary erection, inspection, tests and complete final erection as shown on the drawings or as directed by the Engineer and as specified in these Specifications.

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**1100 BRICK MASONRY****1100.1 DESCRIPTION**

This work shall consist of construction of structures with bricks jointed together by cement mortar, In accordance with the details shown on the drawings or as approved by the Engineer.

**1100.2 MATERIALS**

All materials to be used in the work shall conform to the requirements laid down in Section 2000 of these specifications.

**1100.3 PERSONNEL**

Construction of brick work shall be carried out only by masons having sufficient experience/training in the work.

**1100.4 CEMENT MORTAR****1100.4.1 Proportioning and Mixing of Mortar**

Cement and sand shall be mixed in specified proportions given on the drawings. Cement shall be proportioned by weight, taking the unit weight of cement as 1.44 tonne per cubic metre. Sand shall be proportioned by volume with due allowance for bulking. All mortar shall be mixed with a minimum quantity of water to produce desired workability consistent with required density. The mix shall be clean and free from soil, acid, alkali, organic matter or other deleterious substances.

The mixing shall be done in a mechanical mixer operated manually or by power. As an exception, hand mixing can also be resorted to as long as uniform density of the mix and its strength are assured. Hand mixing shall be permitted only for very small and isolated works like CD works, subject to the prior approval of the Engineer. Hand mixing shall be carried out on a clean watertight platform, where cement and sand shall be first mixed dry in the required proportion by being turned over and over, backwards and forwards, several times till the mixture is of uniform colour. Thereafter, minimum quantity of water shall be added to bring the mortar to the consistency of a stiff paste. The mortar shall be mixed for at least two minutes after addition of water.

Mortar shall be mixed only in such quantity as required for immediate use. The mix which has developed initial set shall not be used. Initial set of mortar with ordinary Portland cement shall normally be considered to have taken place in 30 minutes

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after mixing. In case the mortar has stiffened during initial setting time because of evaporation of water, it can be re-tempered by adding water as frequently as needed to restore the requisite consistency, but such re-tempering shall not be permitted 30 minutes after mixing. Mortar remaining un used for more than 30 minutes after mixing, shall be rejected and removed from site of work.

#### 1100.4.2 Testing of Mortar

Necessary tests to determine compressive strength of the mortar, its consistency and water resistivity shall be carried out in accordance with IS: 2250. For compressive strength tests, the frequency of testing shall be 1 cube for every 2 cu.m of mortar, subject to a minimum of 3 cubes for a day's work.

#### 1100.5 SOAKING OF BRICKS

All bricks shall be thoroughly soaked in a tank filled with water for a minimum period of one hour prior to being laid. Soaked bricks shall be removed from the tank sufficiently in advance so that they are skin dry at the time of actual laying. Such soaked bricks shall be stacked at a clean place where they are not contaminated with dirt, earth, etc.

#### 1100.6 JOINTS

The thickness of joints shall not exceed 10 mm. All joints on exposed faces shall be tooled to give concave finish.

#### 1100.7 LAYING

All brickwork shall be laid in an English bond, even and true to line, plumb and level and all joints accurately kept in accordance with the drawing or as directed by the Engineer. Half and cut bricks shall not be used except when necessary to complete the bond. Closer in such cases shall be cut to the required size and used near the ends of the walls. The bricks used at the face and also at all angles forming the junction of any two walls shall be selected whole bricks of uniform size, with true and rectangular faces.

All bricks shall be laid with frogs up on a full bed of mortar except in the case of tile bricks. Each brick shall be properly bedded and set in position by slightly pressing while laying, so that the mortar gets into all its surface pores to ensure proper adhesion. All head and side joints shall be completely filled by applying sufficient mortar to brick already placed and on brick to be placed. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left. No bats or cut bricks shall be used except to obtain dimensions of the different courses for specified bonds or wherever a desired shape so requires.



The brick work shall be built in uniform layers and for this purpose, wooden straight edge with graduations indicating thickness of each course including joint shall be used. Corners and other advanced work shall be raked back. Brickwork shall be done true to plumb or in specified batter. All courses shall be laid truly horizontal, and vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other.

During construction, no part of work shall rise more than one metre above the general construction level, to avoid unequal settlement and improper jointing. Where this is not possible, the work shall be raked back according to the bond (and not toothed) at an angle not steeper than 45 degree with prior approval of the Engineer. Toothing may also be permitted where future extension is contemplated. The construction of Brick wall shall be completed including proper pointing on both the side of the wall face.

Before laying bricks in foundation, the foundation slab shall be thoroughly hacked, swept clean and wetted. A layer of mortar not less than 12 mm thick shall be spread on the surface of the foundation slab before the first course of bricks is laid.

#### 1100.8 JOINTING OLD AND NEW WORKS

Where fresh masonry is to join with masonry that is partially/entirely set, the exposed jointing surface of the set masonry shall be cleaned, roughened and wetted, so as to achieve the best possible bond with the new work. All loose bricks and mortar or other material shall be removed.

In the case of vertical or inclined joints, it shall be further ensured that proper bond between the old and new masonry is obtained by interlocking the bricks. Any portion of the brick work that has been completed shall remain undisturbed until thoroughly set.

In case of sharp comers especially in skew bridges, a flat cutback of 100 mm shall be provided so as to have proper and bonded laying of bricks.

#### 1100.9 CURING

Green work shall be protected from rain by suitable covering and shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out during the day shall be suitably marked indicating the date on which the work was done, so as to keep a watch on the curing period. The top of the masonry work shall be left flooded with water at the close of the day. Watering shall be done carefully so as not to disturb or wash out the green mortar.

During hot weather, all finished or partly completed work shall be covered or wetted in such a manner as to prevent rapid drying of the brickwork.

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During the period of curing, the brick work shall be suitably protected from all damages. At the close of day's work or for other period of cessation, watering and curing shall have to be maintained. Should the mortar perish i.e. become dry, white or powdery through neglect of curing, work shall be pulled down to the extent required and rebuilt as directed by the Engineer.

If any stains appear during watering, the same shall be removed from the surface.

#### 1100.10 SCAFFOLDING

The scaffolding shall be sound, strong and safe to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one metre in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good. Scaffolding shall be got approved by the Engineer, but its safety shall be the responsibility of the Contractor.

#### 1100.11 EQUIPMENT

All tools and equipment used for mixing, transporting and laying of mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

#### 1100.12 FINISHING OF SURFACES

##### 1100.12.1 GENERAL

All brickwork shall be finished in a workmanlike manner with the thickness of joints, manner of striking or tooling as described in these specifications.

The surfaces can be finished by jointing, pointing or plastering, as shown on the drawings. For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm, while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly cleaned and wetted.

The mortar for finishing shall be prepared as per Clause 1004.

##### 1100.12.2 JOINTING

In jointing, the face of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work. The faces of brick work shall be cleaned to remove any splashes of mortar during the course of raising the brick work.

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*1100.12.3 POINTING*

Pointing shall be carried out using mortar not leaner than 1:3 by volume of cement and sand or as shown on the drawing. The mortar shall be filled and pressed into the raked joints before giving the required finish. The pointing shall be ruled type for which it shall, while still green, be ruled along the centre with half round tools of such width as may be specified by the Engineer. The superfluous mortar shall then be taken off from the edges of the lines and the surface of the masonry shall be cleaned of all mortar. The work shall conform to IS: 2212. Raised pointing which projects beyond the face of stone, brick or block shall be avoided.

*1100.12.4 PLASTERING*

Plastering shall be done where shown on the drawing. Superficial plastering may be done, if necessary, only in structures situated in fast flowing rivers or in severely aggressive environment.

Plastering shall be started from top and worked down. All holes shall be properly filled in advance of the plastering, while the scaffolding is being taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 m to 4 m apart, to act as gauges and guides in applying the plaster. The mortar shall be laid on the wall between the screeds using the plasterer's float and pressing the mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm to 75 mm at a time. Finally, the surface shall be finished off with a plasterer's wooden float. Metal floats shall not be used.

When re-commencing plastering beyond the work suspended earlier, the edges of the old plaster shall be scraped, cleaned and wetted before plaster is applied to the adjacent areas.

No portion of the surface shall be left unfinished for patching up at a later period. The plaster shall be finished true to plumb surface and to the proper degree of smoothness as directed by the Engineer.

The average thickness of plaster shall not be less than that specified. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm.

Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut in rectangular shape and re-done as directed by the Engineer.

*1100.12.5 CURING OF FINISHES*

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Curing shall be commenced as soon as the mortar used for finishing has hardened sufficiently so as not to be damaged during curing. The curing shall be done for a period of at least 7 days, during which the finishing shall be suitably protected from all damages.

#### 1100.12.6 SCAFFOLDING FOR FINISHES

Stage scaffolding independent of the structure, shall be provided for the work of finishing.

#### 1100.13 ACCEPTANCE OF WORK

All work shall be true to lines and levels as indicated on the drawing or as directed by the Engineer, subject to tolerances as indicated in these specifications.

Mortar cubes shall be tested in accordance with IS: 2250 for compressive strength, consistency of mortar and its water retentivity. The frequency of testing shall be one sample for every 2 cubic metres of mortar subject to a minimum 3 samples for a day's work. In case of plaster finish, the minimum surface thickness shall not be less than the specified thickness by more than 3 mm.

#### 1100.14 MEASUREMENTS FOR PAYMENT

All brick work shall be measured in cubic metres. Any extra work done by the Contractor in excess of the specified dimensions shall be ignored.

In arches, the length of arch shall be measured as the average of the lengths along the extrados and the intrados.

The work of plastering and pointing shall be measured in square metres of the surface treated.

Coping shall be measured in linear metres.

#### 1100.15 RATE

The contract unit rate for brick work shall include the cost of all labour, materials, tools and plant, scaffolding and other expenses incidental to the satisfactory completion of the work, sampling, testing and supervision as described in these specifications and as shown on the drawings.

The contract unit rate for plastering shall include the cost of all labour, materials, tools and plant, scaffolding and all incidental expenses, sampling, testing and supervision, as described in these specifications.

The contract unit rate for pointing shall include erecting and removal of scaffolding, all labour, materials, and equipment incidental to completing the pointing, raking out joints, cleaning, wetting, filling with mortar, trowelling, pointing and watering, sampling and testing and supervision as described in these specifications.

The contract unit rate for coping shall include cost of all labour, materials, tools and plant, sampling and testing and supervision as described in these specifications.

## 1200 STONE AND CONCRETE BLOCK MASONRY

### 1200.1 DESCRIPTION

This work shall consist of construction of structures with stones or concrete blocks jointed together by cement mortar in accordance with the details shown on the drawings and these specifications or as approved by the Engineer.

### 1200.2 MATERIALS

All materials to be used in stone and concrete block masonry, shall conform to Section 2000 of these Specifications, except cement mortar which shall conform to Clause 1004 of these Specifications.

### 1200.3 PERSONNEL

Only trained personnel shall be employed for construction and supervision.

### 1200.4 TYPE OF MASONRY

The type of masonry used for structures shall be random rubble (coursed or uncoursed) or coursed rubble (first sort) or concrete block. For bridge work generally, coursed rubble masonry shall be used. The actual type of masonry used for different parts of structures shall be specified on the drawings. For facing work, ashlar masonry shall be used where indicated on the drawings.

### 1200.5 CONSTRUCTION

#### 1200.5.1 STONE MASONRY

##### 1200.5.1.1 General

The dressing of stone shall be as specified for individual type masonry work and it shall also conform to the general requirements of IS: 1597 and requirement for dressing of stone covered in IS: 1129. Other specific requirements are covered separately with respect to particular types of rubble stone work.

##### 1200.5.1.2 Laying

The masonry work shall be laid to lines, levels, curves and shapes as shown on the drawing. The height in each course shall be kept same and every stone shall be fine

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tooled on all beds, joints and faces, full and true. The exposed faces shall be gouged out, grooved, regulated and sunk or plain moulded as the case may be. The faces of each stone between the draft shall be left rough as the stone comes from the quarry, except where sacrificial layer is to be provided or plastering is resorted to in aggressive environment.

Stone Soling: Stones as obtained from the quarry shall be packed with their broader surface as base. The packing shall be as dense as possible and the interstice shall be filled with small stones. The height of stones shall be as per the thickness of soling required. The stones shall be arranged neatly and the joints shall be as thin as possible.

Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar. Stratified stones shall be laid on their natural beds. All bed joints shall be normal to the direction of pressure coming on them.

Stones in the hearting shall be laid on their broadest faces so as to give better facility to fill the spaces between them.

The courses of the masonry shall ordinarily be pre-determined. They shall generally be of the same height. When there is to be variation in the height of courses, the larger courses are to be placed at lower levels, heights of courses decreasing gradually towards the top of the wall. The height of course shall not be less than 160 mm. placing loose mortar on the course and pouring water on it to fill the gaps in stones is not acceptable. Mortar shall be mixed thoroughly and poured in the joints in fluid state. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar.

In tapered walls, the beds of the stones and the planes of course should be at right angles to the batter. In case of bridge piers with batter on both sides, the course shall be horizontal.

The bed which is to receive the stone, shall be cleaned, wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a wooden mallet immediately on placement and solidly embedded in mortar before it has set. Clean chips and spalls shall be wedged into the mortar joints and bed wherever necessary to avoid thick beds or joints of mortar. When the foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into rock snugly, when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. For masonry works over rock, a levelling course of 150 mm thick M15 concrete shall be laid over rock and then stone masonry work shall be laid without foundation concrete block.

Face works and hearting shall be brought up evenly but the top of each course shall not be levelled by the use of flat chips.

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For sharp corners especially in skew bridges, through stones shall be used in order to avoid sapling of corners.

In case any stone already set in mortar, is disturbed or the joints broken, it shall be taken out without disturbing the adjoining stones and joints. Dry mortar shall be thoroughly cleaned from the joints and stones and the stones reset in fresh mortar. When freshly laid, no attempt shall be made to slide one stone on top of another.

Shaping and dressing shall be done before the stone is laid in the work. No dressing or hammering, which will loosen the masonry, will be allowed after the stone is placed in position. All necessary chases for joggles, dowels and clamps, should be formed beforehand.

Sufficient transverse bonds shall be provided by the use of bond stone extending from the front to the back of the wall and in case of thick wall, from outside to the interior and vice versa. In the latter case, bond stones shall overlap each other in their arrangement.

In case headers are not available, precast headers of M15 concrete shall be used. Cast in-situ headers are not permitted.

Stones shall break joint on the face for at least half the height of the course and the bond shall be carefully maintained throughout.

In band work at all angle junctions of walls, the stones at each alternate course shall be carried into each of the respective walls so as to unite the work thoroughly.

Building up thin faces tied with occasional through stones and filling up the middle with small broken stones or even dry packing, is not acceptable.

All quoins and the angles of the opening shall be made from selected stones, carefully squared and bedded and arranged to bond alternately long and short in both directions.

All vertical joints shall be truly vertical. Vertical joints shall be staggered as far as possible. Distance between the vertical joints of upper layer and lower layer, shall not be less than half the height of the course.

Only rectangular shaped bond stones or headers shall be used. Bond stones shall overlap each other by 150 mm or more.

All connected masonry in a structure shall be carried up nearly at one uniform level throughout but when breaks are unavoidable, the masonry shall be raked in sufficiently long steps to facilitate jointing of old and new work. The stepping of raking shall not be more than 45 degree with the horizontal.

#### 1200.5.1.3 Random Rubble Masonry (Uncoursed and Coursed)



#### 1200.5.1.3.1 Dressing

The stone shall be hammer dressed on the face, the sides and beds to enable it to come in proximity with the neighboring stone. The bushing on the exposed face shall not be more than 40 mm.

#### 1200.5.1.3.2 Insertion of Chips

Chips and spalls of stone may be used wherever necessary to avoid thick mortar beds or joints and it shall be ensured that no hollow spaces are left anywhere in the masonry. The chips shall not be used below hearting stones to bring these upto the level of face stones.

Use of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 percent of the quantity of stone masonry.

#### 1200.5.1.3.3 Hearting Stones

The hearting or interior filling of the wall face shall consist of rubble stones not less than 150mm long in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.

#### 1200.5.1.3.4 Bond Stones

Through bond stones shall be provided in masonry upto 600 mm thickness and in case of masonry above 600 mm thickness, a set of two or more bond stones overlapping each other at least by 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous limestone and sandstones, etc,) the bond stone shall extend only about two-thirds into the wall, as through stones in such cases may give rise to penetration of dampness and therefore, for all thicknesses of such masonry, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. One bond stone or a set of bond stones shall be provided for every 0.50 sq.m of the masonry surface.

#### 1200.5.1.3.5 Quoin Stone

Quoin stone specially selected and neatly dressed for forming an external angle in masonry work, shall not be less than 0.03 cu.m in volume.

#### 1200.5.1.3.6 Plum Stone

The plum stones are selected long stones embedded vertically in the interior of the masonry to form a bond between successive courses and shall be provided at about 900 mm intervals.

#### 1200.5.1.3.7 Laying

The masonry shall be laid with or without courses as specified. The quoins shall be laid header and stretcher alternately. Every stone shall be fitted to the adjacent stone so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints, as much as possible, and to avoid long vertical lines of joints.

#### 1200.5.1.3.8 Joints

The face joints shall not be more than 20 mm thick, but shall be sufficiently thick to prevent stone-to-stone contact and shall be completely filled with mortar.

#### 1200.5.1.4 Coursed Rubble Masonry (First Sort)

##### 1200.5.1.4.1 Dressing

Face stone shall be hammer dressed on all beds and joints so as to give them rectangular shape. These shall be square on all joints and beds. The bed joints shall be chisel drafted for at least 80 mm back from the face and for at least 40 mm for the side joints. No portion of the dressed surface shall show a depth of gap more than 6 mm from the straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints. The requirements regarding bushing shall be the same as for random rubble masonry.

##### 1200.5.1.4.2 Hearting Stones

The hearting or interior filling of the wall face shall consist of flat bedded stone carefully laid, on prepared beds in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of masonry. While using chips it shall be ensured that no hollow spaces are left anywhere in the masonry.

##### 1200.5.1.4.3 Bond Stones

The requirements regarding through or bond stone shall be the same as for random rubble masonry, but these, shall be provided at 1.5 to 1.8 metre apart clear in every course.

##### 1200.5.1.4.4 Quoin Stone

The quoins shall be of the same height as the course in which they occur and shall be formed of header stones not less than 450 mm in length. They shall be laid lengthwise alternately along each face, square in their beds which shall be fairly dressed to a depth of at least 100 mm.

##### 12000.5.1.4.5 Face Stone

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Face stones shall tail into the work for not less than their heights and at least one-third of the stones shall tail into the work for a length not less than twice their height. These shall be laid as headers and stretchers alternately.

#### 1100.5.1.4.6 Laying

The stones shall be laid on horizontal courses and all vertical joints should be truly vertical. The quoin stones should be laid header and stretcher alternately and shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm.

#### 1200.5.1.4.7 Joints

The face joints shall not be more than 10 mm thick, but shall be sufficiently thick to prevent stone-to-stone contact and shall be completely filled with mortar.

### .1200.5.2 CONCRETE BLOCK MASONRY

#### 1100.5.2.1 Laying

The bed, which is to receive the block, shall be cleaned, wetted and covered with a layer of fresh mortar. The masonry works shall be laid to lines, levels, curves and shapes as shown on the drawing. In battered sections, the beds of blocks and the plane of courses shall be horizontal. Face blocks for such sections shall be manufactured specially for the purpose.

The block shall be soaked in water for at least 15 minutes before laying, to prevent absorption of water from mortar. Concrete block masonry shall be constructed generally like fine tooled ashlar masonry. Each block must be fitted into its place dry in order that discrepancy of figure may be discovered and corrected before it is finally laid in mortar and settled in bed. The block shall be laid full in thin mortar, the bed and side joints being not more than 15 mm in thickness. Each block shall be struck with a wooden mallet when laid in place in mortar to bring it to solid bearing as to bed and joints. All visible edges shall be free from chippings.

The course shall be horizontal and side joints vertical throughout unless otherwise indicated in plans. Joints shall be struck.

For bond, face blocks shall be laid header and stretcher alternately unless otherwise ordered by the Engineer, the header being arranged to corner as nearly as possible in the middle of stretchers below. The blocks in the courses above and below shall break joints for about half the height of the course and bond shall be carefully maintained throughout section.

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While carrying out masonry work, templates prepared to the correct shape and approved by the Engineer, shall be used to ensure correct batter as well as correct shape of masonry, specially cut and ease water in piers. The finished work shall be checked at every stage by the competent authority to ensure that it has the correct shape and batter as required by design.

In case of skew bridges and for cut and ease water, the acute angle at the corners shall not be less than 45 degree. In case a smaller angle cannot be avoided, then a flat face of 100 mm shall be provided.

#### 1200.6 POINTING

Pointing shall be carried out using mortar not leaner than 1:3 by volume of cement and sand or as shown on the drawing. The mortar shall be filled and pressed into the raked out joints before giving the required finish. The pointing shall conform to Clause 1012.3 of this specification. The work shall conform to IS: 2212. However, the maximum thickness of joints in different works shall be as follows:

Random Rubble : 20 mm

Coursed Rubble : 15 mm

#### 1200.7 CURING

Curing shall conform to Clauses 1009 and 1012 of these Specifications.

#### 1200.8 SCAFFOLDING.

For scaffolding, Clause 1010 of these Specifications, shall apply.

#### 1200.9 WEEP HOLES

Weep holes shall be provided on all plain concrete, reinforced concrete, brick masonry and stone masonry structures such as, abutment, wing wall and return walls as shown on the drawings or as directed by the Engineer to permit water to flow out without building up pressure in the back fill. Weep holes shall be provided with 100 mm diameter AC/PVC/HDPE pipe for structures in plain/reinforced concrete or brick masonry. In case of stone masonry, weep holes shall be of rectangular shape 80 mm wide, 150 mm high or circular with 150 mm diameter. Weep holes shall extend through the full width of concrete/masonry with slope of about 1 vertical: 20 horizontal towards the draining face. The spacing of weep holes shall be 1 m in either direction or as shown in the drawings with the lowest at 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer.

**1200.10 JOINTING WITH EXISTING STRUCTURES**

For jointing with existing structures, the specifications as given for brick masonry under Clause 1000 of these Specifications, shall apply for stone masonry also.

**1200.11 COPING FOR WING/RETURN/PARAPET WALLS**

Coping for wing/return/parapet walls shall conform to Clause 1111 of these Specifications.

**1200.12 TESTS AND STANDARDS OF ACCEPTANCE**

All work shall be done to the lines and levels as indicated on the drawing or as directed by the Engineer, subject to tolerances as specified in these specifications. Mortar cubes shall be taken in accordance with IS: 2250 for testing of compressive strength, consistency and water retentively. The frequency of testing shall be one sample for every two cubic meters of mortar subject to a minimum of 3 samples for a day's work.

**1200.13 MEASUREMENTS FOR PAYMENT**

Stone masonry shall be measured in cubic meters.

In arches, the length of arch shall be measured as the average of the lengths along the extrados and the intrados.

The work of pointing shall be measured in square meters.

Architectural coping shall be measured in linear meters.

**1200.14 RATE**

The contract unit rate for stone masonry shall include the cost of all labour, materials, tools and plant, scaffolding, sampling and testing, supervision and other expenses incidental to the satisfactory completion of the work as described in these Specifications.

The contract unit rate for pointing shall include erecting and removal of scaffolding, all labour, materials and equipment incidental to completing the pointing, raking out joints, cleaning, wetting, filling with mortar, trowelling, pointing and watering, sampling and testing and supervision as described in these specifications.

The contract unit rate for coping shall include the cost of all labour, materials, tools and plant, sampling and testing and supervision as described in these specifications.

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1300 ROOFING

## 1300.1 PAINTED CORRUGATED SHEET

The corrugated iron sheet shall be of the specified gauge. A 24g sheet shall weigh 5.4kg/m<sup>2</sup>. The sheet shall be free from rust and the zinc covering at the time of fixing shall be on perfect condition. Each sheet shall be laid on wooden or steel purling with an end overlap of 150mm minimum or as per drawing and side overlap of two and half corrugations. The sheet shall be joined together with galvanized hook-bolts of L type of 8mm diameter, with bitumen and limpet washers. L hook shall be fixed at 300mm interval along bearer and 600mm along edge. Each bolt shall have "limpet" dome washer in addition to bitumen washer.

*1300.1.1 HEALTH AND SAFETY:*

Ensure that handling staff are equipped with gloves and sturdy boots to prevent injury, and that a first aid package is available at loading and off-loading locations.

*1300.1.2 STORAGE:*

Bundles shall be so laid that the corrugations run in the same directions in every course. One end of the stack shall be raised by 100 mm to 150 mm to allow water to flow freely away from the sheets. If the sheets are not to be used immediately, they must be stored in a covered area

C.G.I sheets shall be of the thickness specified, in the item. The sheets shall conform to IS: 277 in all respects.

Wooden purlins of the specified wood or MS rolled sections of requisite size shall be fixed over the principle rafters. Maximum spacing of purlins shall not exceed 1.60 metre

The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

Slope: Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal.

*1300.1.3 LAYING AND FIXING*

The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer. The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

The sheets shall be laid with a minimum lap of 20 cm at the ends and two ridges of corrugation at each side. The above end lap of 20 cm shall apply to slopes of 1 vertical to 3 horizontal and flatter slopes. For steeper slopes the minimum permissible end lap shall be 15cm. The minimum lap of sheets with ridge hips and valleys shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shape of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge and chisel to give a smooth and straight finish.

#### *1300.1.4 LAPPING*

Lapping in C.G.I. sheet shall be painted with a coat of approved steel primer and two coats of painting with approved paint for steelwork before fixing in place. Sheets shall not generally be built into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at-least 7.5 cm. The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with galvanised J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washer filled with white lead as directed by the Engineer. The length of the hook bolt shall be varied to suit the particular requirements. The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron bolts and nuts 25 x 6 mm size, each bolt with bitumen and a G.I. limpet washer or a G.I. limpet washer filled white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two over lapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground. Sheets with wrongly drilled holes shall be rejected. The holes in the washers shall be of the exact diameter of the hook bolts or the seam bolts. The nuts shall be tightened from above to give a leak proof roof.

#### *1300.1.5 WIND TIES*

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Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eaves ends of the sheets. The fixing shall be done with the same hook bolts, which secure the sheets to the purlins.

#### *1300.1.6 FINISH:*

The roof when completed shall be true to lines and slopes and shall be leak proof.

#### *1300.1.7 MEASUREMENT:*

The length and breadth shall be measured correct to 10 mm. Area shall be worked out in sq.m correct to two places of decimal. The superficial area of roof coverings shall be measured on the flat without allowance for laps and corrugations. Portion of roof coverings overlapping ridge or hip etc. shall be included in the measurements of the roof. Roofs with curved sheets shall be measured and paid for separately.

Measurements shall be taken on the flat and not girth. No deduction in measurement shall be made for opening up to 0.4sq.m. For any opening exceeding 0.4 sq.m in area, deduction in measurements for the full openings shall be made and, in such cases, the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girth.

#### *1300.1.8 RATE:*

The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.I. sheets. This includes the cost of roof sheets, galvanized iron J or L hooks, bolts and nuts, galvanized iron seam bolts and nuts bitumen and(galvanized iron) limpet washers. The ties shall be paid for separately.

### **1300.2 RIDGES**

Providing & fixing 600 mm ridges or hips in plain G.I. including bolts, hooks and nuts 8 mm dia G.I limpet and bitumen washers for connection – 24g

#### *1300.2.1 RIDGES AND HIPS*

Ridges and hips of C.G.I. roofs shall be covered with ridge and hip sections of plain G.I. sheet with a minimum lap of 20.0 cm on either side over the C.G.I. sheets. The end laps of the ridges and hips, and between ridges and hips shall also be not less than 20.0 cm.



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The ridges and hips shall be of 60 cm overall width plain G.I. sheets and shall be properly bent to shape.

#### *1300.2.2 FIXING*

Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins. Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided. The end laps of ridges and hips shall be joined together by galvanized iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or as directed by the Engineer. There shall be at least two such bolts in each end lap.

#### *1300.2.3 FINISH*

The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

#### *1300.2.4 MEASUREMENT*

The measurements shall be taken for the finished work in length along with centre line of ridge or hip, as the case may be, correct to 10 mm. The laps in ridges and hips and between ridges and hips shall not be measured.

#### *1300.2.5 RATE*

The rate shall include the cost of all labour and materials specified above, including the cost of seam bolts and any extra G.I. hook bolts, nuts and washers required for the work.

### **1300.3 GUTTER**

Gutter shall be fabricated from plain G.S. Sheets of thickness as specified in the item. Eaves gutters shall be of the shape and section specified in the description of the item. The overall width of the sheet referred to therein shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge. The ends of

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the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

Slope: Gutters shall be laid with a minimum slope of 1 in 120.

#### *1300.3.1 LAYING AND FIXING*

Gutters shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bent to shape and fixed rigidly to the sides of rafters with 3 Nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12cm centres.

Where the brackets are to be fixed to the purlins, the brackets shall consist of 40 x 3 mm M.S. flat iron bent to shape, with one end turned at right angle and fixed to the purlin-face with a 10 mm dia. bolt, nut and washer. The perpendicular over hung portion of the 40 x 3 mm flat bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg shall be fixed to face of purlin with 1 No. 10mm dia, bolt, nut and washer. The overhang of the vertical portion of the flat iron bracket from the face of the purlins shall not exceed 20 cm with this arrangement. The gutters shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters

For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.I. sheet of the same thickness as the gutter and riveted to the gutter, the other end tailing into the socket of the rain-water pipe. Wherever necessary stop ends, angles, etc. should be provided.

#### *1300.3.2 FINISH*

The gutters when fixed shall be true to line and slope and shall be leak proof.

#### *1300.3.3 MEASUREMENT:*

Measurement shall be taken for the finished work along the centre line of the top width of the gutter correct to a 10 mm. The hooked lap position in the junctions and gutter lengths shall not be measured.

**1300.3.4 RATE:**

The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends etc., flat iron brackets and bolts and nuts required for fixing the latter to the roof members.

**1300.4 RAINWATER DOWNPIPE****1300.4.1 GENERAL**

A rainwater downpipe is a pipe that is used to direct rainwater away from a building, typically from roof guttering to a drainage system. It is sometimes also referred to as a downspout, drain spout, roof drain pipe or leader

**1300.4.2 NECESSARY INFORMATION**

For the efficient planning and installation of rainwater pipes and detailed information with regard to the following is necessary: The maximum intensity of rainfall for which the roof drainage system is to be designed; and local bye-laws, if any, governing house drainage, which will affect the design and installations of rainwater pipes and gutter, refer IS 2527-1984

**1300.4.3 SPECIFICATION**

Rainwater downpipes are most commonly round in section, but may be any shape. They typically have a diameter ranging from 50 - 150 mm, but any size can be used. The material thickness is 0.65 mm. The Ø 80 mm pipe is often used.

They may include access panels for inspection or rodding, branch connectors, bends, hoppers and leaf guards at the top, diverters, rainwater harvesting systems, angled shoes at the bottom, and so on.

Rectangular pipes are also often used. Thickness is 0,65 mm if one right-angle is = 100 mm. Thickness is 0,70 mm if this side = 100 and < 120 mm. In the case of a right angled side of =120 mm the minimum thickness is 0.80 mm. Standard lengths 2 and 3 metres.

The accessories, namely: bends, wreathes, clamps etc. can be ordered as a standard or according to drawing from the wholesale trade or be made by the metal worker

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#### 1300.4.4 INSTALLATION OF RAINWATER DOWNPIPES

The rain pipes are hung from above to below. The rainwater downpipes are slipped in to one another with a min. overlap of 50 mm. Each length of piping must be bracketed at least once. The brackets must allow for the expansion of the pipe, and a soldered wreath prevents sagging. The upper short length of piping may not be able to press against the bottom side of the gutter and must therefore have at least 20 mm space. The outlet piece must be slipped at least 50 mm into the downpipe so that the projecting outlet piece must be min. 70 mm in length. See figs. 5 and 10.

#### 1300.4.5 ATTACHMENT OF BRACKETS

The brackets must be attached at a maximum of 2 metres distance, and the upper bracket must be installed at least 1 metre under the gutter bottom, see fig. 6. When the movement (expansion) of the gutter is absorbed by bends, the bracket distance to the gutter bottom may be less than 1 metre. The attachment of the bracket must be taken from the instructions of the bracket manufacturer and/or the specifications.

#### 1300.4.6 SPECIAL CONSTRUCTIONS

A downpipe is typically vertical and extends to ground level. They are most commonly found attached to the corners of a building. The discharge from a downpipe can be:

- i. Directly connected to a drain discharging into a soak away.
- ii. Directly connected to a drain discharging into a surface water sewer.
- iii. Indirectly connected to a drain via a trapped gully if the drain discharges into a combined sewer.

If rainwater downpipes do not lead in a vertical line to the sewer, short lengths of piping in staggered line must be led to the lowest point. Use can be made of bends and jumps, or as Customs-made work of lengths of piping made in mitre. The corner between an inclined short length of piping and the preceding length of piping may not be smaller than 120°.

The slope of a rainwater downpipe must be minimum 5 mm per metre, if the specifications do not require otherwise.

#### 1300.4.7 MATERIALS

Traditionally, rainwater downpipes were made using cast iron, although uPVC systems are increasingly common due to ease of installation and

low maintenance requirements. As long as adequate size, strength and durability can be assured, they can also be made of aluminum alloy, galvanized, stainless steel, and so on.

Downpipes have a tendency to become blocked when debris such as leaves and twigs accumulate. To prevent this, they should be properly maintained, and are usually attached to a building using brackets which can be easily removed for cleaning if necessary.

The size and number of rainwater downpipes required will depend on the intensity of rainfall that is likely and the area of the surface to be drained. A number of online calculators are available to help determine the required size and number of rainwater downpipes.

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**1400 PLASTERING****1400.1 GENERAL**

Plastering shall be started from top and worked down. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 to 4 meters apart to act as gauges and guides in applying the plaster. The mortar shall be laid on the wall between the screeds using the plaster's float and pressing the mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm or 75 mm at a time. Finally, the surface shall be finished off with a plaster's wooden float.

Providing and laying of cement plaster in different thickness will be applied with the nature of work. Like ceiling, concrete walls, masonry walls flooring etc with different cement mortar ratio as per the design and drawing provided.

**1400.1.1 PREPARATION OF SURFACE:**

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. In case of concrete surface, if a chemical retarder has been applied to the formwork, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarder is left on the surface. The joints of masonry shall be raked out properly so that the plaster is well keyed with the masonry.

**1400.1.2 Material****1400.1.3 MORTAR:**

The mortar of the specified mix described in the item shall be used.

**1400.1.4 SCAFFOLDING:**

For all exposed brickwork or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. For all other masonry in buildings, single scaffolding shall be permitted. In such cases, the inner

end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose.

Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width, or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

Note: In case of special type of brickwork, scaffolding shall be got approved from Engineer.

#### *1400.1.5 APPLICATION OF PLASTER:*

Ceiling plaster shall be completed before commencement of wall plaster. Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is taken down. To ensure even thickness and true surface, plaster about 15 x 15 cm, shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. The surface shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time.

Finally the surface shall be finished off true with trowel or wooden float accordingly as a smooth or a sandy granular texture is required. Excessive trowelling or over working the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished.

Rounding or chamfering corners, junctions etc. where required shall be done without any extra payment. Such rounding or chamfering shall be carried out with proper templates to the sizes required. In suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically, when recommencing the plastering, the edge of the old work shall be scraped cleaned and wetted with lime putty or cement grout before plaster is applied to the adjacent areas, to enable the two to properly join together.

Plastering work shall be closed at the end of the day on the body of the wall and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of the features such as plasters, bands and copings, as these invariable lead to leakages. No portion of the surface shall be left out initially to be patched up later on.

The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

*1400.1.6 FINISH:*

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

*1400.1.7 PRECAUTION:*

Any cracks which appear in the surface and all portions, which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer.

*1400.1.8 THICKNESS:*

The thickness of the plaster specified shall be measured exclusive of the thickness of key. The average thickness of the plaster shall not be less than the specified thickness and the minimum thickness over any portion of the surface shall not be less than specified thickness by more than 3 mm. Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brickwork, the minimum thickness over any portion of the surface shall not be less than 15 mm while in the case of stonework the minimum thickness over the bushings shall be not less than 12 mm.

*1400.1.9 CURING:*

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

*1400.1.10 MEASUREMENT:*

Length and breadth shall be measured correct to 10mm and its area shall be calculated in square metres correct to two places of decimal. Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick works. The measurements of wall plaster shall be taken between the walls or



partitions (the dimensions before plastering shall be taken) for the length, and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.

The following shall be measured separately from wall plaster:

- (a) Plaster bands 30 cm wide and under.
- (b) Cornices, beadings and architraves or architraves moulded wholly in plaster.
- (c) Circular work not exceeding 6 m in radius.

#### *1400.1.11 RATE:*

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

### 1400.2 PLASTER OF PARIS WORKS

#### *1400.2.1 GENERAL*

The plaster of Paris shall be of semi – hydrate variety calcium sulphate. Its fineness shall be such that when sieved through a sieve of IS sieve designation 3.35mm for 5 minutes, after drying the residue left on it shall be not more than 1% by weight. It shall not be too quick setting. Initial setting time shall not be less than 13 minutes.

#### *1400.2.2 PREPARATION OF SURFACE*

Projecting burrs of mortar formed during existing cement plaster shall be removed. The surface shall be scrubbed clean with wire brushes. In addition the plastered surface shall be pock marked with pointed tool, at spacing of not more than 4cm centers and depth of pocks to be approx. 3mm deep. This is to ensure a proper key for the plaster. The surface shall be cleaned of oil and grease marks etc.

#### *1400.2.3 APPLICATION*

The material shall be mixed with water to a workable consistency. Plaster of Paris shall be applied directly on the wall plasters in suitable size panels and finished to a smooth surface by a steel trowels. The plaster shall be applied in such a manner that it fully fills the gaps the thickness over the plastered surface is as specified in the

description of the item. The finished surface shall be smooth and true to plane, slopes or curves as required.

#### *1400.2.4 MEASUREMENT*

Measurement shall be in square meter of area of application. Rate shall include materials, mixing, laying, curing, finishing and labour etc. all complete.

### 1400.3 FALSE CEILING

#### *1400.3.1 SCOPE OF WORK:*

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

#### *1400.3.2 MATERIAL:*

The Fibre Cement Board or Gypsum Board shall be of the thickness as mentioned in the relevant items of the schedule of quantities and the size of panels and the arrangement of panels etc. for different area of the building shall be as indicated in drawings / as decided by the Engineer-in-Charge.

Fibre Cement Board or Gypsum Board shall be of approved quality and shall be free from cracks, bends and other defects. Samples of materials to be used on the work shall first be furnished by the contractor and got approved by the Engineer-in-Charge. All materials which are used on the works shall strictly conform to the samples, other-wise the materials shall be summarily rejected.

The Fibre Cement Board or Gypsum Board shall be fixed to the frame work by means of suitable

counter sunk brass self tapping screws not more than 200 mm. centre to centre or as directed, and all holes after fixing the screws be filled with approved filler. Necessary openings in the ceiling shall be left for trap doors, ducts etc.

#### *1400.3.3 ERECTION*

The Fibre Cement Board or Gypsum Board when brought to site shall be stacked carefully on floor over wooden sleeper supports. The boards shall be cut to required sizes either by sawing or by score and snap method. The edges shall be smoothened by wood rasp file or with emery paper.

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Wherever required the edges of each panel may require bevelling which also shall be done carefully to the correct line and dimensions.

The Fibre Cement Board or Gypsum Board shall be fixed to the frames either wooden or metallic or as mentioned in the Schedule of work. In case of metallic frame, the Fibre Cement Board or Gypsum Board are held to the frame by means of self tapping screws or by the ordinary machine screws and nuts, as directed by the Engineer-in-Charge.

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

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

1400.3.4 Fibre cement board or gypsum board false ceiling and masking etc. with pressed steel frame work/anodized aluminium frame work:

1400.3.4.1 GENERAL:

The work covered by these specifications shall consist of furnishing all labour, materials and equipment necessary for installation of the suspended false ceiling and vertical masking, with Fibre Cement Board or Gypsum Board on pressed steel frame work / Aluminium frame work interlocked and suspended by adjustable M.S. suspenders with necessary cut outs in the Fibre Cement Board or Gypsum Board for lighting fixtures, trap doors, A.C. grills etc., providing m.s. lighting troughs etc., erecting to proper line and level in the specified areas, floors and levels as indicated in the drawing and as directed by the Engineer-in-Charge.

1400.3.4.2 Fabrication of Pressed Steel Frame:

The frame work for "snap grid" false ceiling shall be made out of tested special springs grade steel or approved cold rolled sheets of specified gauge as per schedule, accurately formed and die cuts with identical ends in automatic machine with precision tools. All workmanship shall be best quality as followed in a modern sheet metal shops equipped with all machines such as press, dies, spot welding machine, baking oven etc. and should be done in a manner that will not damage the materials. All work shall be accurately formed to the required dimensions, true to line, level and plane in all directions and properly sized to suit the exact dimension within permissible tolerances.

Twisted or bent sections shall not be permitted to be used on work. Main runners and cross tees shall be of sizes as specified in the schedule/shown in the drawing. The main runners shall be slotted for cross tees and punched for hangers/suspenders. Cross tees shall have identified die formed ends accurately cut for easy, correct and proper fit assembly. Shearing, cropping shall be clean,

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reasonably square and free from distortion. Surfaces and joints to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials. The surface shall be wire brushed vigorously.

Welding sequence shall be followed to avoid needless distortion and minimise shrinkage stresses.

Holes to be made in pressed M.S. sheet shall not be made by flame cutting. The flame cut or unfair holes are not acceptable with regards to connection of supported members with clearance. Where for practical reasons greater clearance is necessary, suitable designed seating should be provided. Any damages done to the walls/ceiling shall be reinstated to the original condition. The contractor shall not be entitled for any extra cost on this account.

#### 1400.3.4.3 Suspended Aluminium Grid system :

Aluminium grid system shall be of BEST LOK/EEZI LOCK or equivalent approved standard suspended aluminium grid system. The suspended ceiling grid shall be of self interlocking anodised aluminium T bars for main runners and cross runners of specified section and pattern as required to suit the span and as specified in the work schedule.

#### 1400.3.4.4 Fibre Cement Board or Gypsum Board:

Fibre Cement Board or Gypsum Board shall be plain and of specified thickness, approved best quality and shall conform in all respect to the relevant Indian Standard Specifications. The sheets shall be free from cracks, chipped edges or corners, twist dents, rough patches and other damages etc.

#### 1400.3.4.5 M.S. Works:

All MS works shall conform to relevant specification mentioned under Structural Steel here-in-before.

#### 1400.3.4.6 Fastening:

All bolts, nuts, screws, fittings & fixtures shall be of best quality and of approved manufacture.

#### 1400.3.4.7 FIXING:

The contractor shall take all necessary field measurements before the commencement of the frame work to ensure proper fittings of the work to actual condition of work at site. Particular care should be taken to examine the positions of all recessed lighting, trap doors and other openings indicated on drawings or as directed by the Engineer-in-Charge. The correct panel sizes shall be decided to suit

each location. The false ceiling levels shall then be marked on walls. The position of the runners should be marked to suit the span of the area. The wall angles are to be fixed up with approved metal fasteners and then levelled correctly. The position of suspender shall then be marked on the R.C. slab as per the sizes of the panels decided for each area with due consideration to location of air-conditioning ducts, grills etc. Suspenders of type and design fabricated as per drawing and approved by the Engineer-in-Charge, shall then be securely fixed at correct points with approved metal fasteners/expansion bolts of specified dia., as per manufacturer's specifications. It shall be ensured that the hanger/suspender shall remain perpendicular and not pulled by the suspension system to any side. The runners are to be fixed to the suspenders and locked up at the joints. The levelling should start from fixed points and proceed towards the other end. The cross tees are to be fixed up at every runner joint to have stability while levelling. Neoprene rubber gasket shall then be fixed all along the frame work with approved type of adhesive. Approved Fibre Cement Board or Gypsum Board cut to correct sizes shall then be placed on the runner, starting from the centre of the width towards sides. All cross tees are to be connected and put on the approved spring type hold down clip/pins as per drawing or as directed by Engineer-in-Charge. Holes if required to be provided in A.C. sheets shall be drilled and on no account holes shall be punched. The runner tees and tiles are to be locked with hold down clips/pins as required. Wherever grouting for frame work, suspenders etc. is required to be done in masonry walls columns/beams etc., the same shall be done after the entire frame work is properly levelled.

The contractor shall take into consideration all wastage in the Fibre Cement Board or Gypsum Board, aluminium grid system frame work/pressed steel frame work, M.S. suspenders, screws, nuts, bolts, washers etc. required for fixing Fibre Cement Board or Gypsum Board false ceiling and vertical masking while quoting his rates. Fibre Cement Board or Gypsum Board false ceiling and vertical masking shall be fixed to pressed steel frame or Aluminium grid system by means of spring clip (brass counter sunk machine screws in case of masking) of approved size, make and at approved spacing or as shown in drawing or as instructed by Engineer-in-Charge.

After fixing the Fibre Cement Board or Gypsum Board, all holes of screws etc. shall be filled with approved putty, levelled with the Fibre Cement Board or Gypsum Board and sand papered, so that no sign of screw is visible on the Fibre Cement Board or Gypsum Board. For all the Fibre Cement Board or Gypsum Board false ceiling and vertical masking work, the Fibre Cement Board or Gypsum Board of required size and shape shall be cut as per approved panel size shown in drawing and fixed on pressed steel frame in the best workman like manner.

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Trap doors/lighting recesses/troughs of approved size and shape with approved matching work, shall be provided in the false ceiling and vertical masking at the specified places.

Any damage done to the walls/columns/ceilings/plasters/floors etc. shall be made good to the original condition by the contractor at his own cost. The contractor shall not be entitled for any extra cost on this account. During the execution of this work, the contractor shall take all the precautions to prevent damage to the painted surface, plaster, floor tiles, doors etc. Contractor should specifically note that the area where the false ceiling is required to be provided will be in advance stage of completion with various finishing items such as painting, floor polishing etc. Any damage to these finishes will have to be made good by him at no extra cost to the Department.

#### *1400.3.5 MEASUREMENT:*

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

#### *1400.3.6 RATES*

Quoted by the contractor for the work shall include cost of all materials and labour required to complete the work as per item description, as per above specifications and as shown in the drawing.

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**1500 WOODWORK****Description****1500.1 TIMBER**

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The scantling shall be planed smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made, before assembling. Patching or plugging of any kind shall not be permitted except as approved by Engineer. A tolerance of +2 mm and -3 mm shall be allowed in the finished cross-sectional dimensions of door and window frames.

**1500.1.1 Joints:** Joints shall be mortise and tenon type, simple, neat and strong. Mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be glued, framed, put together and pinned with hard wood or bamboo pins not less than 10mm dia. after the frames are put together pressed in position by means of a press.

**1500.1.2 Surface Treatment:** Woodwork shall not be painted, oiled or otherwise treated before the Engineer has approved it. All portions of timber abutting against masonry or concrete or embedded in ground shall be painted with approved wood primer or with boiling coal tar.

**1500.1.3 Gluing of Joints:** The contact surfaces of mortise and tenon shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer.

**1500.1.4 Fixing in Position:** Before the frames are fixed in position these shall be inspected and approved by the Engineer. The frames shall be placed in proper position, and secured to walls or columns as the case may be, with metallic fastener, iron holdfasts or as directed by the Engineer.

In case of doorframes without sills, the vertical members shall be embedded in the flooring to its full depth. When sills are provided, these sills shall be embedded sunk in the floor to its full depth. The door frames without sills, while being placed in position, shall be suitably struttred and wedged in order to prevent warping during construction. The frame shall also be protected from damage during construction.

All wood work shall be planed neatly and truly finished to the exact dimensions. All joints shall be neat and tight, truly and accurately fitted. Wall plates, purlins and rafter shall be painted with 2 coats of creosote conforming IS 218 -1952.

All beams shall be bedded on (1:2:4) RCC beds of 10cm x 7.5cm x4.5cm dimension with a minimum of 15cm bearing or as specified in the drawing. All portion of timber in contact with masonry shall have 6mm gap sides. All beams shall rest on bearing.

## 1500.2 DOORS AND WINDOWS (WOODEN FRAMES)

The contractor is to clear out and destroy or remove all cut and shavings and other wood waste from all parts of the building and the site generally, as the work progress and at the conclusion of the work.

### 1500.2.1 CARPENTRY:

All carpentry shall be executed with workmanship of the best quality. Scantling and boarding shall be accurately sawn and shall be of uniform width and thickness throughout. All carpenter's work shall be left with sawn surface except where particularly specified to be wrought. All carpenter's work shall be accurately set out in strict accordance with the drawings and shall be framed together and securely fixed in best possible manner with properly made joints. All necessary brads, sheet metal screws, etc. shall be provided as directed and approved.

### 500.2.2 JOINERY:

All joints shall be accurately set out on boards to full size for the information and guidance of the artisans before commencing the respective works, with all joints, iron work and other works connected there with fully delineated. Such setting out must be submitted to the Engineer In-charge and approved before such respective works are commenced.

All joiner's work shall be cut out and framed together as soon after the commencement of the building as is practicable, but is not to be wedged up or glued until the building is ready for fixing same. Any portions that warp wind or develop shakes or other defects within six months after completion of the works shall be removed and new fixed in their place on contractor's own expense.

All work shall be properly mortises, tenons, house, shouldered, dovetailed, notched, wedged, pinned, braided, etc., as directed and to the satisfaction of the consultants and all properly glued up with the best quality approved glue.

Joints in joinery must be as specified or detailed, and so designed and secured as to resist or compensate for any stresses to which they may be subjected. All nails, springs, etc. are to be punched and puttied. Loose joints are to be made where provision must be made for shrinkage, glued joints where shrinkage need not be considered and where sealed joints are required. Glue for load-bearing joints or where conditions may be damp must be of the resin type. For non-load-bearing joints or conditions may be guaranteed casein or organic glues may be used. All exposed surfaces of joinery work shall be wrought and all arise "eased-off" by planing and sandpapering to an approved finish suitable to the specified treatment.



*1500.2.3 DIMENSIONS:*

Joinery shall hold up to the specified sizes and as measure.

*1500.2.4 FIXING JOINERY:*

All beads, fillets and small members shall be fixed with round or oval brads on nails well punched in and stopped. All large members shall be fixed with brass screws, the heads let in and palette to match the grain.

Unless otherwise specified, plugs of external work shall be of hardwood; plugs for internal work may be of softwood. Holes for plugging must be made with a proper drilling tool and the holes completely filled with the plugging material.

Unless otherwise specified all skirting, window, grounds and backing for same, fillets etc., shall be plugged at intervals not exceeding 600mm.

*1500.2.5 BEDDING JOINERY:*

All door and window frames, sills, wooden bars etc., which are fixed to brickwork, concrete by means of grounds, lugs, etc., shall be bedded solid in mortar as previously described and pointed with a recessed joint 6mm deep to the approval of the Engineer In-charge.

Plywood, Block boards, Chipboards and MDF board, shall be bonded with synthetic resin of "interior" type and sheet metal screws unless otherwise stated for the doors. Where stated to be "exterior" type, they shall be weatherproof. All exposed edges of block board and chipboard shall be lipped with hardwood as described below.

Samples of all such materials and their source of manufacture must be approved by the Engineer In-charge before used in the works.

*1500.2.6 INSPECTION AND TESTING*

The Engineer In-charge shall be given facilities for inspection of all works in progress whether in workshop or on site. All timber as it arrives on the site and not approved by them must be removed forthwith, failing which the Employer, with the advice of the Engineer In-charge, may arrange for the removal of the rejects and impose of them as they may consider advisable at the contractor's expenses.

Notwithstanding approval having been given as above, any timber incorporated in the works found to be in any way defective before the expiry of the maintenance period shall be removed and renewed at the contractor's expense. The contractor is to allow for testing or proto types of special construction units and the Engineer In-charge shall be at liberty to select any samples they may require for the purpose of testing i.e. for moisture content, or identification of species, strength, etc.

Where timbers need to be extended into a wall, they shall be thoroughly "Brush Treated" with a wood preservative approved by the Engineer In-charge, and as much clear air space maintained around the timber where it adjoins the wall as possible.

#### *1500.2.7 MEASUREMENT:*

Wood work wrought and framed shall be measured for finished dimensions. No allowance shall be paid for wastage and for dimensions supplied beyond those specified. Length of each piece shall be measured overall nearest to 10mm so as to include projections for tenons, scarves or miters width and thickness shall be measured to the nearest mm. Cubical contents shall be worked out in cubic metre nearest to 0.01 cubic metre. Increase of mouldings, rounding, rebates, circular and varying sections, the sectional area of the piece shall be taken as the area of the least square or rectangle from which such a section can be cut.

#### *1500.2.8 RATE:*

Payment for work will be made on the basis of contract unit price indicated in the BOQ. The payment will be full and final compensation for all material, labour, and equipment to complete the works as specified.

### 1500.3 PANELLED SHUTTERS

The window shutters may be fully panelled, fully glazed, partly glazed and partly panelled, battened or Venetian as specified. Styles and panels shall be neatly planed and truly finished to exact dimensions.

Styles and rails shall be framed properly and accurately with mortise and tenon joints and fixed with bamboo pins as per drawing. Glue shall be applied at all joints before clamping and fixing with bamboo pins. Panels shall be of one piece without any joints and shall be housed with 12.5mm insertion into rails and styles.

Panels shall be of thickness as specified in the drawing. All rails above 100mm in width shall have double tenon. No tenon shall exceed 6mm the thickness of the member. In case of swing door, swing door hung in lace shall not be rebated together. It shall be fitted with vision panels.

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*1500.3.1 MEASUREMENT*

Measurement of works will be made in m<sup>2</sup> of works as specified.

*1500.3.2 PAYMENT*

Payment for work will be made on the basis of contract unit price indicated in the BOQ. The payment will be full and final compensation for all material, labour, and equipment to complete the works as specified.

*1500.4 ALUMINIUM DOORS AND WINDOWS*

These shall be fabricated from 15 micron natural or colour anodized Aluminum profiles conforming to IS: 733-1983. The glazing glass shall be clear IAG float glass or equivalent without any distortion.

The window shall be made out of extruded aluminum section (Al. Mg.Si.) and shall conform to IS – 63400, AA-6063 unless otherwise directed. Aluminum sections shall be anodized and the anodic films shall be 12-15 microns. The colours shall be as directed. The 2-3 tracks on outer frame of standard size otherwise directed shall be fixed in the position by using heavy duty plastic grips with necessary plugs and fillers. All the sliding shutters shall be provided with two ball bearing rollers and ratting pieces/guides one each at the top and bottom, weather strips all around.

Openable window shall be double weather stripped, one strip shall be provided in outer frame and outer shall be in the shutter frame. The hinges or stay hinges of openable window shall be strong. Pin of the hinges shall be of non-corroding materials, preferably nylon/steel. All the joints shall be mechanically fixed. The entire window shutter shall be provided with special locking arrangement. Glass shall be fixed in the shutter by means of rubber gaskets.

*1500.4.1 CONSTRUCTION PROCEDURES*

The sliding window frames are of two-track design and the shutters are to be joined by special cleats for extra strength. Rollers mounted on ball bearings are to be fitted to obtain smooth operation. The sliding shutters shall have provisions for grooves for weather strips to exclude wind, water or dust ingress. The shutters are glazed with 4mm thick approved quality and clear transparent glass using gaskets of ethylene-propylene or PVC (EPDM/ PVC). The doorframe shall be made of aluminum extrusion as per design. The ventilator frames with fixed glass shall be of same dimension as the sliding two-track frame. The frames and shutters are to be fabricated by using the crimping method of corner jointing. Corners of frames are to be miter cut on high speed TCT saw machines to give burr free corners. Sturdy

corner cleats should hold the frames with only a hairline corner joint visible and the frames should be square/ rectangular and free from distortions. The frames shall be firmly secured to the walls in line and level. Only aluminum screws shall be used for joining and no welding will be allowed.

The joint between the frame and the plaster on walls, sill and lintel beam shall be filled with silicon sealant. The aluminum windows/ ventilators/ doors shall be free from scratches and other visible defects.

The frames are fixed to the wall with plastic grips and steel screws of suitable colour.

#### *1500.4.2 STANDARD SIZES, TOLERANCES AND DESIGNATIONS*

The overall sizes of aluminum doors, windows and ventilators are derived after allowing 1.25 mm clearances on all the four sides for the purpose of fitting the doors, windows and ventilators into modular openings.

#### *1500.4.3 TOLERANCES*

The sizes for doors, windows and ventilators frames shall not vary by more than  $\pm 1.5$  mm.

#### *1500.4.4 GLASS PANES*

Glass panes shall weigh at least 7.5 kg/m<sup>2</sup> and shall be free from flaws, specks or bubbles. All panes shall have properly squared corners and straight edges.

#### *1500.4.5 STAINLESS STEEL FRICTION STAY*

The stainless steel friction stays of make approved by the Engineering in-charge shall be used.

#### *1500.4.6 LOCKABLE HANDLES*

The lockable handle shall be of make approved by the Engineer in-charge and of required colour to match the colour of powder coated/anodized aluminum window sections.

#### *1500.4.7 TUBULAR HANDLE*

The tubular handle bar shall be aluminum polyester powder coated minimum 50 micron to the required colour/anodized AC 15. Outer dia of tube shall be 32 mm, tube thickness 3.0 mm and centre to centre length 2115 mm + 5 mm.

#### 1500.4.8 MEASUREMENT

Measurement of works will be made in m<sup>2</sup> of works as specified.

#### 1500.4.9 RATE

Rate shall include full and final compensation for all material, labour, and equipment to complete the works as specified.

### 1500.5 STEEL AND OTHER METAL FITTINGS

#### 1500.5.1 SHUTTERS' FITTINGS

1500.5.1.1 Providing and fixing brass pressed butt hinges with necessary screws etc. complete Sizes of 50mm, 100mm and 150mm

1500.5.1.2 Providing and fixing brass tower bolt (barrel type) with necessary screws etc. complete Sizes of 100mm, 150mm and 250mm

1500.5.1.3 Providing and fixing brass sliding door bolt, bright finished, enamelled with necessary screws etc. complete. Sizes of 200mm, 250mm, 300mm

1500.5.1.4 Providing and fixing brass handle with necessary screws etc. complete Sizes of 75mm, 100mm, 125mm and 150mm.

1500.5.1.5 Providing and fixing brass hook-and-eye with necessary screws etc. complete. Sizes of 100mm, 150mm, 200mm and 300mm

1500.5.1.6 Providing and fixing bright finished brass door stopper with nuts and necessary screws complete

#### 1500.6 DOOR STOPPER

1500.6.1. Providing & fixing M.S. door stopper with nuts and necessary screws complete

The fittings to be provided in a particular work shall be as directed by the Engineer. The cost of providing and fixing fittings shall include the cost of hinges and necessary screws for fixing the same. Where fittings are stipulated to be supplied by the department free of cost, screws for fixing the fittings shall be provided by the contractor and no extra will be paid for the same. The screws used for fittings shall be of the same metal and finished as the fittings.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer. These shall be truly vertical or horizontal as the case may be. Recesses shall be cut to the exact size and depth for the countersinking wherever required. Appropriate length of screws and numbers shall be used for each fitting. Screws shall be driven home with screwdriver so those headrests snugly in the countersunk provided. Screws shall not be hammered in. The fixing of the fittings shall be so done that the fittings operate smoothly and perform the functions for which they are intended without any constraint, nor should they hamper the functions of the doors, windows etc in any way.

#### *1500.6.2 MEASUREMENT:*

All fittings listed above except the kicking plates shall be measured in numbers. The kicking plate shall be measured correct to 10 mm and area calculated in sq. m corrects to two decimal places.

#### *1500.6.3 RATE:*

The rate includes the cost of labour and materials required for all the operations described above.

#### **1500.7 DOORS/WINDOWS (ALUMINIUM)**

Providing & fixing Aluminum section for doors, windows, ventilators, partitions and false ceiling of specified sections including all accessories such as U-rubber gasket for glass panes, weather strip fiber glass or weather seals, roller, etc complete (excluding cost of providing & fixing glass panes, ceiling boards). Type of Windows, doors and frames are as below:

- Sliding, open able, fixed and pivoted windows
- Sliding, open able doors
- Partition framing
- False ceiling framing

All Aluminum sections for doors, windows, ventilators, partitions and false ceiling shall be of specified sections and anodized to international standards.

Windows and ventilators shall be fully weather sealed using high quality weather seals/strips to reduce ingress of air and water as well as the escape of interior atmosphere.

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All glass panes shall be 4 mm thick clear transparent sheet glass. All such glazing shall be firmly secured with matching aluminum glazing beads and gaskets of PVC (ethylene-propylene).

#### 1500.7.1 Tolerances

The sizes of doors, windows or ventilator frames shall not vary by more than  $\pm 1.5\text{mm}$ .

#### 1500.7.2 Designation

Doors, windows and ventilators shall be designated by standard symbols denoting width, type and height in succession. For details refer aluminum section under "*Material Specification*" or refer IS: 1948 for further details and illustrations.

#### 1500.7.3 Fixing of frame

Outer frames will be provided with fixing holes centrally in the web. The frame shall be fixed to the wall or other base by using the screws and lugs. Any steel lug coming in contact with aluminum shall be either galvanised or given one coat of bituminous paint.

#### 1500.7.4 Measurement:

The work as fixed in place shall be measured in running metres correct to 10mm and their weights calculated on the basis of standard tables/weights in kilogram correct to two places of decimal, unless otherwise specified. Weight of cleats, brackets, bolts, nuts, fish plates, etc. shall be added to the weight of respective item unless otherwise specified.

#### 1500.7.5 Rate:

The rate shall include the cost of labour and materials involved in all the operations described above excluding the cost of glass and ceiling boards.

#### 1500.8 FAN CLAMPS

Providing & fixing MS fan clamps of 16 mm dia. in R.C. slabs, including painting with red lead paint.

The fan clamp shall be of the following types.

- (a) Fan clamp to be fixed during the laying of R.C.C. slab, shall be of type I. This shall be made of 16 mm dia. MS bar bent to shape with its ends hooked. The overall height of the clamps shall be made to suit the depth of the slab.

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- (b) Fan clamp for beams shall be of type II. It shall be similar to fan clamp type I, except that its height shall be greater depending on the depth of the beam rib.

#### 1500.8.1 FIXING

Holes for inserting the fan clamps in the positions shown in the drawing or as instructed by the Engineer shall be made in the shuttering after the latter has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the underside of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut pieces of MS bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed. The exposed portion of loops of the clamp shall be given two or more coats of paint, including priming coat, of shade as ordered by the Engineer.

#### 1500.8.2 MEASUREMENTS

Clamps shall be counted in numbers.

#### 1500.8.3 RATE

The rate per fan clamp shall include the cost of labour and materials involved in all the operations described above.

### 1500.9 STAINLESS STEEL RAILING

Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc...including welding, grinding, buffing, polishing and making curvature New items for BSR 2017 (wherever required) and fittings the same with necessary stainless steel nuts and bolts complete, i/e fixing railing with necessary accessories and stainless steel dash fasteners, stainless steel bolts etc, of required size on the top of the floor or the side of waist slab with suitable arrangement as per approval of engineers in charge

#### 1500.9.1 FABRICATION

Fabrication of all stainless steels should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolor the surface of the fabricated product.

#### 1500.9.2 WELDING

Fusion welding performance for type 304 stainless steel is excellent both with and without fillers. Recommended filler rods and electrodes for stainless steel 304 is grade 308 stainless steel. For 304L the recommended filler is 308L. Heavy welded sections may



require post-weld annealing. This step is not required for 304L. Grade 321 may be used if post-weld heat treatment is not possible. Welding shall be executed from the non-exposed side, as far as possible and in each case the welds shall be ground smooth and finished with a texture matching the parent metal. All welds shall be finished smooth and square.

#### 1500.9.3 Measurement

The stainless steel shall be measured in kg. For payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc

#### 1500.9.4 RATE

The rate shall include the cost of all materials and laborers involves in all the operations.

#### 1500.10 ROLLING SHUTTER

Providing & fixing rolling shutters, including all accessories complete but excluding top cover.

Rolling shutters shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with chain and crank device supplied by the firm. Shutters up to 10 square metre shall be of push and pull type and shutters with an area over 10 square metre shall generally be provided with reduction gear operated by mechanical device with chain or handle; if bearings are specified for operation, these shall be paid for separately.

#### 1500.10.1 SHUTTERS

These shall consist of MS laths 1.25 mm thick and 80 mm wide or as specified. The laths shall be machine rolled and straightened with an effective bridge depth of 16 mm and shall be interlocked together throughout their entire length and jointed together at the end with end locks. These shall be mounted on specially designed pipe shaft. Each lath section shall be a continuous single strip piece without any joint.

The springs shall be, preferably of coiled type. The spring shall be manufactured from high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring, pipe shaft etc. shall be supported on strong mild steel brackets.

#### 1500.10.2 GUIDE CHANNELS

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The guide channels shall be of mild steel deep channel section and of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15 mm.

The minimum depths for guide channels shall be as follows:

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Clear width of shutter	Depth of guide Channel
Up to 3.5 m	60 mm
3.5 m and above	75 mm

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The gap between the two legs of the guide channel shall be sufficient to allow the free movements of the curtain and at the same time close enough to prevent the rattling of the curtain due to wind. Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the walls or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jambs, plumb and true, either in the overlapping fashion, projecting fashion or embedded in grooves, depending on the method of fixing. Top cover of shaft, spring etc. shall be of the same material as that of lath.

#### 1500.10.3 FIXING

Brackets shall be fixed on the lintel or under the lintel as specified with raw-plugs and screw bolts etc. The shaft along with the spring shall then be fixed on the brackets. The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with it with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guides channels and the cover frame shall then be fixed to the walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screw bolts, and rawl plugs drilled in the wall. The plates and screw bolts shall be concealed in plaster to make their location invisible. Fixing shall be done accurately in a workman-like manner so that the operation of the shutter is easy and smooth.

#### 1500.10.4 MEASUREMENT

Clear width and clear height of the opening for rolling shutter shall be measured correct to 10 mm. The clear distance between the two jambs of the opening shall be the clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height. The area shall be calculated in square metres correct to two places of decimal.

*1500.10.5 RATE*

The rate shall include the cost of materials and labour involved in all the operations described above including spring and ball bearing except top cover and mechanical device of chain and crank operation, which shall be paid for separately.

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**1600 FLOORING WORKS****1600.1 CONCRETE FLOORING****1600.1.1 MATERIALS:**

Cement: Portland cement as per specification under "Concrete Work" Aggregate of 12mm nominal gauge shall be properly gauged. Sieving may be insisted upon in which case the contractor shall provide/supply necessary sieves and labour at his own cost. Sand shall be clean inner bed. Grain distribution shall be same as described under 'Plastering'.

**1600.1.2 PROPORTION:**

The concrete shall be either 1:2:4 mix or 1:4:8 mix or as specified in the drawing. All mix shall be matched by volume except cement, which shall be proportioned by weight and as specified.

**1600.1.3 MIXING:**

Mixing shall be done on a watertight platform. Material shall be dry mixed after accurately gauging different materials in wooden boxes. The dry mixture shall be turned over thrice (at least) till the colour is uniform and then twice while wet. Water shall be added gradually and no more than necessary to sufficiently wet the materials. Only that much concrete shall be mixed which can be used within half an hour. Each stock of dry mix shall not be larger than consuming one bag of cement. In case of machine mixing IS. Code shall be strictly followed and the mixing done under the supervision of the site In-charge.

**1600.1.4 PREPARATION OF SUB-GRADE**

The sub-grade shall be cleared of all loose earth, rubbish, and other foreign matter. If necessary the sub-grade shall be cleaned with wire brushes. Cleaned sub-grade shall then be wetted with water thoroughly, but no water pool shall be allowed. Necessary slope shall be given in the sub-grade itself. If the sub-grade is of lean concrete the flooring shall be commenced within 48 hours.

**1600.1.5 PLACING**

Concrete shall be laid in horizontal layers and gently rammed.

**1600.1.6 FINISHING**

It shall be compacted first with wood float. The blows shall be fairly heavy but as consolidation takes place, light rapid strokes shall be given. Beating shall continue till all hollows in concrete are filled with mortar paste. Then the surface shall be trawled till the moisture disappears. The surface shall be checked with straight edge. The surface must be uniform in colour. Immediately after trawling, well mixed neat cement slurry mixed integrally with hardening liquid 2litres. to 50kg of cement shall be sprinkled in a uniform layer at the rate of 2.2 kg. per sq.m. The cement slurry shall be trawled smooth with a steel float several times till approved finish is achieved. The surface shall be without the float marks or air holes. Sample of workmanship shall be got to approved prior to work.

#### *1600.1.7 CURING*

Curing shall not be commenced until the top layer has hardened. Hardened concrete shall be kept wet for 15 days. Covering with empty cement gunnies shall be avoided, as the colour is likely to be bleached with the remnants of cement matter from the bags.

#### *1600.1.8 MEASUREMENT*

It shall be measured in square meter for specified thickness measured from wall to wall exclusive of any finishing or as per instructions of Engineer.

Unless otherwise stated in the schedule of quantities, nothing extra shall be admissible for small areas and corners and work in any shape. No deductions shall however, be made for protruding or independent columns occurring in the floors, door frames embedded in floor or any other part out when the area does not exceed 0.1 m<sup>2</sup> for each. However nothing extra shall be allowed for the cutting involved at such places.

### **1600.2 MOSAIC/TERRAZZO TILE FLOORING**

Marble Chips: Marble chips shall be of 3 mm gauge having maximum size 3mm and minimum size of 1.5 mm and shall be of good quality. The color shall be as per the instruction of engineer or drawings. Sample of marble stone to be used shall be submitted to the Project manager and his approval should be taken before the bulk purchase. All the marble chips supplied shall conform to the approved sample in all respect.

#### *1600.2.1 PROPORTION AND MIXING*

#### *1600.2.2 BASE COURSE*

For cement concrete base course, all mix (as per specified proportion) shall be batched by volume except cement, which shall be proportioned by weight and as specified. Mixing shall be done on a watertight platform. Material shall be dry mixed after accurately gauging different materials in wooden boxes. The dry mixture shall be turned over thrice (at least) till the color is uniform and then twice while wet. Water shall be added gradually and no more than necessary to sufficiently wet the materials. Only that much concrete shall be mixed which can be used within half an hour. Each stock of dry mix shall not be larger than consuming one bag of cement. In case of machine mixing IS. Code shall be strictly followed and the mixing done under the supervision of the site In-charge.

For cement sand Base Course: 1 part cement; 2 parts sand and mixing shall be done as per specification for mortar mixing of brick masonry work

#### *1600.2.3 TOP COURSE:*

The marble chips and cement shall be mixed by measuring with boxes to have the required proportion first dry mixed, and then thoroughly mixed by adding water gradually to have a uniform plastic mix. Within two hours of laying of the bottom layer of cement concrete, the upper layer of marble chips and cement shall be laid, and the surface tamped lightly and finished perfectly level with straightedge float and trowel. After about 2 hours of laying, the surface shall be covered with wet bags and kept wet and left undisturbed for two days. The surface shall then be cut or ground by rubbing with sandstone blocks and all the cement in the surface removed. A neat cement wash shall then be given in the surface and left undisturbed for six days and then the surface shall be ground (or rubbed) with carborundum stones of different grades starting with coarse one and successively with finer ones, and the rubbing continued until the entire surface shows a uniform granular appearance. The surface should be kept wet during all these days. After final rubbing the surface shall be thoroughly cleaned by washing with soap water and then with clean water.

#### *1600.2.4 LAYING*

The base shall be made rough and watered and given a cement wash and then the mortar shall be laid in 20 mm. thick layers as per instruction of Engineer. After laying mortar, it should be levelled with wooden floats. Proper slope for draining wash water shall be provided as per instruction of the Engineer. And over this, marble stone should be laid; the joints should not be more than 3 mm. The joints should be painted with white cement slurry.

#### *1600.2.5 CURING*

After about two hours of laying, the surface shall be covered with wet bags and kept wet and left undisturbed for two days.

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*1600.2.6 FINISH*

Finally, when the surface is absolutely dry, oxalic acid powder shall be rubbed well on the surface with grinding machine with water, and this operation shall be repeated until the surface becomes perfectly smooth and glossy. The surface shall be rubbed with wax to give a glazing surface. White cement or color cement shall be used in joint to have the required color as per specified or as per instruction of Engineer. Care shall be taken that the floor is not left slippery and that ordinary wax is not used under any circumstances

If required by the Engineer, the grinding and polishing shall be done by grinding machine in 3 operations, first grinding with machine fitted with coarse Carborundum stone, second grinding with medium grade Carborundum stone and final grinding with fine grade Carborundum stone.

*1600.2.7 MEASUREMENT*

Measurement shall be in square meter of exact length and breadth (length and height in dado) of the floor.

*1600.2.8 RATE*

Rate shall include materials, mixing, laying, curing, finishing, grinding, polishing and labor etc., all complete.

*1600.3 TILING**1600.3.1 TILES:*

The tile material for Glazed/Non-glazed Vitrified Porcelain(Granite Viglacera-Vietnam, Portebello- Brazil or equivalent make) /Glazed/Non-glazed Ceramic tiles (Somany, Kajaria or equivalent make), shall confirm to IS:777 (respective IS standards) or Equivalent approved by the Engineer The tiles shall be of approved colour, size and shape or as shown in the drawings. and shall be laid to the pattern approved by the Engineer. The tiles shall be of uniform colour, true to size and shape and free from cracks, twists, uneven edges, crazing and other defects.

The size and thickness of the tiles shall be as specified. The contractor shall submit samples of tile for selection and approval by the Engineer In-charge and all tiles delivered to the site shall conform to the approved samples with regard to size, quality, texture and colour.

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*1600.3.2 MIXING:*

Mixing shall be done as per specification for mortar mixing of brick masonry work

*1600.3.3 PREPARATION OF SURFACE AND INSTALLATION*

Wall surfaces shall be brushed cleaned and wetted. Prior to installing any tile, the Contractor shall inspect surface and conditions in areas to receive tile work and shall notify the Engineer of any serious defects or conditions that will interfere with or prevent a satisfactory tile installation and shall coordinate with other traders of work. Approximately 12 mm thick level and plumb, scratch coat of cement mortar 1:4 or as specified by site engineer shall be applied. The scratch coat shall be moist cured for at least 24 hours before application of floating coat.

Before applying floating coat the scratch coat shall be thoroughly wetted. The floating coat, plastic mix of neat cement of approximately 3 mm thickness shall be applied even with screeds to true plane.

Floating coat shall be applied over areas no larger than can be covered with tile while the mortar is still plastic (half set).

Glazed tile shall be soaked, completely immersed in clean water at least 30 minutes and drained. Individual tile that exhibits drying along edges shall be allowed to remain on the backs of tile at the time of setting.

Tiles shall be installed by applying a skin coat of a plastic mix of neat cement to backs of tile and firmly pressing tile into the floating coat to true plane and position. White cement shall be used for the skin coat where white joints are required.

During the process of setting tiles, continuous horizontal and vertical cuts every 40cm to 60 cm shall be made through the floating coat while plastic, using the point of a trowel turned edge wise, Care shall be taken to prevent cutting into the scratch coat. Where full size tile cannot be laid, it shall be cut (sawn) to required size and edges rubbed smooth to ensure a true and straight joint.

All tile work finishing shall be adequately protected from damage during the progress of construction and any damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

*1600.3.4 JOINTS IN TILE WORK*

Joints in tile work shall be accurately aligned with horizontal joints level and vertical joints plumb. Joints shall be maintained uniformly wide by aligning spacer lugs on tile edges if tiles are so manufactured or by use of wetted strings.

*1600.3.5 TILE LAYOUT*



Tiles shall be laid out in such a way that no tile less than half size occurs. Where tile must be cut at edges or penetrated the cut edges shall be carefully filed and neatly ground. Chipped, cracked or broken tile shall not be used and all defective work shall be replaced and repaired to the satisfaction of the Engineer at the Contractor's expense.

#### *1600.3.6 GROUTING THE TILE JOINTS*

After tiles have been set firm and strings removed, the tiles shall be dampened and joints grouted full with a plastic mix of neat cement by trowel, brush or finger application. Unless otherwise directed, grout shall be white cement. During grouting all excess grout shall be cleaned off the tile surface with damp cloth sponges

The finished floor surface shall be true to required levels. All tile work finishing shall be adequately protected from damage during the progress of construction till completion and any damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Upon completion prior to final inspection and acceptance, the Contractor shall clean all tile work. Acids or agents liable to damage the work shall be avoided. If tile surface show mass scratches, crack or other imperfections, which cannot be removed by cleaning; the Contractor shall remove the defective material and replace with new material at no additional expense. Sample of workmanship and tile grout proposed (silicone) shall be approved prior to execution of work.

#### *1600.3.7 MEASUREMENT*

The measurement shall be in square meters of the work done including the setting mortar. The rate shall be for the material and labour, all complete.

### **1600.4 GRANITE FLOORING**

#### *1600.4.1 MATERIALS*

##### **1600.4.1.1 Cement**

Portland cement (white as well) as per specification under “Concrete Work”

##### **1600.4.1.2 Sand**

As per specification under “Concrete Work”

##### **1600.4.1.3 Granite**

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Granite shall be of good quality,  $16 \pm 2$ mm thick, having smooth, hard polished surface, regular in shape, size and of uniform thickness, of good appearance, and of sharp and square edges. It shall be free from cracks and other defects. The color and size shall be as per the instruction of the engineer and drawing. Sample of granite stone to be used shall be submitted to the engineer and his approval should be taken before the bulk purchase. All the granite stone supplied shall conform to the approved sample in all respect.

#### *1600.4.2 PROPORTION*

Base Course: 1 part cement; 2 parts sand and mixing shall be done as per specification for mortar mixing of brick masonry work.

#### *1600.4.3 DRESSING*

Each granite stone slab shall be machine cut to required size and shape as specified in the drawings. All angles and edges of the granite slabs shall be true and square and free from chippings and the surface shall be true and plane. The thickness of the stone shall be as specified in the drawings. No tolerance shall be allowed for thickness.

The granite slabs shall be mirror polished. All granite stones shall be brought pre-polished to the site. The contractor shall prepare samples and obtain approval of the Engineers before proceeding with the work.

The contractor shall ensure that no chisel marks are visible on the surface of the stone before fixing. Stones with chisel marks or broken edges shall be rejected.

#### *1600.4.4 LAYING*

The base shall be made rough and watered and given a cement wash and then the mortar shall be laid in 19-20 mm. thick layers as per instruction of Engineer. After laying mortar, it should be leveled with wooden floats. Proper slope for draining wash water shall be provided as per instruction of the Engineer. And over this, granite stone should be laid; the joints should not be more than 1.5 mm. The joints should be painted with approved colored cement slurry.

#### *1600.4.5 CURING*

After about 2 hours of laying, the surface shall be covered with wet bags and kept wet and left undisturbed for 2 days.

#### *1600.4.6 FINISH*

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Finally, when the surface is absolutely dry, the surface shall be rubbed with wax to give a glazing surface, as per instruction of Engineer. Care shall be taken that the floor is not left slippery and that ordinary wax is not used under any circumstances.

#### *1600.4.7 MEASUREMENT*

Measurement shall be in square meter of exact length and breadth of the floor.

#### *1600.4.8 RATE*

Shall include materials, mixing, laying, curing, finishing and labor etc. all complete.

### **1600.5 MARBLE FLOORING**

#### *1600.5.1 MATERIAL*

1600.5.1.1 Marble stone: Marble shall be of good quality having smooth, hard surface, regular in shape, size and of uniform thickness, of good appearance, and of sharp and square edges. It shall be free from cracks and other defects. Marble stone of uniform size with more than 45cm and the minimum length of 1200mm to fit in the counter and floor, may be from Godavari Marble factory (polished of minimum size 600mmx600mm) or Rajasthani (Indian) Marble equivalent conforming to IS 1130 – latest Revision or BS specification or as approved by the engineer. No small marble will be allowed except in the thin wall or skirting or the edges or unless specified by engineer. The marble must be backed with the nylon grip net. The marble shall be of thickness of 20mm. The colour shall be as per the instruction of engineer or drawings. Sample of marble stone to be used shall be submitted to the Project manager and his approval should be taken before the bulk purchase. All the marble stone supplied shall conform to the approved sample in all respect.

#### *1600.5.2 PROPORTION*

Base Course: 1-part cement; 2 parts sand and mixing shall be done as per specification for mortar mixing of brick masonry work.

#### *1600.5.3 DRESSING*

Each marble stone slab shall be machine cut to required size and shape as specified in the drawing and as instructed by engineer. All angles and edges of the marble slabs shall be true and square and free from chippings and the surface shall be true and plane. The thickness of the stone shall be as specified in the drawing. No tolerance shall be allowed for thickness.

For flooring, the marble slabs shall be machine cut with good finish at edges and corners. The contractor shall ensure that no chisel marks are visible on the surface of the stone before fixing. Marbles with chisel marks or broken edges shall be rejected.

#### *1600.5.4 LAYING*

The base shall be made rough and watered and given a cement wash and then the mortar shall be laid in 20 mm. thick layers as per instruction of Engineer. After laying mortar, it should be levelled with wooden floats. Proper slope for draining wash water shall be provided as per instruction of the Engineer. And over this, marble stone should be laid; the joints should not be more than 3 mm. The joints should be painted with white cement slurry.

#### *1600.5.5 CURING*

After about two hours of laying, the surface shall be covered with wet bags and kept wet and left undisturbed for two days.

#### *1600.5.6 FINISH*

Finally, when the surface is absolutely dry, oxalic acid powder shall be rubbed well on the surface with grinding machine with water, and this operation shall be repeated until the surface becomes perfectly smooth and glossy. The surface shall be rubbed with wax to give a glazing surface. White cement or colour cement shall be used in joint to have the required colour as per specified or as per instruction of Engineer. Care shall be taken that the floor is not left slippery and that ordinary wax is not used under any circumstances. If required by the Engineer, the grinding and polishing shall be done by grinding machine in 3 operations, first grinding with machine fitted with coarse Carborundum stone, second grinding with medium grade Carborundum stone and final grinding with fine grade Carborundum stone.

#### *1600.5.7 MEASUREMENT*

Measurement shall be in square meter of exact length and breadth (length and height in dado) of the floor.

#### *1600.5.8 RATE*

Shall include materials, mixing, laying, curing, finishing, grinding, polishing and labour etc., all complete.

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**1700 PAINT WORKS****1700.1 GENERAL**

All materials shall be delivered on site intact in the original drums or tins and shall be mixed and applied strictly in accordance with the manufacturer's instructions and to the approval of the Engineer. All cement paints and washable distemper shall be applied by brush; emulsion paints shall be applied by means of a brush then rolled. All enamel paints are applied by brush or sprayed, and bitumen and bituminous base aluminium paints are applied by brush. Before application of any paint, adjoining surfaces shall be covered by cloth, or paper and wherever paints stains it shall be removed before leaving the work in same day.

The only addition, which will be allowed to be made locally will be liquid thinners supplied or recommended by the manufacturers and none shall be, thinned more than approved by the Engineer.

**1700.1.1 PREPARATION AND PRIMING OF SURFACES:**

Concrete and Cement rendered surfaces shall be smooth and free from defects and shall be allowed to dry out thoroughly. Surfaces shall be thoroughly brushed down and left free from all efflorescence, dirt and dust.

All such surfaces, which are to be finished with oil or enamel paint, shall be primed with two coats of alkali resisting primer. Plaster surfaces shall be perfectly smooth and free from defect. All such surfaces shall be allowed to dry for a minimum period of four weeks. Surfaces shall be stopped with approved plaster compound, rubbed down flush, thoroughly brushed down and left free from all efflorescence, dirt and dust.

Fair-faced surfaces shall be dry, brushed down and free from dust or dirt and shall be treated with an approved alkali resisting primer (for plastic emulsion). Metal work generally shall be thoroughly wire brushed to remove all scale, rust, and through sand papering shall be done before any painting is done. Where severe rust exists, the special anti-rust primer must be used. After painting it shall be stored in covered shed and 60cm above ground.

Shop primed surfaces shall have bare places touched up with an approved metal primer. Un-primed surfaces shall be given one coat of primer as last. Galvanized surfaces, which are thoroughly weathered, shall be, brushed down with white spirit, washed down and given one coat of zinc chromate primer. Bituminous-coated surfaces shall be given as isolating coat of shellac knotting followed by an approved metal primer.

Woodwork generally shall be rubbed down, given one coat shellac knotting, one coat wood self knotting primer, and all cracks, nail holes, defects, and uneven surfaces,

etc., stopped and faces up with hard stopping rubbed down flush. Before oiling  
woodwork all stains must be removed and uniform colour obtained and filled.

#### *1700.1.2 COLORS AND PRIMING:*

The priming undercoats and finishing coats shall each be of differing tints and the priming and undercoats shall be of the correct types and tints to suit the respective finishing coats in accordance with the following instructions. All finishing coats shall be of colours and tints selected by the Engineer. The paintwork shall have and uniform finish and all paint for external work shall be exterior quality only.

#### *1700.1.3 RUBBING DOWN:*

Each coat of paint shall be properly dried and shall be well rubbed down with fine glass paper before the next coat is applied. The paintwork shall be finished smooth and free from brush marks. Samples Cards of all paints, etc., shall be submitted to and samples prepared for approval of the Engineer before laying on and such samples, when approved, shall become the standard for work.

#### *1700.1.4 Program:*

The contractor shall so arrange his program of work that all other Trades are completed and away from the area to be painted when the painting begins.

#### *1700.1.5 IRONMONGERY, PROTECTION AND CLEANING UP:*

All ironmongery shall be removed from joinery before painting is commenced and shall be cleaned and renovated of necessary and re fixed after completion painting. Cover up all floors, etc., with non-resinous sawdust or other approved covering when executing and all painting decorating work. Paint splashes, spots and stains shall be removed from floors, woodwork, etc., and damaged surface touched up and the whole of the work left clean upon completion.

#### *1700.1.6 MATERIALS:*

All paint materials of specified brand shall be obtained from the manufacturer or authorized dealer. All sealers, primers and under coating are to be obtained from the makers of the finishing materials and are to be in accordance with their recommendation for the particular finish required.

#### *1700.1.7 Knot Sealer:*

For use on knots and resinous portions of woodwork.  
Stopping and Filling composed of parts putty to one part of stiff white lead.

*1700.1.8 LACQUER:*

Approved polyurethane eggshell clear lacquer applied in accordance with the manufacturer's instructions. Polish shall be an approved brand of wax polish Oil shall be best quality linseed oil. Filler for polished or oiled surfaces to be Beeswax filler.

*1700.1.9 WOOD PRESERVATIVE:*

All wood work, as specified or instructed shall, be treated after cutting and preparation but before assembly or fixing with three coats of solution consisting of one part of Atlas "A" wood preservative brown grade to three parts of water. The solution is to be brushed in all faces of all timbers unless exposed to view and painted. This is applicable in the wood frame contact with masonry and roof purling, batten and counter rafter.

The contractor shall note that this solution is HIGHLY POISONOUS and shall take all necessary precautions and instruct his workmen accordingly.

*1700.1.10 PAINT APPLICATION:*

Painting Items as described hereafter shall comprise the following, and shall all include for preparing and priming surfaces as above described: -

Cement Paint: Apply two coats.

Plastic Emulsion: Apply a minimum of three coats, using a thinning medium or water only if and as recommended by the manufacturer. An approved plaster primer tinted to match may be substituted for the first coat.

Paint: Apply two undercoats and one finishing coat of enamel gloss oil paint.

Flat oil paint: Apply two coats of flat oil paint, using thinning medium in accordance with the manufacturer's instructions.

Oil: Apply two coats of linseed oil.

Wax Polish: Apply a minimum of two coats to approval.

Lacquer: Apply three coats of Polythene lacquer as described, to approval.

Prime: Prepare and prime only before fixing.

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*1700.1.11 MOULDED CORNICES AND COVES.*

- (a) Length shall be measured at the centre of the girth.
- (b) Moulded cornices and coves shall be given in square metres the area being arrived at by multiplying length by the girth.
- (c) Flat or weathered top to cornices when exceeding 15 cm in width shall not be included in the girth but measured with the general plasterwork.
- (d) Cornices which are curved in their length shall be measured separately.

If the old Paint of existing surface is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint. If the old Paint is blistered and flaked, it shall be completely removed.

*1700.1.12 MEASUREMENT*

Measurement shall be in square meters of the actual covered area of the paints. Nothing extra shall be allowed for painting any rough surface. The rate shall include for specified coats inclusive of materials, labour, scaffolding all complete.

*1700.2. PAINTING & WALL PAPER**1700.2.1 GENERAL*

Painting shall not be started until the Engineer has inspected the items of work to be painted and satisfied himself about their proper quality and given his approval to commence the painting work. Painting, except the priming coat, shall generally be taken in hand after practically finishing all other builder's work. Painting of external surface should not be done in adverse weather condition like hail or dust storm etc. The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the painting work being started. The contractor shall bring approved paints, oils and varnishes to the site of work, in their original containers in sealed condition. The material shall be brought in at a time inadequate quantities to suffice for the whole work or at least a fortnight's work. The empties shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer.

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface being washed. For all exposed brick work or tile work, double scaffolding having two sets of vertical



supports shall be provided. The supports shall be sound and strong, tied together with horizontal piece over which scaffolding planks shall be fixed.

In case of special type of brickwork, scaffolding shall be got approved from Engineer in advance. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damages or scratches to walls. For white washing the ceiling, the proper stage scaffolding shall be erected.

#### *1700.2.2 PREPARATION OF SURFACE:*

1700.2.2.1 Wooden surface: The woodwork to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sandpaper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot.

Appropriate filler material with same shade, as paint shall be used where specified. The surface treated for knotting shall be dry before painting is applied. After the priming coat is applied, the holes and indentation on the surface shall be stopped with a glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in the stopping and the latter is therefore liable to crack.

1700.2.2.2 Iron & Steel Surface: All rust and scales shall be removed by scraping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling, which becomes loose by rusting shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken.

1700.2.2.3 Plastered surface: The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

#### *1700.2.3 MEASUREMENTS*

The length and breadth shall be measured correct to 10 mm. The area shall be calculated in sq.m correct to two places decimal, except when otherwise stated. Small articles not exceeding 0.1sq.m of painted surfaces where not in conjunction with similar painted work shall be enumerated. Painting up to 15 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres. Components of trusses, compound girders, stanchions, lattices and similar work shall, however be given in sq. metres irrespective of the size or girth of members. In measuring painting, varnishing oiling etc., of joinery, and steel work etc. the coefficients as in following tables shall be used to obtain the area payable.

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The following coefficients shall be applied to the areas measured flat and not girth.

1. Measurements for doors windows etc., shall be taken flat (and not girth) overall including frames, where provided. Where frames are not provided, the shutter measurements shall be taken.
2. Where doors, windows etc., are of composite types other than those included in Table -1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.
3. The coefficients for doors and windows shall apply irrespective of the size of the frames and shutters members.
4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.
5. When two faces of a door, windows etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer, and measurement of this will be deemed to be included in the measurement of the face treated with that finish.
6. In the case where shutters are fixed on both faces of the frames, the measurement for the doorframe and shutter on one face shall be taken in the manner already described. While the additional shutter on the other face will be measured for the shutter area only excluding the frame.
7. Where shutters are provided with clearance at top or/ and bottom each exceeding 15 cm height, such openings shall be deducted from the over-all measurements and relevant co- efficient shall be applied to obtain the area payable.
8. Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
9. Co-efficient for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for painting guides, rollers, fittings etc.
10. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shades for which no extra will be paid.
11. The measurements of guard bars expanded metal, hard drawn steel wire fabric of approved quality grill work and gratings, when fixed in frame work,

painting of which is once measured elsewhere shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

12. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), up to the top of rails or palisades which-ever is higher, but not up to the top of standards when the latter are higher than the top rails or the palisades. Width of moulded work of all other kinds, as in band rails, cornices, and architrave shall be measured by girth. For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sq.m and no extra shall be paid for painting on bolts heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

Measurements of wall surfaces and wood and other work not referred to already shall be recorded as actual. Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

#### *1700.2.4 PRECAUTIONS*

All furniture, fixtures, glazing, floor etc. shall be protected by covering and stairs, smears, splashing, in any shall be removed and any damage done shall be made good by the contractor at his cost.

#### *1700.2.5 PREPARATION OF SURFACE*

Before new work is white washed, the surface shall be thoroughly brushed free from mortar dropping and foreign-matter. In the case of old work, all loose pieces and scales shall be scraped off and shades in plaster as well as patches of less than 50sq.cm area shall be filled up with mortar of the same mix. The surface shall then be allowed to dry for at least 48 hours. Where so specifically ordered by the Engineer, the entire surface of old white wash shall be thoroughly removed by scraping. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

#### *1700.2.6 MEASUREMENT:*

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Length and breadth shall be measured correct to 10 mm and area shall be calculated correct to two places of decimals. Corrugated surface shall be measured flat as fixed and the area so measured shall be increased by 20% to allow for the girth area. Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements. The item shall include removing nails, making good holes, cracks, and patches etc. not exceeding 0.1sq.m each with material similar in composition to the surface to be prepared. Work on old treated surfaces shall be measured separately and so described. Measurement for jambs, soffits, sills, etc. shall be same as for plastering works.

#### *1700.2.7 RATE*

The rate shall include the labour and materials involved in the work.

### 1700.3 SURFACE PREPARATION

#### *1700.3.1 PREPARATION OF SURFACE*

Before new work is white washed, the surface shall be thoroughly brushed free from mortar dropping and foreign-matter. In the case of old work, all loose pieces and scales shall be scraped off and shades in plaster as well as patches of less than 50sq.cm area shall be filled up with mortar of the same mix. The surface shall then be allowed to dry for at least 48 hours. Where so specifically ordered by the Engineer, the entire surface of old white wash shall be thoroughly removed by scraping. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

#### *1700.3.2 MEASUREMENT*

Length and breadth shall be measured correct to 10 mm and area shall be calculated correct to two places of decimals. Corrugated surface shall be measured flat as fixed and the area so measured shall be increased by 20% to allow for the girth area. Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.1.m each with material similar in composition to the surface to be prepared. Work on old treated surfaces shall be measured separately and so described.

Measurement for jambs, soffits, sills, etc. shall be same as for plastering works.

#### *1700.3.3 RATE*

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The rate shall include the labour and materials involved in the work.

#### 1700.4 PRIMERS

##### 1700.4.1 GENERAL

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on asbestos cement surfaces before oil emulsion distemper paints are applied on them. The cement primer is composed of a medium and pigments which are resistant to the alkalis present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper paints. Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion paints etc.

##### 1700.4.2 APPLICATION

The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for atleast 48 hours, before oil emulsion paint is applied. The specifications in respect of scaffolding protective measures, measurements and rate shall be as described above for surface preparation.

The primer for woodwork, ironwork shall be as specified in the description of the item. The primer shall be applied with brushes, worked well into the surface and spread even and smooth. Primers for plaster/wood/iron & steel/aluminium surfaces shall be as specified in the Table below:

Surfaces	Primer to be used
1. Wood work (hard & soft wood)	Pink conforming to (IS: 3536)
2. Resinous wood and ply wood	Aluminum Primer.
3. Aluminium steel and galvanised Zinc chromate	primer conforming Steel work to (IS: 104).
4. Cement, brick work, plaster surface, Asbestos surface oil bound for	Cement Primer distemper and paint.

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

## 1700.5 WALL WASHING

*1700.5.1 PREPARATION OF LIME WASH*

The wash shall be prepared from fresh stone white lime. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water shall be added to each 0.01cubic metre of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 kg of lime. Blue up to 3 gm per kg of lime dissolved in water shall be added and wash stirred well. Water then shall be added @ about 5 litres per kg of lime to produce a milky solution.

*1700.5.2 APPLICATION*

The specified number of coats of the white wash shall be applied with the brushes. The operation for each stroke shall consist of a stroke of the brush given from the top downwards, another from the bottom upward over the first stroke and similarly one stroke horizontally from the right and another from left before it dries. Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer before the subsequent coat is applied. No portion of the surface shall be left out to be patched up later on.

For new work, three or more coats shall be applied till the surface presents a smooth and a uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off on the hand when rubbed. For old work, after the surface has been prepared as described above, a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The whitewashed surface should present a uniform finish through which the plaster patches do not appear. The washing on ceiling should be done prior to that on walls.

The mineral colours, not affected by lime, shall be added to white wash. Blue (Neel) shall, however, not be added. No colour wash shall be done until a sample of the colour washes of the required tint or shade has been got approved from the Engineer-. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, the contractor shall redo it. For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats shall then be applied on the entire surface till it represents a smooth and uniform finish. For old work, after the surface has been prepared a coat of colour wash shall be applied over the patches and repairs. Then a single coat or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall

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present a uniform finish. The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Note: In case of Hessian ceiling, on no account, lime shall be used as it rots cloth and hessian.

#### *1700.5.3 PROTECTIVE MEASURES*

Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed shall be protected from being splashed upon. Splashing and droppings if any shall be removed by the contractor at his own cost. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

#### *1700.5.4 MEASUREMENT*

Measurement shall be same as described under item X above.

#### *1700.5.5 RATE*

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

### **1700.6 CEMENT PAINT**

#### *1700.6.1 MATERIAL*

The cement paint shall be (equivalent to IS 5410) of approved brand and manufacture.

#### *1700.6.2 PREPARATION OF SURFACE*

For new work, the surface shall be thoroughly cleaned of all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing. The surface shall be thoroughly wetted with clean water before the cement paint is applied. In the case of old work, all loose pieces and scales shall be removed and the surface shall be cleaned of all dirt, dust, algae, oil etc. by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement paint shall be applied over patches after wetting them thoroughly.

#### *1700.6.3 PREPARATION OF MIX*

Cement paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement paint shall be mixed with water in two stages. The first stage shall comprise of two parts of cement paint and one part of water stirred thoroughly and allowed standing for 5 minutes. Care shall be taken to add the cement paint gradually to the water and not vice-versa.

The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously. The lids of cement paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement paint rapidly becomes air set due to its hygroscopic qualities.

#### *1700.6.4 APPLICATION*

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface, which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work.

The second coat shall be applied after the first coat has set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. For new work, the surface shall be treated with three or more coats of waterproof cement paint as found necessary to get a uniform shade. For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

#### *1700.6.5 PRECAUTION*

Water cement paint shall not be applied on surfaces already treated with whitewash, colour wash, distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

#### *1700.6.6 MEASUREMENT AND RATE*

Shall be same as described under item X above.

### **1700.7 FINISHING PAINTS**

#### *1700.7.1 MATERIAL*



Synthetic Enamel paint (conforming to IS: 1932) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of shade to match the top and as recommended by the manufacturer shall be used.

#### *1700.7.2 PAINTING ON NEW SURFACE*

##### *1700.7.2.1 Preparation of Surface for Wood work:*

The surface shall be cleaned and all unevenness removed. Knots if visible shall be covered with a preparation of red lead. Hole and indentations on the surface shall be filled in with glazier's putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

*1700.7.2.2 Preparation of Surface for Iron and steelwork:* The priming coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly

*1700.7.2.3 Application:* The number of coats including the undercoat shall be as stipulated in the item.

*1700.7.2.4 Under Coat:* One coat of the specified paint of shade suited to the shade of the topcoat shall, be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

*1700.7.2.5 Topcoat:* Topcoats of specified paint of the desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

*1700.7.2.6 Painting:* The number of coats as stipulated in the item shall be applied with the specified paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If, however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

#### *1700.7.3 MEASUREMENT AND RATE*

Shall be same as described under item X above.

*Note: Providing and applying finishing coats, with Bituminastic enamel, for steel work, two coats on new work, for steel work, one coat on old work, for steel & wood work, one coat on old work and for steel & wood work, two coats on new work.*

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1700.8 HIGH GLOSS SYNTHETIC ENAMEL*1700.8.1 PAINTING ON NEW SURFACE*

The surface which has not been painted earlier or the paint has been removed by paint remover, burning, caustic soda etc. shall be considered to be new surface.

*1700.8.2 PREPARATION OF SURFACE:*

1700.8.2.1` Wood Work: The surface shall be cleaned and all unevenness removed as specified under items 57 to 60. Knots if visible shall be covered with a preparation of red lead. Holes and indentations on the surface shall be filled in with glazier's putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

1700.8.2.2 Iron and Steel work: The priming coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

1700.8.2.3 Plastered surface: The priming coat shall have dried up completely before painting is started. All dust or dirt that has settled on the priming coat shall be thoroughly wiped away before painting is started.

1700.8.2.4 Application: The specifications described below shall hold good as far as applicable. The number of coats to be applied will be as stipulated in the item. The painted surface shall present a uniform appearance and glossy finish, free from streaks, blisters etc. The general specifications described after item 54 shall hold well in so far as they are applicable.

*1700.8.3.MEASUREMENT*

Length and breadth shall be measured correct to 10mm and area shall be calculated correct to two places of decimal. The item shall include removing nails, making good holes, cracks, patches etc. Work on old treated surfaces shall be measured separately. Measurement for jumps, soffits, sills, etc. shall be same as for plastering works.

*1700.8.4 RATE*

The rate shall include the labour and materials involved in the work.

## 1700.9 TRADITIONAL PAINTING

#### 1700.9.1 GENERAL

Traditional Painting shall not be started until the Engineer has inspected the items of work to be painted and satisfied himself about their proper quality and given his approval to commence the painting work. Painting, except the priming coat, shall be started after practically finishing all other builder's work. Traditional Painting of external surface should not be done in adverse weather condition like hail or dust storm etc. The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the painting work being started.

#### 1700.9.2 MATERIAL

The contractor shall bring approved painting materials to the site of work, in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The empties shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer.

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface being painted. For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal piece over which scaffolding planks shall be fixed. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damages or scratches to walls.

#### 1700.9.3 CLASSIFICATION:

Traditional Bhutanese paintings are classified into four categories namely *Rab*, *Ding*, *Thamar* and *Yutshon*. Bill of quantities shall be based on these categories.

#### 1700.9.4 PREPARATION OF TRADITIONAL PAINT:

Round mud paint (Sa-tshoen) as available in the market shall be put in a tin, filled with water and kept for about 25 to 30 minutes. Water shall then be poured out taking care that mud ball is not shaken / distributed. When the water is completely drained out, either animal glue or fevicol shall be mixed with the soaked mud ball as follows:

- a) Mixing with animal glue: Animal glue and water shall be mixed in the ration of 1:2 (1 animal glue: 2 water) and boiled until whole of the glue is melted and it becomes sticky. The prepared gum shall then be mixed with mud ball already

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soaked in water in the ratio 1:1 (1 gum: 1 soaked mud) and the paint is ready for painting.

- b) Mixing with fevicol: Fevicol shall be mixed with cold water and stirred well in the ratio 1:1 (1water: 1 fevicol). The fevicol solution shall then be mixed with mud soaked in water in the proportion of 1:1 and stirred well. The paint is ready for painting.

#### *1700.9.5 BRUSH FOR PAINTING*

Selection of brush for painting shall be based on the painter's judgment. For design painting round brush is recommended.

#### *1700.9.6 MUD COLOUR*

Four primary mud paint colours are Red, Yellow, White and Black or grey. Supplementary colour, if required may be prepared by mixing the four primary colours as follows:

Pink - Red and white  
Green - Black/blue and yellow  
Sky-blue - Black and white  
Aquamarine - Black, yellow and white  
Brown - Black and red

All the above 10 colours shall be used for medium and ordinary painting. The ready-made packet powder colours shall not be used for traditional paintings unless otherwise allowed by the Engineer. For special painting, a special paint called Chomur or distemper shall be added to the prepared paint to raise the thickness of the design.

#### *1700.9.7 WASHABLE PAINT*

The following steps shall be followed to prepare the washable paint:

1. Dry mud ball paint shall be ground to fine powder;
2. Fine powder shall be sieved by a thin cloth;
3. The sieved powder shall then be mixed with synthetic enamel paint in the proportion one litre of synthetic paint with one kilogram of mud powder and kept for about 30minutes to get a thick paint;
4. A small quantity of turpentine oil shall be added to the thick solution and stirred; and
5. Packet colours shall not be added.

#### *1700.9.8 PRECAUTIONS*

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All furniture, fixtures, glazing, floor etc. shall be protected by covering and stains, smears, splashing, in any shall be removed and any damage done shall be made good by the contractor at his cost.

#### *1700.9.9 PREPARATION OF SURFACE*

- a) Wooden surface: The woodwork to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sandpaper and shall be well dusted. Appropriate filler material shall be used where specified. The surface treated for knotting shall be dry before painting is applied. Apply two coats of yutsh on painting as primer on the surface to be painted.
- b) Iron & Steel Surface: All rust and scales shall be removed by scraping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling, which becomes loose by rusting shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat (yutshon) is undertaken.
- c) Plastered surface: The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer (yutshon) shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of Paris and rubbed smooth.

#### *1700.9.10 DRAWING CHAPA*

Adjust the paper to the surface to be painted, draw the design on the paper, and prick the lines of the design by a pin. Place the paper back to the surface to be painted and rub the powder soaked cloth on the design paper. When the paper is withdrawn, powder marks are left on the surface, which is to be painted for specified painting. This process is continued for painting the required surface.

#### *1700.9.11 PAINTING ON OLD SURFACE*

If the old paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sandpaper and dusted. Rusty patches, etc shall be cleaned up. If the old paint is blistered and flaked, it shall be completely removed. Chadam (Bangchang + animal glue together) shall be boiled and applied on the surface to be painted. Drawing Chapa shall be same as for the new work.

#### *1700.9.12 PHYSICAL CHECKING*

Physical checking shall be carried out on the quality of painting only after two days after paintings. The following steps shall be used as thumb rule to check the quality of the completed works:

1. Rub the surface already painted with palm and feel for smoothness.
2. When rubbed with palm, the colour should not be seen in the palm. If the colour comes when rubbed, the mixture is not proper and vice versa.

#### 1700.9.13 APPLICABILITY

Generally, the following types of painting shall be applicable against the type of structures specified unless otherwise directed and approved by the Engineer.

I. Sumdang:

- Rab painting shall be used in office, Dzong and other important places;
- Ding painting shall be used in institutional buildings such as school, hospital, etc.
- Thama painting shall be used in residential, staff quarter, and other similar buildings

II. Dangtshon:

- All the three types of paintings (Rab, Ding, Thama) may be used for internal decoration of all types of buildings only and external decoration for Royalcottages

#### 1700.9.14 MEASUREMENTS

The length and breadth shall be measured correct to 10 mm. The area shall be calculated in sq.m correct to two places of decimal. The co-efficient in Table 1 above shall be applied to the areas measured flat and not girth for all the items listed in the table wherever applicable. For railings either for staircase or balcony, the area shall be measured flat and equivalent area calculated for payment using 0.5 co-efficient for each side.

Measurement of areas of for all types of cornices including at lintel level shall be measured flat. Length of the cornices being measured along with junction of wall and cornice (separate measurement for boh, kah, etc. shall not be allowed). For wall decoration design such as *Tashi-tagey symbols*, *Tashi-Zeegay*, *Za-Tshering*, and *alike*, the area shall be measured flat as square or rectangle and equivalent area

calculated for payment using 0.8 as the co-efficient or actual painted area calculated using appropriate method of area measurement.

*1700.9.15 RATE*

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

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**1800 PLUMBING - INDOOR WORK****1801 WATER SUPPLY (GENERAL)****1801.1 GENERAL REQUIREMENTS:**

All water supply installation work shall be carried out through skilled plumbers. It is most important that a wholesome water supply provided for drinking and culinary purposes shall not be liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash-pit or manure-pit or any material of such nature that would be likely to cause undue deterioration of the pipe. Where the laying of any pipe through fouled soil or pervious material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

All pipe work shall be so laid or fixed, and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage to property and the risk of contamination of the water conveyed. Due attention shall be given to the maximum rate of discharge, protection against damage and corrosion, protection from frost, and to avoidance of airlocks, noise transmission and unsightly arrangement. To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise. Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially diminish or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support. Where the service pipe is of diameter less than 50 mm, the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.



### 1801.2 PIPE WORKS

Providing and fixing G.I. pipes including G.I. fittings & clamps & repair walls (internal works) ranging from 15mm, 20mm, 25mm, 32mm, 40mm and 50mm and H.D.P.E/CPVC pipes including clamps & repair walls etc. complete ranging from 20mm, 25mm, 32mm, 40mm and 50mm diameter.

For internal work, the pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools.

The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer, a M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements.

In case the pipe is embedded in walls or floor it should be painted with anticorrosive bit mastic paint of approved quality. The pipe shall not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors.

The CPVC pipes shall be jointed with cold Fusion as per the manufacturer's specification. Special Care shall be taken to remove any burn from the end of the pipes. Pipes and joints for water supply shall be tested to a pressure of 7.0 kg. Per sq.cm for not less than 30 minutes.

#### 1801.2.1 Cutting and Threading:

Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded with pipe dies and taps in such a manner as not to result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack as the later procedure may not result in a water tight joint. The screw threads of pipes and fittings shall be protected from damage until they are fitted.

#### 1801.2.2 Fitting/Jointing:

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of pipes shall be oiled and rubbed with a white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, tee etc, with pipe wrench. Care shall be taken that all pipes and fittings are kept at all times free from dust and dirt during fixing. Burn from joint shall be removed after screwing.

After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Internal CPVC pipe as per ASTM D 1785, (SDR-11) and fittings inside the Toilet and Kitchen shall be fixed by means of standard pattern holder bat clamps keeping the pipe 20mm clear of the wall everywhere or concealed as directed. Where it is imperative to fix the pipe in front of a house or in any conspicuous position, where it looks ungainly, chasing may be adopted. Concealed pipes are to be secured to the walls by hooks. The valves should be fitted with a male / female treaded adopter.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size as to fit tightly on the pipes when tightened with screw bolts. The clamps shall be embedded in brickwork in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in table below.

Dia. of pipe (mm)	Horizontal length (m)	Vertical length (m)
15	2.0	2.5
20	2.5	3.0
25	2.5	3.0
32	2.5	3.0
40	3.0	3.5
50	3.0	3.5

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer. The pipes shall be tested as follows.

#### 1801.2.3 Testing the joints:

After laying and jointing the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6kg/cm<sup>2</sup> (60ft of head of water). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock and water hammer. The draw off taps and stop cocks shall then be closed and hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped the test pressure should be maintained without loss for at least half an hour.

The pipes and fittings shall be tested in section as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

#### *1801.3 MEASUREMENTS:*

The lengths shall be measured in running metre correct to 10 mm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps(cocks), valves, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) shall be measured separately.

#### *1801.4 RATE:*

The rate shall include the cost of labour and material involved in all the operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. This shall not however include concealed pipe work in which case cutting of chase and making good shall be paid separately. It shall not include painting of pipes and providing sleeves.

#### *1801.5 WATER STORAGE TANK*

Providing and fixing plastic tank with accessories complete, 500, 1000 and 2000 ltrs

1801.5.1 Fittings: Each tank shall be provided with 40 mm dia G.I scour pipe, which shall terminate into a socket and a plug, 25 mm G.I over flow pipe with fittings and brass mosquito proof coupling conforming to the municipal design and approved by the Engineer and ball valve with copper or plastic float of specified size and pressure. The ball valve shall be securely fixed to the tank independent of the inlet pipe and set in such a position that body of the ball valve cannot become submerged when the tank is full upto waterline.

1801.5.2 Hoisting: The hoisting of tanks into position as directed by the Engineer shall be carried so that no part of the tank or structure is damaged in the operation.

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The tank shall be installed in position truly level and secure to concrete members with necessary bolts and nuts.

1801.5.3 Measurements: Water storage tanks shall be counted in numbers for complete job.

1801.5.4 Rate: The rate shall include the cost of materials and labour involved in all the operations described above.

## 1802 SANITATION (GENERAL)

### *1802.1 GENERAL REQUIREMENTS FOR INSTALLATION:*

The work shall be carried out, complying in all respects with the requirements of relevant byelaws of the local body in whose jurisdiction the work is situated. Any damage caused to the building or to electric, sanitary water supply or other installations etc therein either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the contractor. Nothing extra shall be paid for it except where otherwise specified.

In all the above operations the damaged portion shall be cut in regular geometric shape and cleaned before making good the same. All exposed G.I., C.I. or lead pipes and fittings shall be painted with approved quality of paint and shade as specified.

### *1802.2 MEASUREMENTS:*

Measurement shall be counted in numbers for complete job.

### *1802.3 RATE:*

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

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1803 PANS & CISTERNS

## 1803.1 MATERIAL

Providing and fixing Indian-type vitreous china w.c squatting pan, including 100mm H.C.I. P or S trap, 10 litres low level vitreous china cistern & fittings, repair walls complete of 500mm white, 580mm white Orissa-model and 580mm colour Orissa-model.

## 1803.1.1 Flushing Cistern:

The cistern shall be fixed on C.I. cantilever brackets, which shall be firmly embedded in the wall in cement concrete (1:2:4) block 100x75x150 mm. The cistern shall be provided with 20mm nominal bore overflow pipe. The outlet or flush pipe from the cistern shall be connected to the pan by means of cement or putty joint. The flush pipe shall be fixed to wall by using holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts. The clamps shall be embedded in brickwork in cement mortar 1:3 (1cement: 3 sand). The connection between the cistern and the closet shall be made by means of 40 mm flush bend with an inlet connection as specified.

## 1803.1.2 Painting:

The cistern, brackets, overflow and flush pipe etc. shall be painted with two or more coats of paint of approved shade and quality.

1803.1.3 Squatting pan: The pan shall be sunk into the floor and embedded in a cushion of average 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so as to allow flooring and its bed concrete. The pan shall be provided with a 100 mm S.C.I.(H.C.I.), 'P' or 'S' type trap with an approximately 50mm seal and 50 mm dia. vent horn, where required by the Engineer. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1cement: 1 sand). Cost of concrete shall be paid separately.

## 1803.1.4 MEASUREMENTS:

Measurement shall be counted in numbers for complete job

## 1803.1.5 RATE:

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

**1803.2 EUROPEAN TYPE WATER CLOSET**

Providing and fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 litres white vitreous china low level cistern with flush pipe, fittings, brackets, repairing walls complete, White, with plastic seat & lid.

**1803.2.1 W.C. pan with white plastic seat and lid.**

**1803.2.1.1 Seat and Cover:** The seat shall be fixed to pan by means of two 8 mm diameter corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 15 mm of the head. Each bolt shall be provided with two suitably shaped washers of rubber or other similar materials for adjusting the level of the seat while fixing it to the closet. In addition, one non-ferrous or stainless steel 8mm washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25mm. One arm of the hinge in each bolt shall be fixed to the underside of seat by three Nos. 20mm long, 6 gauge wood screws. The other arm of the hinge shall be fixed to the underside of the cover, flush with the surface by means of three 10mm long 6 gauge wood screws.

**1803.2.2 Water closet:** The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter sunk bolts and nuts embedded in floor concrete. The low level cistern shall be fixed as per specifications given above for Indian type W.C.

**1803.2.3 Measurements:** The squatting pan shall be measured in numbers.

**1803.2.4 Rates:** The rate shall include the cost of the materials and labour involved in all the operations described above.

**1804 URINALS****1804.1 MATERIAL**

Providing and fixing white vitreous china flat back, lipped front urinal basin 430x 260x350mm including C.I. cistern & fittings, brackets, G.I. flush pipe & spreaders, brass unions, G.I. clamps, painting, repairing walls with one bowl-5 litres C.I. cistern and two bowls-10 litres C.I. cistern.

The installation shall consist of lipped urinal (single or range) automatic flushing cistern, G.I flush and waste pipes. The size of the flushing pipe shall be as under:

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No. of urinals in range	Size of Pipe	
	Main	Distribution
One	-	15 mm
Two	20 mm	15 mm
Three	25 mm	15 mm

Urinals shall be fixed in position by using wooden plugs and screws. It shall be at a height of 65cm from the standing level to the top of the lip of the urinal, unless otherwise directed by the Engineer. The plugs shall be fixed in the cement mortar 1:3. After the plugs are fixed the mortar shall be cured until it is set. Each urinal shall be connected to 32mm dia waste pipe, which shall discharge into the channel or a floor trap. The connection between the urinal and the flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

#### 1804.2 MEASUREMENT:

Urinals shall be measured in numbers.

#### 1804.3 RATE:

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

### 1805 WASH BASIN

#### 1805.1 GENERAL

The wash basin shall be provided with one or two taps as mentioned in the item. The front edge of the wash basin from the floor level shall be 80 cm. They shall be of white/ color and of vitreous China with best quality manufactured by an approved firm and size as specified.

#### 1805.2 FIXING:

Under cut Oval/circular washbasins shall be supported by a pair of CI brackets of approved design. The brackets shall be fixed in position before dado work is done. The wall plaster on the rear shall be cut so that overhangs of the top edge of the basin can rest on it. After fixing the basin the plaster shall be made good and surface finished matching with existing one. The union shall be connected to 32 mm dia waste pipe which shall be suitably bent towards the wall and which shall discharge into an open drain leading to gully trap or direct into the gully trap on the ground floor

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and shall be connected to waste pipe stack through a floor trap on upper floors. The C.P. brass trap and union shall not be provided when the waste pipe is discharged through a floor trap or a surface drain leading to a floor trap, where so specified C.P. brass trap and union shall be paid for separately.

Where so specified a G.I. puff 20 mm terminating with perforated brass cap screwed on it on the outside of the wall or connected to the anti-siphon stack, will be provided.

#### 1805.3 MEASUREMENT:

Wash basin with specified fittings shall be measured in numbers.

#### 1805.4 Rate:

Rate for wash basin shall include the cost of specified fittings and labour involved in the work. Rates shall include the other fittings mentioned in the item and the labour for fixing the same.

#### 1806 WALL MIRROR

Providing and fixing 700x500mm bevelled edge mirror (superior glass) including 4mm A.C sheet base fixed to wooden cleats with C.P brass screws and washers.

The mirror shall be mounted on 4 mm thick plain asbestos sheet ground and shall be fixed in position by means of 4 C.P. brass screws and C.P. brass washers, over rubber washers and wooden plugs firmly embedded in walls. C.P. brass clamps with C.P. brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

1806.1 Measurement: Mirror shall be measured in numbers.

1806.2 Rate: Rate shall include the cost of all the materials and labour involved in all the operations described above.

#### 1807. PAPER HOLDER

Providing and fixing toilet paper holder (Stainless steel)

The toilet paper holder shall be of the type as specified and size and design as approved by the Engineer. It shall be fixed in position by means of screws and rawl plugs embedded in the wall. In case of C.P. brass toilet paper holder C.P. brass screws shall be used for fixing the holder to the rawl plugs.



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Measurement: Holder shall be measured in numbers.

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

#### 1808. FLOOR TRAPS FRAME AND GRATING

Floor traps where specified shall be siphon type multi trap of PVC having a minimum 50 mm deep seal. The trap shall be fitted with anti- cockroach grating. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

Floor and urinal traps shall be provided with 100 - 150 mm square or round stainless steel gratings with frame and rim of approved design and shape or as specified in the bill of quantities approved by the Engineer-in-Charge.

Grating with hinged cover is to be placed on the floor traps flushed with the floor; the edge sealing is to be done with colorless silicon compound.

#### 1809. STAINLESS STEEL TOILET SPRAY GUN

##### 1809.1 DEFINITION:

A Toilet Spray gun is a hand-held triggered nozzle that is placed near the toilet and delivers a spray of water used for anal cleansing and cleaning of the genitals after using the toilet for defecation and urination. It is placed in a holder that is fitted to the wall on the right hand side of toilet. It is connected from the faucet/tap via a short pipe.

##### 1809.1.2 Description

For the bathroom cleanliness and hygiene are essential. The toilet jet hand spray represents the technological evolution of the traditional toilet brush making toilet hygiene easier and more efficient. The toilet jet hand spray can be fitted with discretion and elegance in whichever bathroom, new or existing. It sprays a thin jet of water which cleans the toilet safely and efficiently.

With a little practice you can manage the excessive spraying while using it. ABS or brass for the lance, EPDM for the internal opening and closing mechanics and stainless steel for the hose grant performance, safety and durability.

## 1809.1.3 Feature :

- i. 3 way tee connector (T-valve) with water pressure control for spray adjustability.
- ii. Elegant stainless steel spiral hose with inner woven core, about 1.2 Meter (47inches) in length
- iii. Backflow prevention function
- iv. Comes with bracket and hook, be suitable for wall mount or toilet mount, and all accessories included for standard installation
- v. No electricity or batteries required
- vi. Compatible and universal for most of family.

## 1809.1.4 Product parameter:

Shower dimension: 2.2" x4.8", faucet: 1/2"

T-adapter dimension: 15/16" x 15/16" x 1/2"

Hose dimension: 1/2" x 1/2", 1.2 Meter (47inch) in length

## 1810. COMPACT LAMINATE WATER PROOF BOARD

*1810.1 DEFINITION*

Compact Laminated, High Pressure Laminate (HPL) and EO Melamine Board (MFC), whilst having different performance characteristics, still share a common palette of surface colours and textures and they can be combined on any washroom project for installations including (but not limited to):

- Toilet Partitioning
- Shower Partitioning
- Locker Systems
- Seating and Vanity options

In addition to offering endless design possibilities, the larger sheet sizes allow ideal optimization when higher partition division and door frontals are required - providing greater privacy and security.

Only 13mm Compact Laminate and 18mm Compressed Fibre Cement (CFC) systems are recommended for use in wet and high moisture areas (showers).

Customs colours and surface structures available depending on scope and size of project.

Black core with decorative melamine surface on both sides. Waterproof and perfect for the wet conditions of toilet and shower cubicles

#### 1810.1.2 Descriptions and Installation

13mm Compact Laminate				
Size	Dimensions (Standard Sizes)	Fixings	Hardware included	Notes
Division Panels	Toilet divisions 1700mm H x 1500mmW Shower divisions 1700mm H x 1800mmW Mounted approx. 200mm off floor	Aluminium channel to rear wall and frontal panels.	Stainless steel screws	Division panels are cut smaller to allow for channel and expansion tolerances
<i>Frontal Panels</i>	1800mm H x 300mm W (min. 200mm W)	Aluminium channel fixed to division. Supported by 2 single legs.		
<i>Nib Panels</i>	1800mm H x 150mm W (min. 80mm W)	Aluminium channel fixed to wall. Supported by 1 single leg		Nib panels are cut smaller to allow for channel and expansion tolerances
<i>Doors</i>	1700mm H x 600mm W (Standard)	Hinged to the frontals. Edges cut square as	3 Hinges screw fixed	Routed option available for further

	1700mm H x 720mm W (Ambulant)	standard	per door	privacy
<i>Headrails</i>	Standard round headrail. Square headrail is optional	Fixed to frontal and nib panels with provided screws	Snap in inserts to enclose door openings	Supplied oversized to allow docking to suite specific site measurement
<i>Foot Assemblies</i>	200mm Nova Adjustable legs	Nova legs are fixed to floors with screws		

18mm Compressed Fibre Cement (CFC)

Size	Dimensions (Standard Sizes)	Fixings	Hardware included	Notes
Division Panels	Toilet divisions 1800mm H x 1500mmW Shower divisions 1800mm H x 1800mmW Mounted approx. 200mm off floor	Aluminium channel to rear wall and frontal panels. Supported by one single leg.	Rivets	Division panels are cut smaller to allow for channel and expansion tolerances
Frontal Panels	1900mm H x 300mm W (min. 200mm W)	Aluminium channel fixed to division.		
Nib Panels	1900mm H x 150mm W (min. 80mm W)	Aluminium channel fixed to wall.		Nib panels are cut smaller to allow for channel and expansion tolerances

Doors	1800mm H x 600mm W (Standard) 1800mm H x 720mm W (Ambulant)	Hinged to the frontals. Edges cut square as standard	2 Bolt through hinges per door	
Headrails	Square headrail	Fixed to frontal and nib panels with provided rivets	Snap in inserts to enclose door openings	Supplied oversized to allow docking to suite specific site measurement
Foot Assemblies	300mm solid aluminium leg	Hole in drilled into floor and leg is chem set to desired height		

**1900 PLUMBING - OUTDOOR WORK****1901 WATER SUPPLY****1901.1 MATERIAL**

Providing and laying H.D.P.E pipes, pressure class 2.5/4/6/ 10 kg/cm<sup>2</sup>, including H.D.P.E fittings or CPVC pipes including fittings but excluding trenching & refilling for various sizes of pipes ranging from 25mm to 90mm, the specified pipes and fittings shall be laid in trenches. The width and depths of the trenches of different diameters of the pipes shall be as shown in the table below.

Dia. of pipe	Width of trench	Depth of trench
15mm to 50mm	30 cm	60 cm
65mm and above	45 cm	75 cm

At joints, trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth working trenches. In case of GI pipes, the pipes shall be painted with two coats of anticorrosive bit mastic paint of approved quality. The pipes shall be laid in a layer of 7.5 cm sand and filled upto 20 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed off as directed by the Engineer.

When excavation is done in rock, the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand of minimum 7.5 cm. In case of bigger diameter pipes where the pressure is very high thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends to transmit the hydraulic thrust without impairing the ground and spreading it over a sufficient area.

**1901.2 TESTING THE JOINTS:**

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. The pipes and fittings after

they are laid shall be tested to hydraulic pressure of 6kg/cm<sup>2</sup> (60 metres). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off takes and the stop-cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

#### *1901.3 MEASUREMENTS:*

The lengths shall be measured in running metre correct to 10 mm for the finished work, which shall include pipe and fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples, flanges, nuts, etc. but exclude brass or gun metal taps (cocks), valves, lead connection pipe and shower rose. The length shall be taken along the central line of the pipe and fittings. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. The diameter shall be the nominal diameter of the internal bore. The pipe shall be described as including all cuttings and waste.

In case of fittings of equal bore, the largest bore shall be measured. Digging and refilling of trenches shall be measured separately.

#### *1901.4 RATE:*

The rate shall include the cost of labour and material involved in all operations described above (excluding the cost for excavation in trenches, refilling of trenches, painting of pipes and sand filling all round the pipes).

### 1902 SOIL WASTE PIPES & FITTINGS

#### *1902.1 GENERAL*

##### *1902.1.1 Fixing and Jointing:*

Pipes shall be fixed on face of wall. Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The pipes shall be fixed to the wall by embedding the hooks of the clamps in cement concrete blocks 10 x 10 x 10 cm 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25mm clear of finished face of wall, so as to facilitate cleaning and painting of pipes.

The pipes shall be fixed perfectly vertical or to the lines and slopes as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The joint shall be caulked in with lead as soon as the next length of pipe is placed in position. The open end (socket end) of the pipe shall be kept closed till the next length of pipe is fitted and jointed, to prevent any brickbat or concrete or pieces of wood falling in and choking the pipe. The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot shall be first well packed in with spun yarn or rubber ring leaving 25 mm from the lip of the socket for the lead. The joint shall then be lead caulked. All soil pipes shall be carried up above the roof and shall have sand cast iron terminal guard.

#### 1902.1.2 Height of ventilating pipes:

The ventilating pipe or shaft shall be carried to height of at least one metre above the outer covering of the roof of the building or in the case of window in a gable wall or a dormer window it shall be carried upto the ridge of the roof or at least 2metres above the top of the window. In the case of flat roof to which access for use is provided, it shall be carried upto a height of at least one metre above the parapet or 2 metres above the roof whichever is greater and shall not terminate within 2 metres measured vertically from the top of any window or opening which may exist upto a horizontal distance of 5 metres from the vent pipe into such building and in no case shall be carried to height less than 3 metres above plinth level. Where ventilating pipes are carried in pipe shafts, the shafts shall be a minimum size of one metre x one metre. If shafts are also used to give light and air to rooms, the ventilating pipe must be carried to a horizontal distance at roof level on not less than 5 metres, from the side of the shaft. The payment for the shaft be made separately.

The pipes above the parapet shall be secured to the wall by means of M.S. stay and clamps. The stay shall be minimum one metre long of 10 mm dia. M.S. bar. One end of the stay shall be bent to form a hook to be fixed with the clamps by means of bolt and nut and other end shall be bent for embedding in the wall in cement concrete block of size 20 x 10 x 10 cm in 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size). The concrete shall be finished to match with the surrounding surface.

#### 1902.1.3 Other Details:

The connection between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning. Floor traps shall be provided with 25mm dia. puff pipe where the length of the waste is more than 180 cm or the floor trap is connected to a waste stack through bends. The waste from lavatories, kitchens, basins, sinks, baths and other floor traps shall be separately connected to respective waste stack of upper floors. The waste stack of lavatories will be connected directly to manhole while the waste stack of others shall separately discharge over gully trap.



Every starting manhole shall have a 100 mm sand cast iron vent, terminating at 1 metre above the parapet of building. The main anti-siphon age pipe shall be 50 mm internal diameter.

When more than one branch from water closet/sink are connected with the soil pipe and discharge into it anti-siphon age from the lowest one should pass through the wall and be carried up outside the building parallel to the soil pipe to a point 1.5 metres minimum above the highest branch. It can then be connected to the soil pipe or it can be carried independently. The anti-siphon age pipes of all the intermediate floors water closet should be joined with the main anti-siphon age pipe. The ventilating pipe shall have internal diameter of not less than 50 mm in all parts and shall be connected with arm of soil pipe on trap through a 45 degree branch, at a point not less than 7.5 cm and not more than 30 cm from the highest part of the trap and on the outside of the water seal which nearest to the soil pipe.

#### 1902.1.4 Preparing the joint:

The interior of the socket and exterior of the spigot shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right upto the back of the socket and carefully entered by two or three laps of treated spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipeline shall be at required levels, and directions.

#### 1902.1.5 Leading:

The leading of pipes shall be made by means of ropes covered with clay or by using special leading rings. The lead shall be melted so as to be thoroughly fluid and each joint shall be filled in one pouring.

#### 1902.2 THE FOLLOWING PRECAUTIONS SHALL BE TAKEN FOR MELTING LEAD:

- (a) The pot and the ladle in which lead shall be put shall be clean and dry.
- (b) Sufficient quantity of lead shall be melted.
- (c) Any scum or dross, which may appear on the surface of the lead during melting, shall be skimmed off.
- (d) Lead shall not be over heated.

Minimum quantity of lead for each joint shall be:

Sl.No.	Pipe dia	Quantity
i.	50mm	0.52kg
ii.	75mm	0.88kg

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iii.	100mm	0.98kg
iv.	150mm	1.20kg

#### 1902.2.1 Caulking:

After the lead has been run into the joint the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipes has been laid and leaded. The leading ring shall first be removed and any lead outside the socket shall be removed with a flat chisel and then the joint caulked round three times with caulking tools of increasing thickness and hammer 2 to 3 kg weight. The joints shall not be covered till the pipeline has been tested under pressure, though the rest of the pipeline should be covered upto prevent expansion and contraction due to variation in temperature.

#### 1902.2.2 Testing:

All sand cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Engineer and left in working order after completion.

#### 1902.2.3 Smoke test shall be carried out as stated under:

Smoke shall be pumped into the pipe at the lowest end from a smoke machine, which consists of a bellow and a burner. The material usually burnt is greasy cotton waste, which gives out a clear pungent smoke, which is easily detectable by sight as well as by smell if there is leak at any point of the drain.

#### 1902.2.4 Painting:

All sand cast iron pipes and fittings shall be painted with colour as directed by the Engineer.

#### 1902.3 MEASUREMENT:

The pipes shall be measured net when fixed, correct to 10 mm. excluding all fittings along its length. When collars are used, these shall be measured along with and paid as pipes and no extra shall be paid for collars or for fixing them to wall with bat clamps. No allowance shall be made for the portions of the pipe length entering the sockets of the adjacent pipes or fittings. The above will apply to both cases i.e. whether the pipes are fixed on wall face, or the pipes are embedded in masonry. No deduction will be made in the former case from the masonry measurements for the volume of concrete blocks embedded there in.

Similarly no deduction will be made for the volume occupied by the pipes from the masonry when the former are embedded in the latter.

**1902.4 RATE:**

The rate shall include cost of the labour and materials involved in all the operations described above including the supply and fixing M.S. holder bat clamps but excluding fittings, lead caulk jointing, and M.S. stays and clamps, floor trap and painting, which shall be paid for separately.

**1903 PVC SOIL WASTE PIPES & FITTINGS****1903.1 GENERAL**

Providing and fixing PVC soil waste and vent pipes, single or double socketed including clips complete but excluding PVC fittings like PVC Pipe connector, PVC Coupler, PVC Reducer, PVC plain bend, PVC door bend, PVC Long arm bend with door, PVC Single Tee plain, etc.

**1903.2 INSTALLATION**

1903.2.1 Underground installation: For laying PVC pipes in trenches, trench width shall not be less than pipe diameter plus 125mm in each side. Laying of pipes, trench filling, depth of trenches, precaution, etc shall be as described above for CI pipes.

1903.2.2 Concealed installation: For concealing the drain lines, slots shall be made in the wall or concrete. The slot size shall be such that the system remains stress free at the time of installation. Sharp edges should be avoided. All PVC pipes and fittings shall be cleaned and alight coat of solvent cement applied externally before they are inserted in the slots. Leakage test shall be carried out before concealing the system.

**1903.3 STORAGE:**

To avoid damages to the pipes and fittings following precautions shall be taken when intended for storage of PVC pipes:

- i. Pipes shall be stacked on an even surface, the staking height not exceeding 1.5m
- ii. Pipes and fittings shall not be kept on sharp objects
- iii. All fittings shall be stored in cartons or bags

- iv. Pipes and fittings shall not be dragged
- v. Rubber rings shall be kept tension free
- vi. Lubricants and solvent cement shall be stored in a cool place, away from direct sunlight.

#### *1903.4 JOINTING:*

The commonly used joints are as follows:

- a) Solvent welded joints,
- b) Flanged joints
- c) Screwed or treaded joints, and
- d) Rubber ring joints.

#### *1903.5 MEASUREMENT:*

The pipes shall be measured in running meters and the fittings shall be measured in numbers in similar manner as specified for C.I. pipes/ fittings above.

#### *1903.6 RATE:*

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

### 1904 SOAK PITS

#### *1804.1 GENERAL*

The earthwork excavation shall be as per general specifications given under "Earth work". After the excavation is complete, the soak pit shall be filled with brickbats. The brickbats shall be from properly burnt bricks.

#### *1904.2 CIRCULAR SOAK PIT:*

The earthwork excavation shall be carried out to the exact dimensions as given in the description of the item. In this pit, a honeycomb dry brick shaft 45x 45 cm and 292.5 cm high shall be constructed centrally. Round this shaft and within a radius of 60 cm shall be placed well-burnt brickbats. Around the brickbats upto a radius of 90 cms brick ballast of size from 50 to 80 mm nominal size shall be packed. The remaining portion shall be filled with brick ballast of 40 mm nominal size. The construction of the shaft filling of the bats and ballast shall progress simultaneously.

Over the filling shall be placed single matting, which shall be covered with minimum layer of 7.5 cm earth. The shaft shall be covered with 7.5 cm thick stone or R.C.C slab.

Brick edging 10 cm wide 10 cm deep shall be provided round the pit. The connection of the open surface drain to the soak pit shall be made by means of a 100 mm dia. S.W. pipe with open joints.

#### 1904.3 MEASUREMENTS:

The soak pits shall be measured in numbers.

#### 1904.4 RATE:

The rate shall include the cost of labour and material involved in all the operations described above.

### 1905 SEPTIC TANKS

#### 1905.1 GENERAL

Septic tank shall be located away from the nearest building as per the regulations of the local implementing authority. Every septic tank shall be provided with CI ventilating pipe of at least 50mm dia. and extended to a height of 2m. The top of the pipe shall be provided with a suitable cage of mosquito proof wire mesh.

Constructing Septic Tanks, in R.R. Masonry in cement mortar 1:6, including fittings, CI cover with frame, 40mm thick concrete flooring (40mm aggregate) cement plaster concrete base in C.M 1:4:8 etc. complete as per standard design.

Septic tank shall have minimum width of 750mm, and minimum liquid capacity of one  $\text{cm}^3$ . Length of the tank shall be 2 to 4m. However, the actual sizes of the tank shall be as per the standard size based on the number of users. The minimum size for different number of users for cleaning interval of 2 years is as shown below:

No. of user	Length (m)	Width (m)	Height (m)
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15	2.00	0.90	2.00
25	2.60	1.30	1.80
50	4.00	1.40	2.00
75	5.00	1.50	2.00
100	5.70	2.10	1.70

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Before the tank is commissioned for use, it shall be tested for water-tightness by filling it with water and allowing it to stand for 24 hours. It shall then be topped up, if necessary, and allow to stand for a further period of 24 hours, during which time the fall in the level of water shall not be more than 15mm.

#### *1905.2 MEASUREMENT*

The measurement shall be made in numbers.

#### *1905.3 RATE*

The rate shall include all operation as described above for construction of septic tank including necessary pipe fitting in position.

**2000 GALVANIZED STEEL BARBED WIRE AND CONCERTINA WIRE****2001 SCOPE**

- i) Scope of work will consist of providing and fixing Concertina coil fencing over the grills of boundary wall on all the four sides. Concertina coil will be fixed over Y-shaped angle which will be fixed to the existing grill as per the drawing.
- ii) Providing and fixing horizontal Barbed wires between vertical portions of Y-angles as shown in the drawing.

This standard covers the requirements for two types of galvanized steel barbed wire with two strands of wire, in a number of sizes and constructions as per IS : 278.

**2001.1 TERMINOLOGY**

For the purpose of this standard, the following definitions shall apply.

- 2001.1.1** Length of the Barb shall mean the distance of the barb point from the axis of the line wire of wires around which the point wire is wound.
- 2001.1.2** Line Wire shall mean a wire of specified diameter of which the Barbed wire is made.
- 2001.1.3** Point Wire shall mean a wire of specified diameter of which the barbs are made.

**2002 MATERIAL**

The galvanized barbed wire shall be manufactured from mild steel wire conforming to IS 280. The galvanized coating shall conform to the requirements for any one of the type of coating as given in IS 4826 as per agreement with the purchaser. The coating requirements of electro galvanized wire shall conform to the requirements for any one of the type as given in IS 12753 as per agreement with the purchaser.

**2003 MANUFACTURE**

- 2003.1** The barbed wire shall be formed by twisting together two-line wires, one or both containing the barbs. The direction of twisting may be in one direction or alternately in left or right directions.
- 2003.2** The barbs shall be so finished that the four points are set and located or

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locked as far as possible at right angles to each other. The barbs shall be well formed, tightly wrapped and shall have a length of not less than 13 mm and not more than 18 mm. The point shall be sharp and cut at an angle not greater than 35° to the axis of the wire forming the barbs.

#### 2004 MARKING

2004.1 Every reel of barbed wire shall be marked legibly with the name of the manufacturer, the type of barbed wire, the diameters of the line and point wires, barb spacing and length and/or mass of the reel.

#### 2005 BIS CERTIFICATION MARKING

Each reel of barbed wire may also be marked with Standard Mark.

2005.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made there under.

#### 2006. BARBED WIRE FENCING WITH ANGLE FENCING IRON EMBEDDED IN RCC POSTS

##### 2006.1 MATERIALS

Barbed wire shall be as per IS: 278 and angle iron shall be 40 x 40 x 6/50 x 50 x 5 mm procured from a reputed brand confirming to IS 800.

##### 2006.1.2 SPACING OF POSTS AND STRUTS

The spacing of posts shall be 3.00 m centre to centre, unless otherwise specified in the drawing or as directed by the Engineer to suit the dimensions of the area to be fenced.

##### 2006.1.3 FIXING OF POSTS AND STRUTS

This shall be as per given in barbed wire and RCC posts above. In addition, Y or L shape angle iron post at top of the RCC column shall be embedded at right angle maintaining proper grip at bottom as directed by the Engineer.

##### 2006.1.4 FIXING BARBED WIRE

The barbed wire shall be stretched and fixed in specified number of rows as per the drawing or specified by the Engineer. The barbed wire shall be held by tearing the



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holes of 10 mm dia in the post and tied with GI wire, turn buckles and straining bolts shall be used at the end post, if so specified.

#### 2007 GALVANIZED RAZOR BARBED WIRE (CONCERTINA WIRE)

2007.1 Concertina wire security barrier is by far one of the most perfect physical obstacles. Security barrier made of galvanized steel strip thickness of 0.55 mm - 1.5 mm, having a double-edged, symmetrically spaced, directed spines, and reinforced with high carbon galvanized wire diameter of 2.65 mm, 2.8 mm, 3.0 mm. Nominal diameter of the razor concertina is 450 mm, 500 mm, 600 mm, 730 mm, 900 mm, 980 mm (after stretching, the diameter is reduced by 5-10%).

Concertina wire according to different shapes can be divided into single coil, crossed and double coils.

Single coil razor wire forms: straight ribbons or single coil concertina.

Characteristics: single coil barbed type wire is installed without clips. It runs in natural loops on walls. Costless and can be easily installed.

2007.1.2 Cross concertina wire coil is two pieces of stainless steel razor wire or zinc-coated wire bound together by clips to make it stronger. This galvanized wire tape compresses the core, and adjacent turns of the cramp in five equidistant points on a circle. Total installed 3 or 5 rows of staples, so that it becomes formidable concertina, springy, spatial design. The spiral intersecting barbed wire presents an intersecting shape after opening. After stretch and installation, concertina creates a fixed and strong spatial structure. In order to overcome this type concertina wire, it must be cut at least three points.

2007.1.3 Double Concertina Razor Coil includes two razor concertina coils with different diameters, and small diameter concertina is included in the large diameter concertina. Three nodes connect the two concertina razor. Double concertina razor wire has more beautiful appearance and better protection than other razor mesh.

2007.1.4 Cross type hot dipped galvanized concertina wire technique parameter:

Razor type wire in length of 14-15 m.

Diameter: 10 cm.

Wire: 2.5 mm.

Thickness: 0.5 mm.

Barb length: 22 mm.

Bard width: 15 mm.

Bard spacing: 34 mm.

Type: cross type.

Material: steel wire.

Surface treatment: hot dipped galvanized.

Type: barbed wire coil.

Razor type: Cross Razor.

Wire diameter: 2.5 mm.

Thickness: 0.5 mm.

Bard length: 22 mm.

Bard width: 15 mm.

Bard spacing: 34 mm.

Outside diameter: 450 mm, 500 mm.

#### 2008 CROSS TYPE RAZOR BARBED WIRE SPECIFICATION.

##### 2008.1 A- BTO-10, cross type razor barbed wire

1. Material of core wire: galvanized #45, diameter: 2.3 mm.
2. Material of blade: galvanized strip, thickness: 0.4 mm.
3. Coil diameter: 90 cm.
4. No. of loops/coil: 39.
5. No. of clips/coil: 19(pairs) × 5(clips/pair).
6. No. of handles/coil: 2(handles) × 2(sides).

##### 2008.2 B- BTO-22, Cross type razor barbed wire

1. Material of core wire: galvanized #45, diameter: 2.3 mm.
2. Material of blade: galvanized strip, thickness: 0.4 mm.
3. Coil diameter: 60 cm.
4. No. of loops/coil: 30.
5. No. of clips/coil: 15(pairs) × 3(clips/pair).
6. No. of handles/coil: 2(handles) × 2(sides).

##### Core Wire

Type: galvanized (275 gms m<sup>2</sup>) high tensile wire (1600 MPa).

Diameter: 2.5 mm diameter.

## 2009 MEASUREMENTS

The length of fencing shall be measured in running meter for the finished work, from centre to centre of the posts and in kg for angle iron

## 2010 RATE:

The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of posts, struts, turn buckle, straining bolts and excavation and concrete in foundations for which separate payments shall be made under respective items.

## 2100. BITUMINOUS SURFACE

### 2101 GENERAL REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

#### 2101.1 GENERAL

Bituminous pavement courses shall be made using the materials described in the Specifications. The use of machinery and equipment mentioned in various Clauses of these Specifications is mandatory. Details of the machinery and equipment are available in the Manual for Construction and Supervision of Bituminous Works. The equipment mandatory for any particular project shall be in accordance with the Contract Specifications for that project.

#### 2101.2 MATERIALS

##### 2101.2.1 Binder

The binder shall be an appropriate type of bituminous material complying with the relevant Indian Standard, as defined in the appropriate Clauses of these Specifications, or as otherwise specified herein. The choice of binder shall be stipulated in the Contract or by the Engineer. Where viscosity grades of bitumen are specified, they are referred to by a designation in accordance with IS: 73. Where modified bitumen is specified, it shall conform to the requirements of IRC: SP: 53 and IS: 15462; and the following provision of this Specification shall apply.

- (i) Modified bitumen from refinery sources or blended at approved central plant or at site using appropriate industrial process and plant with high shear mill, and testing facilities to achieve stable and homogenous mix shall be used. The use of high shear mixer or any other device capable of producing a homogeneous blend is essential when the modifier is in powder form.
- (ii) Transportation tanks and storage tanks shall be insulated and equipped with effective heating system and circulation/ agitating device to maintain the specified temperature, homogeneity and viscosity of the bitumen during transit and storage.

- (iii) Separation, difference in softening point (R&B), shall not be more than 3°C for any type of specified modified bitumen when tested as per Annex B of IS: 15462.

Selection criteria for viscosity grade bitumen, based on highest and lowest daily mean temperatures at a particular site, are given in Table 2100-1

Selection criteria for modified bitumen shall be in accordance with IRC: SP: 53.

Table 2100-1: Selection Criteria for Viscosity-Graded (VG) Paving Bitumens  
Based on Climatic Conditions

Lowest Daily Mean Air Temperature, °C	Highest Daily Mean Air Temperature °C		
	Less than 20°C	20 to 30°C	More than 30°C
More than 10°C	VG - 10	VG - 20	VG - 30
10°C or lower	VG - 10	VG - 10	VG - 20

Both the highest daily mean air temperature and the lowest daily mean air temperatures mentioned in Tables 500-5 and 500-6 of MORTH spec. can be obtained for the weather station nearest to the project site from the Indian Meteorological Organization (IMO). This daily mean high temperature on a specific day is the same as daily "normal" high temperature for that day as usually reported in some newspapers. The highest of the 365 daily mean high air temperatures (which usually occurs on some day in May or June) is used in Tables 2100-5 and 2100-7. Likewise, the lowest daily mean air temperature (which usually occurs on some day in January) can also be obtained from the IMO. Since these are mean temperatures based on the average of 30-40 years data, these temperatures are significantly lower than the absolute maximum temperatures, which may have occurred in a specific year.

## 2102 PRIME COAT

### 2102.1 SCOPE

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix. The work shall be carried out on a previously prepared granular/ stabilized surface complying with the MORT&H specification for Roads and Bridges, and IRC 16-2008.

#### 2102.1.1 OBJECTIVES

. The objectives of priming a granular surface are as under:

- (i) To penetrate the existing base course surface so as to plug capillary voids in it.
- (ii) To coat and bond loose mineral particles on the surface of the base course.
- (iii) To seal surface pores and make the surface of the base course water-resistant.
- (iv) To provide adhesion between the base and the superimposed bituminous surface course in conjunction with a tack coat.

Prime Coat is not to be regarded as a substitute for tack coat, the objective of which is to ensure a proper bond between the surface being paved and the new bituminous course being placed over it.

## 2102.2 MATERIALS

The bituminous material to be used as primer should be such that it can penetrate deep into base course (about 10 mm depth) to perform its intended function in an environment friendly manner. Bitumen emulsion or medium curing cutback bitumen can be used as primer.

The primer shall be cationic bitumen emulsion SS1 grade conforming to IS:8887 or medium curing cutback bitumen conforming to IS:217 or as specified in the Contract. The quantity of SS- 1 grade bitumen emulsion for various types of granular surfaces shall be as per Table 1.

Table 2100-2 : Quantity of Bitumen Emulsion as Primer for Various Surface Types

Type of Surface)	Rate of Spray (kg/m <sup>2</sup>
WMMIWBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9 -1.2

Cutback for primer shall not be prepared at the site. Type and quantity of cutback bitumen for various types of granular surface shall be as given in Table 2100-2.

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Table 2100-3: Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (kg/sq.m)
WMMIWBM	MC 30	0.6-0.9
Stabilized soil bases/ Crusher Run Macadam	MC 70	0.9-1.2

The correct quantity of primer shall be decided by the Engineer and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10 mm. Cutback for primer is *preferred* for the project considering the climatic condition and accurate function of the primer.

#### 2102.3 Weather and Seasonal Limitations

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Cutback bitumen as primer shall not be applied to a wet surface. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water

#### 2102.4 CONSTRUCTION

##### 2102.4.1 Equipment

The primer shall be applied by a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

##### 2102.4.2 Preparation of Road Surface

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/ moorum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

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2102.4.3 Application of Bituminous Primer

After preparation of the road surface as per Clause 2200.4.2 the primer shall be sprayed uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively through the jets of the spray bar and to cover the surface uniformly.

## 2102.4.4 Temperature of application of primer

No heating of SS- 1 bitumen emulsion is permitted at site. In case of cutback bitumen, temperature of application of primer should be high enough to permit the primer to be sprayed effectively through the jets of the spray bar and to cover the base course surface effectively. The temperature of product at the time of application should be more than 10°C.

## 2102.4.5 Curing of Primer and Opening to Traffic

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

## 2102.4.6 Quality Control

The Quality Control shall be undertaken as under:

Test	Frequency of Tests
Quality of Binder	One set of test for a tanker or lot of 10 tonne as per IS:217 for cutback bitumen and IS:8887 for bitumen emulsion
Binder Temperature for application	Regular Intervals
Rate of spread of binder	1 test per 1000 m <sup>2</sup> and not less than two tests per day

## 2102.4.7 Arrangement for traffic



During the period of construction, appropriate arrangement for traffic diversion shall be made as specified in IRC: SP: 55 to prevent any possible damage of primed surface.

#### *2102.5 MEASUREMENT FOR PAYMENT*

Prime coat shall be measured in terms of surface area of application in square metres

#### *2102.6 RATE*

The contract unit rate for prime coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of quantity at 0.6 kg per square metre or at the rate specified in the Contract, with adjustment, plus or minus, for the variation between this quantity and the actual quantity approved by the Engineer after the preliminary trials referred to in Clause 2201.4.3

#### *2103 TACK COAT*

##### *2103.1. SCOPE*

This work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction over it.

##### *2103.2. MATERIALS*

Binder: The binder used for tack coat shall be a bituminous emulsion or cutback as specified in the Contract.

##### *2103.3. CONSTRUCTION OPERATION*

2103.3.1. Preparation of base: The surface on which the tack coat is to be applied shall be cleaned of dust and any extraneous material before the application of the binder, by using a mechanical broom or any other approved equipment/method as specified by the Engineer.

2103.3.2. Application of binder: Binder may be heated to the temperature appropriate to the grade of cutback used and approved by the Engineer and sprayed on the base at the rate specified in Table 2200-2. The normal range of spraying temperature for a bituminous emulsion shall be 20° C - 60° C and for a cutback 50° C – 80° C if RC-70/MC-70 grade is used. It shall be the responsibility of the Contractor to carefully handle the inflammable bituminous cutback material so as to safeguard against any fire mishap. The binder shall be applied uniformly with the aid of either self-propelled or towed bitumen pressure sprayer with self-heating arrangement and spraying bar with nozzles having constant volume or pressure system, capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen. Work should be planned so that no more than the necessary tack coat for the day's operation is placed on the surface. After application and prior to succeeding construction allow the tack coat to cure, without being disturbed, until the water/cutter has completely evaporated, as determined by the Engineer.

Table 2100-4. Rate of application of tack coat

Sl No.	Type Surface	Quantity of liquid Bituminous material in kg per 10 sq. m. area
i.	Normal bituminous surfaces	2.0 to 2.5
ii	Dry and hungry bituminous surfaces	2.5 to 3.0
iii	Granular surfaces treated with primer	2.5 to 3.0
	Non bituminous surfaces	3.5 to 4.0
iv	a) Granular base (not primed)	3.0 to 3.5
	b) Cement concrete pavement	

Note: There is no need to apply a tack coat on a freshly laid bituminous course if the subsequent bituminous course is overlaid the same day without opening it to traffic.

#### 2103.4. QUALITY CONTROL OF WORK

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of Moth specification

#### 2103.5. ARRANGEMENTS FOR TRAFFIC

During the period of construction, the arrangement of traffic shall be done to Clause 116

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**2103.6. MEASUREMENT FOR PAYMENT**

Tack coat shall be measured in terms of surface area of application in square metres.

**2103.7. RATE**

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (v) as applicable to the work specified in these Specifications.

**2104 DENSE BITUMINOUS MACADAM (DBM)****2104.1 SCOPE**

This clause specifies the construction of dense graded bituminous macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as a road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50mm to 100mm.

**2104.2 MATERIALS**

The sources of materials proposed to be used by the Contractor shall be tested to the satisfaction of the Engineer who shall give the necessary approval. The Engineer may from time to time withdraw approval of a specific source, or attach conditions to the existing approval. Any change in aggregate source for bituminous mixes shall require a new mix design, and laying trials, where the mix is based on a job mix design. Stockpiles from different sources approved or otherwise, shall be kept separate, such that there is no contamination between one material and another. Each source submitted for approval shall contain material sufficient for at least 5 days' work.

2104.2.1 Bitumen: The bitumen shall be paving bitumen of Penetration Grade complying with IS: 73. Table 1

IS:73 Table 1 Requirement for Paving Bitumen

Sl No	Characteristics	Paving Grade	Method of Test
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		VG 10	VG 20	VG 30	VG 40	
1	Absolute viscosity at 60 <sup>0</sup> c	800	1600	2400	3200	IS 1206
2	Kinematic viscosity at 135 <sup>0</sup> c	250	300	350	400	IS 1206
3	Flash Point	220	220	220	220	IS 1209
4	Solubility in trichloroethylene	99.0	99.0	99.0	99.0	IS 1216
5	Penetration at 25 <sup>0</sup> c	80 - 100	60 - 80	50 - 70	40 - 60	IS 1203
6	Softening Point	40	45	47	50	IS 1205
7	Specific Gravity	1.0 –1.05	1.01-1.06	1.01-1.06	1.01-1.06	ASTM D-70
8	Ductility at 25 <sup>0</sup> c	75	50	40	25	IS 1208
9	Loss on heating	0.5 Max	0.2 Max	0.2 Max	0.2 Max	ASTM D-6

2104.2.2 Coarse Aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, and durable, of cubicle shape, free from dust and soft or friable matter, organic or other deleterious substances. Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table 2100-5: Physical requirements for coarse aggregate for DBM

Property	Test	Specifications
Cleanliness( dust)	Grain size analysis	Max 5% passing 0.075 mm sieve
Particle Shape	Flakiness and Elongation index (combined)	Max 30%
Strength	Los Angeles Abrasion Value	Max 35%

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	Aggregate Impact Value	Max 27%
Durability (Soundness)	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water Absorption	Max 2%
Stripping	Coating and Stripping of bitumen aggregate mixtures	Minimum retained coating  95%
Water Sensitivity	Retained tensile strength	Min 80%

The tests shall be carried out in accordance with the respective IS Specifications

2104.2.3 Fine Aggregates: Fine aggregates shall consist of crushed or naturally occurring mineral material or a combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (part 37). The plasticity index of the fraction passing the 0.425mm sieve shall not exceed 4 when tested in accordance with IS: 2720 (part 5).

2104.2.4 Filler: Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the engineer. The filler shall be graded within the limits specified below.

Table 2100-6 Grading of Filler material

IS Sieve (mm)	Cumulative % by weight of total aggregate
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0.6	100
0.3	95 - 100
0.075	85 - 100

The filler shall be free from organic impurities and have a plasticity index not greater than 4. The plasticity requirement shall not apply if the filler is cement or lime. When the coarse aggregate is gravel, 2% by weight of the total aggregate, shall be Portland cement or hydrated lime and the % of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the requirements of the water sensitivity test in table 2000-4 then 2% by total weight of aggregate, of hydrated lime shall be added without additional cost.

Aggregate Grading and Binder content: when tested in accordance with IS:2386 (part 1) – wet sieving method, the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in the table B below, for DBM grading 1 or 2 as specified in the contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

Table 2100-7 Composition of DBM pavement layers

Grading	1	2
Nominal Aggregate size	40mm	25mm
Layer Thickness	80 – 100mm	50 – 75mm
IS Sieve (mm)	Cumulative % by weight of total aggregate	
45	100	
37.5	95 – 100	100
26.5	63 – 93	90 – 100
19.0	-	71 – 95
12.26	55 – 75	56 – 80
9.5	-	-

4.75	38 – 54	38 – 54
2.36	28 – 42	28 – 42
1.18	-	-
0.6	-	-
0.3	7 – 21	7 - 21
0.15	-	-
0.075	2 - 8	2 - 8
Bitumen content% by mass of total mix	Min 4.0	Min 4.5
Bitumen Grade	65 or 90	65 or 90

*Notes:*

1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

2. Determined by the Marshall method

**2104.3 MIXTURE DESIGN**

Requirement for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 2000-8

Table 2100-8: Requirements for dense graded bituminous macadam

Minimum stability (KN at 60°C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Percent air voids	3-6
Percent voids in mineral aggregate (VMA)	See Table: 2200.8 below. 65-75

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Percent voids filled with bitumen (VFB)

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table 2000.9

Table 2100.9

Nominal Maximum particle Size (mm)	Minimum VMA, percent related to Design Air voids, percent		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Notes: 1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent

2. Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.

#### 2104.4 BINDER CONTENT

The binder content shall be optimized to achieve the requirements set out in table 2100-7 and the traffic volume set out in the contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve by the aggregates passing the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the engineer.

Where the 40mm DBM mixture is specified, the modified Marshall method described in MS-2 shall be used. This method requires modified equipment and procedures; particularly the minimum stability values in table 2100-8 shall be multiplied by 2.25 and the minimum flow shall be 3mm.

#### 2104.5 JOB MIX FORMULA

The contractor shall inform the engineer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works. While establishing the job mix formula, the contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that



the mixture and its different ingredients satisfy the physical and strength requirements of these specifications.

Approval of the job mix formula shall be based on the independent testing by the engineer for which samples of all ingredients of the mix shall be furnished by the contractor as required by the engineer.

The approved job-mix formula shall remain effective unless and until a revised job mix formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the engineer for approval before placing of the material.

#### 2104.5.1 Plant trials – permissible variation in job mix formula:

Once the laboratory job mix formula is approved, the contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in the Table 2000-5. These variations are intended to apply to individual specimens taken for quality control tests in accordance with section 2300.

Table 2100-10: Permissible variations from the job mix formula

Description	Permissible variation	
	Base/Binder course	Wearing course
Aggregate passing 19 mm sieve or larger	± 8%	± 7%
Aggregates passing 22.6 mm, 9.5 mm	± 7%	± 6%
Aggregate passing 4.75 mm	± 6%	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 5%	± 4%
Aggregate passing 0.3 mm, 0.15 mm	± 4%	± 3%
Aggregate passing 0.075 mm	± 2%	± 1.5%
Binder content	± 0.3%	± 0.3%
Mixing temperature	± 10°C	± 10°C

Once the plant trials have demonstrated the capacity of the plant, and the trials are approved, the laying operation may commence. Over the period of the first month of

production for laying on the works, the Engineer shall require additional testing of the product to establish the reliability and consistency of the plant.

Table 2100-11: Manufacturing and rolling temperatures

Bitumen Penetration	Bitumen mixing (°c)	Aggregate mixing (°c)	Mixed Material (°c)	Rolling (°c)	Laying (°c)
35	160 – 170	160 – 175	170 Max.	100 Min.	130 Min.
65	150 – 165	150 – 170	165 Max.	90 Min.	125 Min.
90	140 – 160	140 – 165	155 Max.	80 Min.	115 Min.

2104.5.2 Laying Trials: Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid, and compacted all in accordance with the clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing, by the Engineer.

The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of the project road, and shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

#### 2104.6 CONSTRUCTIONS OPERATIONS

The methodology and plant to be used for the whole project should be based arrived after plant and laying trials for the job mix ratio, which should be based on a correct and truly representative sample of the materials that will actually be used in the work, and that its different ingredients satisfy the physical and strength requirements of these specifications.

2104.6.1 Weather and Seasonal Limitations: Laying shall be suspended while free standing water is present on the surface to be covered, or during rain, fog and dust storms. After rain, the bituminous surface, prime or tack coat shall be blown off with high pressure air jet to remove excess moisture, or the surface left to dry before laying shall start. Laying of bituminous mixture shall not be carried out when the air temperature at the surface on which it is laid is below 10degC, or when the wind speed at any temperature exceeds 40 km/h at 2m height unless specifically approved by the engineer.

2104.6.2 Preparation of Base, prime coat and tack coat: The base on which the dense Graded bituminous material is to be laid shall be thoroughly swept clean by a mechanical broom and the dust removed by compressed air. In locations where mechanical broom cannot access, other approved methods shall be used as directed by the engineer. The prime coat and tack coat as per requirements shall be applied in accordance with their respective specifications, or as directed by the engineer.

2104.6.3 Mixing and Transportation of the mixture at site or from any other certified source approved by the concern agency: The premixed bituminous material for DBM shall be prepared in a hot-mix plant of adequate capacity and capability of yielding a mix of proper and uniform quality with thoroughly coated aggregates at appropriate mixing temperatures; the difference in temperature between the binder and the aggregate at no time should exceed 14 deg C.

The hot mix plant should be calibrated from time to time in order to ensure the uniform quality of the mix and better coating of aggregates.

The bituminous material should be transported in clean insulated vehicles, and unless otherwise agreed by the engineer, shall be covered while in transit or waiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate the discharge of the material.

2104.6.4 Spreading: Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver, and its method of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and leveled with suitable hand tools by experienced staff, and compacted to the satisfaction of the engineer. The maximum thickness of material laid in each paver pass shall be 150 mm. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop short 300 mm short of the joint. The remainder of the pavement up to the joint, and the

corresponding area beyond it, shall be laid by hand, and the joint or the joint cavity shall be kept clear of surfacing material.

Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a binder course is to be sealed or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated the contractor shall make it good to the satisfaction of the engineer. Binder course shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the contract, for more than three consecutive days after being laid. The Engineer may extend the period by minimum amount of time necessary, because of weather conditions or for any other reason.

2104.6.5 Rolling: Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved. Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperature (?).

Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the centre longitudinally except that on super-elevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth wheeled rollers. The intermediate rolling shall be done with 8 – 10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sq.cm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers. Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver.

The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300 mm. Rollers shall move at a speed of not more than 5km/h. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign material on the pavement either when the rollers are operating or standing. The wheels of the rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of the rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

Where longitudinal joints are made, the materials shall be fully compacted and the joint made flush. All joints shall be offset by at least 300 mm from parallel joints in the

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layer beneath or as directed, and in a layout approved by the engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate.

2104.6.6 Opening to traffic: The newly laid surface shall not be open to traffic for at least 24 hrs after laying and completion of compaction, without the express approval of the Engineer in writing.

#### *2104.7 MEASUREMENT*

The finished work shall be measured in sq.m at a specified thickness correct to two places of decimal.

#### *2104.8 RATE*

The rate shall include the cost of materials and labour required to carry out all the operations.

### **2105 ASPHALT CONCRETE**

#### *2105.1 SCOPE*

This clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

#### *2105.2 SOURCE OF MATERIAL*

The sources of materials proposed to be used by the Contractor shall be tested to the satisfaction of the Engineer who shall give the necessary approval. The Engineer may from time to time withdraw approval of a specific source, or attach conditions to the existing approval. Any change in aggregate source for bituminous mixes shall require a new mix design, and laying trials, where the mix is based on a job mix design. Stockpiles from different sources approved or otherwise, shall be kept separate, such that there is no contamination between one material and another. Each source submitted for approval shall contain material sufficient for at least 5 days' work.

2105.2.1 Bitumen: The bitumen shall be paving bitumen of penetration grade complying with IS Specification for paving Bitumen, IS: 73 and of the penetration indicated in the table 1 (requirements for Paving Bitumen), for bituminous concrete, or as otherwise specified in the contract.

2105.2.2 Coarse aggregates: The coarse aggregates shall be generally as specified for DBM, except that the aggregates shall satisfy the physical requirements of Table 2200.5

Table 2100 12: Physical Requirements for coarse aggregate for bituminous concrete pavement layers

Property	Test	Specification
Cleanliness(dust)	Grain size analysis	Max 5% passing 0.075 mm sieve.
Particle shape	Flakiness and Elongation Index	Max 30%(Combined)
Strength	Los Angeles Abrasion Value	Max 30%
	Aggregate Impact Value	Max 24%
	Polished Stone Value	Min 55
Polishing		
Durability(Soundness)	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water Absorption	Max 2%
Stripping	Coating and Stripping of	Minimum retained coating
	Bitumen Aggregate Mixtures	95%
	Retained Tensile Strength	Min 80%
Water Sensitivity		

2105.2.3 Fine Aggregates: The fine aggregates shall be as for DBM.

2105.2.4 Filler: Filler shall be generally as specified for DBM. Where the aggregates fail to meet the requirements of the water sensitivity test in table 2000-5, then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

## 2105.2.5 Aggregate grading and binder content:

When tested in accordance with IS:2386 Part I (wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in table 2100-13 for grading 1 to 2 as specified in the contract.

Table 2100-13: Composition of Bituminous Concrete Pavement Layers.

Grading	1	2
Nominal aggregate size	19mm	13mm
Layer thickness	50 - 65mm	30 – 45mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5	100	
19.0	79 – 100	100
12.26	59 – 79	79 - 100
9.50	52 – 72	70 – 88
4.75	35 – 55	53 – 71
2.36	28 – 44	42 – 58
1.18	20 – 34	34 – 48
0.60	15 – 27	26 – 38
0.30	10 – 20	18 – 28
0.15	05 – 13	12 – 20
0.075	02 - 08	04 – 10
Bitumen content % by mass of total mix	5.0 – 6.0	5.0 – 7.0
Bitumen Grade	65	65

2105.2.6 Binder Content: The binder content shall be optimized to achieve the requirements of the mixture set out in table 2100-14 below, and the traffic volume as specified in the contract.

Table 2100-14: Requirements for bituminous pavement layers

Minimum stability (KN at 60°C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen.
Percent air voids	3-6
Percent air voids in mineral aggregate (VMA)	see table 1.5
Percent air voids filled with bitumen (VFB)	65-75
Loss of stability on immersion in water at 60°C (ASTMD 1075)	Minimum 75 percent retained strength.

### 2105.3 MIXING

2105.3.1 Requirements for the mixture: Apart from the conformity with the grading and quality requirements for individual ingredients, the Pre-mixed bituminous materials shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates.

Appropriate mixing temperatures are given in Table 2100-15 of these Specifications. The difference in temperature between the binder and aggregate shall at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time. The essential features of the hot mix plants are given in Annex A of IRC: 27.

Table 2100-15: Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree Celsius)

Bitumen Viscosity	Bitumen Temperature	Aggregate Temperature	Mixed Material	Laying Temperature	Rolling Temperature
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Grade			Temperature		
VG – 40	160 – 170	160 – 175	160 – 175	150 min	100 min
VG – 30	150 – 165	150 – 170	150 – 165	140 min	90 min
VG – 20	145 – 165	145 – 170	145 – 165	135 min	85 min
VG - 10	140 - 160	140 – 165	140 – 160	130 min	80 min

*Rolling must be completed before the mat cools to these minimum temperatures.*

The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

#### 2105.4 JOB MIX FORMULA

The procedure for formulating the job mix formula shall be generally as specified in DBM.

##### 2105.4.1 Plant trials – permissible variations in job mix formula:

The requirements for the plant trials shall be all as specified for DBM, and permissible limits for variation as shown in table 2100-10 in DBM.

##### 2105.4.2 Laying trials:

The requirements for laying trials shall be all as specified for DBM.

#### 2105.5 Construction operations

The methodology and plant to be used for the whole project should be based arrived after plant and laying trials for the job mix ratio, which should be based on a correct and truly representative sample of the materials that will actually be used in the work, and that its different ingredients satisfy the physical and strength requirements of these specifications.

Weather and seasonal limitations: The provisions as in DBM shall apply.

Preparation of base: The surface on which the bituminous concrete is to be laid shall be prepared as in DBM, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods

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shall be used as directed by the Engineer. Mixing and transportation of the mixture: The provisions as specified in DBM shall be applied.

Spreading: The general provisions as in DBM shall apply, as modified by the approved laying trials.

#### *2105.6 MEASUREMENT*

The measurement shall be as specified in DBM.

#### *2105.7 RATE*

The contract unit rate shall be all as specified in DBM, except that the rate shall include the provision of bitumen at 5.0 percent, by weight of total mixture. The variance in percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

**2200 ELECTRIFICATION****2201 GENERAL***2201.1 INTRODUCTION*

All the works related to Equipment and Facilities shall be carried out as per latest national and international standards and codes, with amendments issued up to the date of submission of bid. In case the relevant specifications are not found applicable and adequate than the relevant BIS specifications shall be used. Further in case, any of these are not applicable to particular, Equipments and Facilities, then the manufacturer's specifications or their relevant instructions shall be followed.

*2201.1.1 LIGHTING SYSTEM**2201.1.2 DRAWINGS AND DATA*

- a) The contractor shall furnish relevant descriptive and illustrative literature on lighting fixtures and accessories dimensioned drawings/ data for the respective lighting fixtures with manufacturer's catalogue numbers.
- b) It shall be the responsibility of the contractor to work out detailed layouts in order to provide the level of installations as indicated under Design Criteria and shall be furnished for the approval of the Engineer before commencement of installation.

*2201.1.3 GENERAL REQUIREMENTS*

The Lighting system includes the following items:

- Lighting fixtures complete with Lamps and accessories
- Lighting system equipment
- Light control switches, receptacle units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system

- Lighting fixture supports, street lighting poles and flood light towers
- Lighting main distribution board, lighting panels.
- Multi core cables for street, boundary and flood lighting
- Provision of automatic on-off road switches through solar system

#### 2201.1.4 DESIGN REQUIREMENTS

It shall be responsibility of the contractor to work out a detailed layout for different units/areas in order to provide the standard levels of illumination. The contractor shall be responsible for measuring the levels of illumination after installation and establish compliance with the specification.

The design, manufacture and performance of equipment shall conform to the latest amended Indian standards and following design and general criterion as given below:

Project Title	:	Land Customs Station	
Location	:	Pasakha	
Nearest Railway Station	:	Jaigaon	
Access Road	:	All weather roads available	
Airport	:	Bagdogra	
Altitude	:	160 m	
Rain Fall	:	Annual	: 1700 mm
		Max. 24 hrs.	: 345 mm
		Period	: Major portion from June to August
Temp. at site	:	Max. 40°C	
		Min. 10°C	
Nominal system supply	:		
1. Incoming power	:	11KV, 3Ø, 3W, 50Hz	
2. Power	:	11KV/ 415V, 3Ø, 4W	

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- |              |          |
|--------------|----------|
| distribution | 50Hz, AC |
|--------------|----------|
3. Lighting & space
 

heating	:	240V, 1Ø, 2W, 50HzAC
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  4. D.C. Controlling : 30V and 24V D.C
  5. A.C. Control : 240V A.C
  6. P T Secondary : 110V, 3 Phase, 50 Hz A.C
  7. Variation in
 

Voltage	:	± 10%,
Frequency	:	± 5%
Combined Voltage and		
Frequency	:	± 10%,
  8. System Earthing :
    - a) 11KV System : Wherever generation is taking place at 11 KV, this will be earthed through resistance.
    - b) 415V system : Neutral solidly earthed
    - c) 240V Single Phase : Neutral solidly earthed
    - d) 30V D, C, System : Unearthed

#### 2201.2 LIGHTING FIXTURES

##### 2201.2.1 luminaries

Luminaires shall be designed for continuous trouble-free operation without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fitting shall be weather-proof and rain proof type conforming to minimum IP-54 protection.

The luminaries shall be designed so as to facilitate easy maintenance including cleaning, replacement of lamps/ starters etc.

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Connections between different components shall be made in such a way that they will not work loose by small vibration.

All luminaries shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage and frequency indicated in the Employer's Requirement.

LED with accessories like lamps, power factor improvement capacitors, starters, re-wire able fuse and fuse base. These shall be mounted as far as possible in the luminaire housing only. If these cannot be accommodated integral with the Luminaires then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop-out connections. Outdoor type fixtures shall be provided with outdoor type weather-proof box. No mercury vapour lamps shall be used indoor & outdoor lighting. Mainly sodium vapour lamps shall be used for outdoor lighting.

LED Luminaires with single or double lamp shall be provided with electronic ballasts and these luminaire shall be used up to maximum height of five meters.

Each luminaire shall have a terminal block suitable for loop-in loop-out and T-off connection by 250/ 400V, 1 core, PVC insulated copper/ aluminium conductor wires up to 4 sq.mm. in size. In outdoor areas the termination at the luminaire shall be suitable for 1100V, PVC insulated, copper/ aluminium conductor, armoured cables of sizes upto 6 sq.mm. alum. conductor or suitably sizes cable as per design. Terminals shall be of stud or clamp type. The internal wiring shall be by means of insulated copper wire of minimum 1.5 sq.mm. size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.

Mounted facility and conduit knock-outs for the luminaries shall be provided.

### **2201.3 EARTHING**

Each Luminaire and control gear box shall be provided with an earthing terminal. All metal or metal enclosed parts of the luminaire/ control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity

### **2201.4 PAINTING/ FINISH**

All surfaces of the luminaire control gear housing accessories shall be thoroughly cleared and degreased. It shall be free from scale, rust, sharp, edges and burrs.

The luminaire housing shall be stove-enamelled/ epoxy stove-enamelled - vitreous enamelled or anodized as indicated under various types of fittings.

Flame proof luminaries shall be considered in all gas handling and other hazardous areas along with its control gear.

#### 2201.5 SODIUM VAPOUR LUMINAIRES

- i) Flood Light Luminaire
- ii)
  - a) General purpose flood Light Luminaire

Flood Light luminaries shall be of weather proof construction with cast aluminium housing, anodized aluminium mirror polished reflector, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust.

The housing shall be supported on a cast iron base and capable of being swivelled in both horizontal and vertical directions and locked in any desired position.

For focusing purposes, knobs, shall be provided along with sector plate indicating the angle in degrees between 0-90 degrees, in vertical direction.

The Luminaires shall be suitable for single and dual sodium vapour lamps up to 400 watts. When or sodium vapour lamp specified, the same shall be mounted in a separate sheet metal enclosed/ cast aluminium weather proof control gear box.

The luminaire shall be provided with cable gland on the canopy in down ward direction for cable connection.

It shall be possible to adjust the lamp position to achieve wide beam, medium beam or narrow beam.

It shall be possible to replace the lamp from the canopy without opening the front glass.

- b) Outdoor Lantern Luminaires Post top Lantern

Post top lantern Luminaires shall be generally outdoor weather proof type of illumination of walkways, gate posts, gardens or in front of office area only.

The luminaire shall have cast aluminium spigot of 50/60 diameter finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

## iii) Street Lighting Luminaires

## a) Sodium vapour luminaries

Street light sodium vapour luminaries shall be outdoor weather proof type for illumination of main roads, traffic islands etc.

The Luminaire shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with near pipe entry.

The luminaire shall be suitable for 1 x 70W sodium vapour lamp and for mounting heights up to 9 meters from natural ground level.

## b) Emergency Light Luminaires

Emergency light of installite luminaire shall be indoor type for providing emergency light during failure of normal AC supply.

The luminaire shall be with CRCA sheet steel enclosure, complete with metallised mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/ relay, two meter length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaire.

The luminaire shall be suitable for connection to 240V, 50 Hz single phase supply. On failure of normal A.C supply the luminaire shall pick-up automatically and on restoration of A.C supply the luminaire shall switch off automatically. The luminaire shall be suitable for flurescent lamp up to 20 watts.

## iv) Accessories For Luminaires

## a) Reflector

The reflectors shall be made of CRCA sheet/ aluminium/ silvered glass/ chromium plated sheet copper as indicated for above mentioned luminaries.

The thickness of steel/ aluminium shall comply with relevant standards. Reflectors made of steel shall have vitreous enamelled finished. Aluminium used for reflector shall be anodized/ epoxy stove enamelled/ mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.

Reflectors shall be free from scratches or blisters and shall have smooth and glossy surface. Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of



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tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

b) Ballasts (Electronic)

The ballasts shall be designed to have a long service life, low power loss & high power factor. Ballasts shall be mounted using self-locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non-combustible enclosures. Electronic ballast shall have very high power factor (more than 0.95) and harmonic distortion shall be less than 10%.

Voltage variation of ballast shall be between 140-320V.

c) Lamps

High intensity discharge lamp: These lamps include high pressure metal halide lamps and high pressure sodium vapour lamps. High pressure sodium vapour lamp shall be with polycrystalline translucent, coated discharge tube, coated shell, quick restrike time (of within 5 minutes) and with burning life (above 10,000 hours) in standard rating up to 400 watts.

v) Lighting System Equipment

Main Lighting Distribution Boards and Lighting Panels (AC & DC)

Construction Features

Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP-52. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP-55. The sheet steel used for frame shall be cold rolled of 2.0mm thick or 2.5 mm hot rolled and all frame enclosures, doors, covers along with partitions will be of same thickness.

All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets. For the main floor mounted distribution boards with the switch fuse units arranged in tier formation, the hinged door of each unit shall be interlocked so as to prevent opening of the door when the switch is ON and to prevent closing of the switch with door not fully closed. However, a device for by-passing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination/ maintenance. For wall mounting 1- phase ways lighting panels wherever provided with MCBs, arranged latched front door shall be provided with key-locking facility and slotted

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bakelite sheet shall be provided inside. Only the MCBs operating knobs or the fuse cap covers shall project out of the bakelite sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with TPN MCB with RCCB. Lighting panels shall be manufactured with 1.6 mm cold rolled sheet.

All accessible live connections/ metals shall be shrouded and it shall be possible to change individual fuses, switches, MCBs from the front of the boards panels without danger contact with live metal.

For floor mounting type distribution boards, adequately sized mounting channel shall be supplied and for wall/ column/ structure mounting type panels suitable mounting straps shall be provided.

Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/ bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

Two earthing terminals shall be provided.

All sheet steel parts shall be undergoing rust-proofing process which should include degrading de-scaling and a recognized phosphating process. The steel works shall be then painted with two coats of Zinc-chromate primer and two coats of final stove-enameled finish paint of specified colours.

vi) 415V, 3 Phase Switch Socket Outlets (Receptacles):

Switch socket outlets shall be suitable for operation on 3 phase, 4 wire, 50 Hz supply system. The switches and sockets shall conform to relevant standards. These units shall be housed in epoxy painted sheet steel boxes and shall be suitable for outdoor installation. The units shall be fed from power distribution boards / switchgear etc. located in relevant areas.

vii) Receptacles (Lighting and Small Power ) :

Decorative and industrial type receptacle (receptacle means a combination of a socket and a switch) units of approved make with switches shall be supplied. The units shall be suitable for mounting flush or within painted sheet steel boxes. Decorative receptacles shall be 5A / 15A rated with 5 pin sockets and 15A switches. Industrial receptacles shall be of 20A rating along with MCB.

2201.5.1 Samples

Contractor shall be required to obtain EMPLOYER approval for samples of items such as lighting fixtures of each type, ceiling fans, switch socket outlets of each type and rating, light/fan control switch of each type and rating, push buttons, conduits of various sizes, junction boxes, cable trays, wires and earthing conductor to be used for lighting system etc. before commencement of installation work.

#### 2201.6 INSPECTION, PRE-DESPATCH INSPECTIONS AND TESTING BY EMPLOYER

- i) The Employer reserves the right for pre- dispatch inspection of Equipment at the manufacturer's place in India or abroad by the representatives of the EMPLOYER along with Contractor or his/their representatives. The total cost of to & fro by Air or any other better conveyance charges, wherever the air routes are not available, boarding and lodging etc., shall be borne by the Contractor. In case the equipment's are not found suitable for despatch or whatsoever the defects may be, and another inspection is required that visit also shall be arranged and borne by the contractor. The EMPLOYER shall not entertain any request on this account; even such inspection may be one or more, as may be required, before the dispatch of the Equipments. The discrepancies of such equipments as pointed out by the representatives of the EMPLOYER shall be rectified at the cost of the Contractor or the Manufacturer and the EMPLOYER shall not hold any liability on this account, what so ever may be.
- ii) A mutually agreed quality assurance plan will be developed which provides for inspection and certification by EMPLOYER at specified times during the negotiations for such items. All costs for independent inspection or testing will be borne by the Contractor, and the Contractor shall be fully responsible to ensure that adequate provisions are made in his tendered rates to cover independent inspections and testing for the following equipments and facilities to be incorporated in the Permanent Works:

Sl. No	Name of the Equipment	Stages of inspection
1.	Weighbridge	1. Visual check-up.  2. All the manufactures test certificates shall be submitted. If EMPLOYER desires any test, contractor shall arrange to perform the same at no extra cost.
2.	DG set	
3.	Fork Lift Trucks	
4	Others	

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In addition to these the contractor shall carry out test of the other equipment in the presence of EMPLOYER engineers and shall submit test certificates for approval.

#### *2201.7 GUARANTEE*

- i) The Contractor shall guarantee all Equipment and Fittings and their equipment's supplied under the Contract, including erection and commissioning works, to be suitable for the application for which it is designed, and against defects due to manufacture or poor workmanship for a period of 12 months from the date of satisfactory completion of the stipulated trial run period. The Contractor shall be responsible to replace, free of cost, the whole equipment or parts thereof which may be found defective during this period, and to ensure the proper working of the equipment during the guarantee period. In case the Contractor fails to repair or replace any defective Equipment & Fittings and equipment or part(s) thereof within 30 days from the date of intimation of any defects by the Engineer, the same will be done by the EMPLOYER/Engineer at the Contractor's cost.
- ii) If it becomes necessary for the Contractor to replace or renew any defect of equipment under this Sub-Clause, the equipment and fittings, so replaced and the work so renewed shall be guaranteed for a further period of 6 months from the date of replacement or renewal or until the end of the 12 month general guarantee period, whichever may be later. Only genuine spare parts are to be used under the supervision and with approval of Engineer.

#### *2201.8 CERTIFICATES AND DRAWINGS FOR ELECTRICAL INSTALLATIONS*

The Contractor shall furnish all the necessary data, drawings, layouts and test certificates, etc., as may be required by the power distribution agency and the Electrical Inspectorate Authorities in respect of all electrical installations, and shall obtain any required approvals or clearances therefrom. Necessary assistance will be given by the EMPLOYER in this respect. It would be obligatory on the part of the Contractor to obtain such sanctions and approval of the electrical load from the concerned authorities.

#### *2201.9 DISPLAY PANELS*

The Contractor shall provide such charts and drawings as are be appropriate to clearly illustrate the process, operation and maintenance requirements of the Equipment and facilities provided under the Contract. Such charts and drawings

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shall be mounted on a panel, protected with a glass cover, and affixed on to the wall(s) of the pump house/control room, as the case may be, and shall include, as appropriate, the following:

- General arrangement drawings.
- Wiring diagrams and detailed drawings of all electrical and mechanical installations.
- Assembly drawings for electrical and mechanical equipment.
- Charts indicating operations and maintenance details and schedules for electrical and mechanical equipment.
- Lists of commonly used spare parts and tools

#### *2201.10 INSTALLATION OF EQUIPMENTS & FITTINGS*

In case of all Equipment & and fittings etc., the tendered rate shall include the costs of supplying, installation/erection, fixing in position, testing and commissioning etc. at the site of work. No extra charges shall be payable on this account by the EMPLOYER.

6 sets of completion drawings, complete set of equipment brochures, dimensional details, approved drawings, installation manuals, pre commissioning tests, commissioning tests, shall be kept & made available at site for inspection of EMPLOYER officers. These sets will be given to Engineer before commencement of supply/erection of equipment.

#### *2201.11 FIRE EXTINGUISHERS*

The Bidder shall provide required atleast 1 number of Foam type fire extinguishers (10 kg) for each of the warehouse and sheds at the suitable locations after consultation with the Employer's Representative:

Besides above CO2 type fire extinguisher is also required to be provided at the admin and service building of appropriate number in consultation with Employer.

- A. General: Provide fire extinguishers throughout in quantity and type as required by the referenced standards and as indicated herein and on the Drawings. Provide fire extinguisher cabinets where indicated. Provide a fire extinguisher for all fire extinguisher cabinets.
- B. Manufacturers: Subject to compliance with requirements, provide products of the following, No Substitutions:

1. Fire Extinguishers. Multi-purpose and water extinguishers shall be Amerex, no substitutions.
  - a. Multi-Purpose (ABC) Amerex Models B402, B402T, B443 or B461
  - b. As required, in addition to the Multi-purpose extinguisher provide an Amerex Model 240 water extinguisher
  - c. As required, in addition to the Multi-purpose extinguisher, provide a Type K extinguisher an Amerex Model 693X
  - d. As required, in addition to the Multi-purpose extinguisher, provide a Type D extinguisher from Amerex, JL Industries, or Larsen's
  - e. As required, in addition to the Multi-purpose extinguisher, provide a Clean Agent extinguisher from Amerex, JL Industries, or Larsen's
2. Fire Extinguisher Cabinet
  1. Construction: Manufacturer's standard steel box, trim frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
  2. Cabinet Type: Provide cabinets suitable for mounting conditions indicated, as follows:
    - a. Recessed: Cabinet box (tub) fully recessed in wall of sufficient depth to accommodate manufacturer's flat style trim or trim shown on Drawings, if indicated.
    - b. Semi-recessed: Cabinet box semi-recessed n wall of sufficient depth to accommodate manufacturer's rolled edge semi-recessed trim or trim shown on Drawings, if indicated.
    - c. Recessed and Fireproof: Same as recessed type, except cabinet to be UL or Warnock-Hersey listed for 1-hour fire-rated wall or 2-hour fire rated wall installation.
    - d. Surface: Manufacturer's standard cabinet box and mounting system with square trim.
3. Cabinet Doors:

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- a. Manufacturer's standard door construction, vertical duo style with double strength glass, door pull, roller catch, continuous hinge and 180 degree swing.
  - b. For loading docks, parking garages, and throughout residential buildings, provide manufacturer's standard break-glass design, vertical duo style window, with ASTM C1048 Type 1 Quality q3, Class 1 glass for break-glass design, lever cylinder lock assembly keyed to Cat 30 Corbin, continuous hinge and 180 degree swing.

#### 2201.11.1 INSTALLATION

- A. Verify all recesses in walls for fire extinguisher cabinets comply with manufacturer's instructions and backing is provided for fire extinguisher brackets.
- A. Install fire extinguishers at a standard mounting height of 48 inches AFF to the top of the extinguisher, unless otherwise shown on the Drawings.
  - 1. In no case shall the top of an extinguisher be higher than 60 inches AFF or the bottom of an extinguisher closer than 4 inches AFF per NFPA 10.
- B. Securely fasten mounting brackets, fire extinguisher cabinets, signs, and other accessories to the construction square, plumb, and in compliance with the manufacturer's instructions and as shown on the Drawings, or as directed herein.
- C. Fire extinguishers shall be furnished no earlier than sixty (60) days and no later than fourteen (14) days, prior to the scheduled date for Substantial Completion.

#### 2201.12 FIRE HYDRANT

##### Sluice Valves / Gate Valves

#### 2201.12.1 General

The sluice valve will confirm to BIS: 780 / BIS: 2906, for selection & installation of sluice valve BIS: 2685. The material to be supplied under this sub-section shall include but not be limited to the following:

- All necessary fittings including bolts, nuts, gaskets, backing rings, counter flanges, jointing material, strainers etc. as required.
- This section covers the requirements for non-rising stem type sluice valve from 80 mm to 200 mm size.
- The valves will be used for water supply on line installations in upright positions, up to 45° C working temperature, with double flange and cap or hand wheel, for manual operation.

#### 2201.12.2 Nominal Pressure and Dimensions

The working pressure of the valves shall be 10 kg/cm<sup>2</sup> (1.0 MPa) unless otherwise mentioned. The dimension and mass of the sluice valves shall be in accordance with BIS: 780 for sizes from 50 to 300 mm. The flanges and their dimensions of drilling shall be in accordance with BIS: 1538 (part-I to XXII).

#### 2201.12.3 Features of Sluice Valve

##### Material

The material for different components parts of sluice valve shall conform to requirements given below:

Sl No.	Component	Material	Ref. to BIS	Grade / designation
1	Body, bonnet, wedge, stuffing box, gland, thrust plate, hand wheel cap. etc.	Grey cast iron	210	FG 200
2	Stem	Stainless steel	6603	AISI 431, AISI 410
3	Wedge nut	Leaded tin bronze	318	LTB 2
4	Body seat ring, wedge facing ring	Leaded tin bronze	318	LTB 2
5	Bolt	Carbon steel	1363	Class 4.6
6	Nut	Carbon steel	1363	Class 4



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7	Bonnet gasket	Compressed fibre board	2712	C
8	Gland packing	Asbestos	4687	nil

#### 2201.12.4 Coating

All sluice valves shall be coated by dipping in a bath of tar base composition as given in Clause 7 of BIS: 780 for sizes from 50 mm to 300 mm. All components susceptible to corrosion attack shall be coated internally and externally. Protective coating shall always be applied to the individual components before they are assembled, following shot blasting to give good adhesion.

#### 2201.12.5 Marking, Testing and Inspection

The standard marking and packing of the valves shall be done as per Clause 10 and 11 of BIS: 780. The direction of rotation for OPEN, CLOSE position shall be marked on the hand wheel and on the bonnet of the valve. The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

Testing of sluice valve shall be done for close end in accordance with BIS: 780 for sizes from 50 mm to 300 mm. All the valves shall be inspected for flaw detection test in accordance with BIS: 780. for sizes from 50 mm to 300 mm. During testing there shall be no visible evidence of structural damage to any of the valve component.

Sluice valves shall be tested as per relevant BIS standard for:

- Seat leakage test
- Body hydrostatic test
- Valve operation

The design, construction material, manufacture, inspection, performance and testing shall comply with

all applicable Indian Standards and Codes.

#### 2201.12.6 Hydrants and Chambers

##### 2201.12.6.1 Fire Hydrant

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The item covers supplying & fixing of Flush Type Fire Hydrant nozzle including the necessary fittings (Flanged, rubber gasket, nuts & bolts with washer etc)

Fire hydrant shall be of stainless steel or gun metallic body, single outlet, 80/100mm inlet, 63mm female coupling outlet and valve wheel conforming to IS 5290. Each valve shall flanged inlet and instantaneous type's outlet. The instantaneous outlet shall be of standard pattern suitable for fire brigade hose.

G.M. Fire Hose delivery coupling Cast iron cap permanently secured to the duck foot bend by means of a chain. Where the fire service requirement of coupling differs, the requisite coupling as shown on the Drawing shall be provided at no extra cost.

The body, spindle and other parts shall be truly machined with its surface smoothly finished. Each hydrant shall be subjected to hydrostatic test and shall prove perfectly water tight under a hydraulic pressure of required head as per the manufacturer specification.

Each hydrant shall be clearly and permanently marked with following information:

- a) Manufacturer's name or trade mark and
- b) Year of manufacture

Fire hydrants will be positioned as shown in the drawing and or as per direction of the Engineer. Pursuant to the procurement of the fire hydrant, the Contractor shall notify the Engineer of the procurement and submit necessary documents as may be deemed necessary to fulfill the requirements of the fire hydrants.

#### 2201.12.7 Hydrant / Valve Chambers

This particular item of work relates to the construction of chambers for housing Fire Hydrant, Sluice valves, Scour valves, Pressure Reducing Valves etc. at the places shown in the Drawings.

The location for construction of chambers should be at an open area and must be easily accessible.

Base course for foundations for chambers shall be in 150 mm thick Cement Concrete using 20 mm and down size metal, with hard broken granite, trap, basalt or with any other approved grade as shown in Drawing and Walls of the valve chambers shall be 2nd class brickwork with cement mortar 1:5 finished

with 12mm 1:3 Cement Mortar plaster with floating coat of neat cement from inside.

Brick walls shall be topped with bedding of PCC with 10mm down size aggregates for placing pre-cast slabs. Valve chambers will be covered with top slab constructed of RCC (1:2:4) and seated on the PCC bedding. All chambers should be provided with drainage arrangement to drain out water. Provision of draining arrangement in the valve chambers will be made as per the details shown on the drawing or as directed by the Engineer for draining purpose.

This item also includes supplying & fixing of GI Chamber covers 600mmx600mmx4mm including frames and locking arrangement complete. Unless otherwise mentioned, all Manhole Cover and frames shall be rectangular and as per drawing. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63<sup>o</sup> C and shall not be so brittle as to chip off at temperatures below 0<sup>o</sup>C. The frame shall be fixed in cement concrete of minimum M150 grade all around and finished with neat cement. The manhole cover and frame shall be painted with 3 coats of anticorrosive black bituminous paint after fixing in position.

## 2202. DIESEL GENERATOR

### 2202.1 General

- a) The diesel engine shall be of the diesel fuelled, cold starting, water-cooled or air-cooled, and speed-governed type.
- b) Preheating and pre-lubrication of the engine are requirements.
- c) The fuel consumption shall be determined in accordance with ISO 3046-1, and given in litres per kilowatt hour (l/kWh). The supplier shall also make reference to lubricating oil consumption.
- d) The diesel generator sets are foreseen to operate on isolated mini grids either alone, in modular combination with other diesel gen sets or in hybrid set-up with gen sets using renewable energy sources (e.g. PV & battery modules). They could also be used as back up supply for grid-connected systems.

Each Generator shall be supplied complete with the following items:

- A. Supply of all installation drawings and documentation, Operation and Maintenance manuals.
- B. Design, supply and warranty of:

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- a. Enclosed diesel generator sets with the given minimum kVA rating Prime rated at 240/415V, 1500/1800 rpm, comprising a diesel fueled, reciprocating, inter-cooled, prime power rated engine which is direct coupled to a three phase 400V synchronous generator;
  - b. The gen set shall be able to provide prime power on variable loads for an unlimited number of hours per year, in island operation mode, providing 110% of prime power during minimum of 1 hour per 12 hours cycle;
  - c. Completely enclosed diesel generators fully suitable for the given environment complete with sufficient space for all engine fluids, base fuel tank, noise abatement, water-air radiator, exhaust systems and all necessary controls, remote monitoring and ancillary components;
  - d. General access and protection structures;
  - e. Diesel generator earthing system;
  - f. Synchronization unit for load sharing across multiple interconnected generators (kW, kVAr),
  - g. Diesel generator control system and enhanced power management;
  - h. Fuels transfer system inclusive manual fuel transfer system from external tanks;
    - i. Factory Acceptance Testing (FAT) complete with all documentation, certificates, test
    - ii. reports;
    - iii. Remedy all defects.
    - iv. Provision of training for Operations and Maintenance staff.
    - v. Provision of Operation and Maintenance manuals.
    - vi. Provision of spare parts, and special tools.
    - vii. Provision of all signed certification (HSNO, Electrical Certification etc.) for the plant supplied.
    - viii. Warranty during the warranty period.

#### 2202.2 Rating

The diesel generators shall be prime rated with an electrical output from each diesel generator as given below :

- A. 5kVA (single phase)
- B. 10kVA (Single phase)
- C. 16kVA (single phase and three phase options)
- D. 25kVA

- E. 40kVA
- F. 60kVA
- G. 80kVA
- H. 100kVA
- I. 150kVA
- J. 200kVA
- K.250KVA

#### 2202.3 Climatological Conditions

The generators, and associated panels shall be able to operate under various climatic (i.e. tropical, semi tropical and arid) conditions and must therefore be constructed to work in difficult conditions i.e. in ambient temperatures varying between minus -15°C to plus 60°C, in altitudes from sea level up to 2,500 meters above sea level, in relative humidity conditions of up to 100%, and in sandy, dusty and/or heavy windy environment.

#### 2202.4 Operating Concept

To provide optimal fuel efficiency and maximum machine life, the supplier shall provide several generators in series to match the load profile provided in each order, (instead of one large generator which would run at high inefficiency). Additionally, should load grow beyond the capacity of the installed diesel generator(s), it shall be possible increase load capacity following a modular concept, adding multiple units to form a single combined source of electricity or mini grid. The operation concept also considers the future connection of PV modules or other RE sources (supplied by others; either with or without batteries) to the generation units. Each diesel generator unit shall be able to operate as stand-alone within the mini grid.

#### 2202.5 CONTROL SYSTEM FUNCTIONALITY

Emergency stop: An emergency stop push-button shall be provided both on the engine and on the control panel. These push-buttons shall be of the self-latching, twist-to-release type, red in colour, and at least 25 mm in diameter. Directly above each push-button, there shall be a red label indicating the function of the push-button. The button shall open the DG main breaker and shut the diesel engine down by cutting the fuel. b) Automatic Voltage Regulator (AVR): The AVR shall control the generator output voltage by three phase sensing. When operating in either the asynchronous or in the synchronous mode, the AVR' shall operate accordingly.

#### 2202.6 Diesel Engine

The first diesel unit takes over all loads. In case load is approaching a certain threshold (preset on site, e.g. 70% of nominal capacity) the second unit will be automatically switched on and synchronized. Switching off and disconnecting second unit from grid will take place when load is below a certain threshold (e.g. 60% of unit capacity). The diesel gen sets are running in isochronous or base load control mode and are adjusted to an internal speed droop.

#### *2202.7 OPERATING INSTRUCTIONS:*

The Instruction Manual shall include detailed Operating Instructions and, as a minimum, should cover starting, synchronizing, stopping, protection of circuits, automatic controls, battery charging, safety considerations, method of adjustment of speed, output voltage, control timers, etc.

Performance parameters of the generator set shall be detailed for the operator's guidance and as a minimum should cover output voltage, frequency, load, engine temperature and oil pressure nominal values and acceptable limits. Circuit drawings with component identifications shall be included for reference purposes.

#### *2202.8 COOLING*

- a) The engine shall be cooled by a pressurized radiator and shall be entirely self-contained. The radiator shall be filled with anti-freeze.
- b) Unless otherwise specified, fans of engines that are installed in an engine room shall draw air through the room and exhaust it externally. The method of driving the radiator fan (i.e. whether it is driven by electric motor or mechanical coupling to the engine) is listed in Schedule A. Electric motors will only be used for remote radiators and should be avoided where possible.
- c) A heating element operating at either UAC 230 V single-phase or UAC 400 V three-phase shall be fitted in the engine water jacket to maintain the engine at a temperature suitable for cold starting. It is a requirement that these jacket water heaters can be isolated individually for heating element change out without draining the complete engine coolant capacity.

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- d) The element terminals shall be brought out separately, such that both terminals of each heater element are available externally. The element wiring shall be terminated on a separate external terminal strip. The circuit shall be wired independently to ensure that a heater element failure will not affect the DG control system. The power to the heater element shall be thermostatically controlled to adequately regulate the engine temperature. An alarm shall be issued if the engine temperature drops below the minimum temperature specified by the supplier.

#### 2202.9 EARTHING

##### 2202.9.1 General

- a) Earthing shall be provided to meet the system protection and safety requirements for the DG Set power circuits. The minimum earth fault current dictates the generator protection settings for correct operation.
- b) The maximum earth fault current and its duration determine the cross-sectional area of the earth conductors to be used.
- c) Independent earthing is required in order to eliminate electromagnetic disturbances in control circuitry, and also to prevent mechanical damage to the shaft and bearings in the set, caused by induced and stray currents.
- d) The Employer shall design the main earth mat under the civil contract. Provision shall be made by the supplier to enable the earthing of the plant to the earth mat in the DG building.
- e) The supplier shall provide details of its specific earthing system requirements, philosophy, etc. clearly indicating the interface points to the DG building earth mat.

##### Generator neutral earthing

- a) Neutral earthing implies interconnection of the generator's neutral and the Customer's power system's neutral, which is generally earthed.
- b) Multiple earth connections can cause neutral circulating currents between parallel systems. Care shall be taken to avoid this phenomenon and the consequent unnecessary operation of the protection.

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- c) The neutral connector shall be able to carry the full earth-fault current of the generator.
  - d) The supplier shall provide protection of the generator against internal earth faults, and details of such protection shall also be supplied.

#### 2202.10 MAINTENANCE RECOMMENDATIONS:

The supplier shall provide complete maintenance procedures for all the equipment supplied. Schedules for maintenance to be affected on a daily, weekly, monthly, etc. or on hourly run basis should be included.

Guidelines for the selection of fuel oil, lubricating oil, use of water treatment additives and anti-freeze if applicable.

#### 2203. TURBO VENTILATOR

##### 2203.1 THE FEATURES OF THE PRODUCT ARE AS FOLLOWS: ·

It is free spinning roof ventilator, which works on free wind energy & provides fresh air in your roof space, working & living areas 24 hrs a day & 365 days year at zero operating cost. ·

It does not require any electrical energy unlike a regular exhaust fan. Therefore, the ventilation system pays for itself in a very short period of time. · These Wind Operated Turbo Ventilators are a combination of both Natural Forced Air Ventilation System.

It functions as a Natural Ventilator when there is a difference in thermal or wind pressure between the inside & outside of the building, which forces the air to move through the opening of the ventilator.

It also acts as a Forced Ventilation System when the ventilator rotates due to the wind velocity acting on it creating a negative pressure within the building. Cooler air from outside will rush into the negative pressure space within the building in order to maintain an equilibrium condition.

This continuous positive extraction eliminates heat, dust, fume etc. & creates a down draught into the building providing a healthier & cooler working environment thereby increasing productivity.

These are very sturdy fit & forget devices requiring no maintenance & are designed to withstand wind velocities up to 180 Kms/per hr for 1hr experienced during cyclonic storms.



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2203.2 DESIGN AND CONSTRUCTION:

- Fitted with Nylon made Typhonic Bearing
- Double top cap ensured permanent alignment in inverted cap design.
- Corrugated Foil Framed vanes gives rigidity strength, air flow and provides protection against weather change. Highly sensitive Roller Bearing Systems, Housing UPPER and LOWER Bearings
- Drives out Dust soil grit and forging material and retains complete lubrication in the unit.
- Available in fabrication from Aluminum & Stainless Steel.
- A Translucent opel base which allows 22% of natural day light inside the building (Optional).
- Impact and Trust resistant easy and quick to install.
- Light weight.

Sl. No. Description 24" Dia 21" Dia

1. Type	Turbine Air Ventilator	Turbine Air Ventilator
2. Power	Wind Driven	Wind Driven

## 2204. FIRST AIDS KIDS

Complete first aid kits at all the sites shall be provided for the maintenance bays of the pump houses. The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns bad effects of inhalation of chlorine, bad effects on skin due to contact of chemicals acids etc. Following materials in general in sufficient quantities shall be provided.

- Medical cotton, sterile cotton pads
- Cotton Bandages, elastic bandages
- Pair of scissors, packet of new shaving blades
- Sticking plaster for medical use.
- Band aid stripes

Following chemicals/medicines shall be provided in sufficient quantities:

- Tinctures iodine and mercury chrome

- Burnol ointment
- Bottles of spirit and of Dettol
- Toilet soaps

To be procured under medical advice:

- Tablets for bad-effects of chlorine inhalation
- Skin lotions and ointments for burns, acid effects
- Eye drops for soothing effects

Fire extinguisher and first aid kits shall be provided for the end of the commissioning period only. They shall not be used before and shall be complete.

## 2205 EXHAUST FAN

The quality of indoor air is always a matter of concern and especially during the winter season when most people keep the windows and the other openings in a room absolutely sealed. Filthy odor, stale and humid air, molds and mildew are the prime results of low quality or less air being circulated within the room.

The best option to keep the rooms in your house clean and healthy is to install an exhaust fan in each one of them. The fan will help eliminate the moisture build up and the level of humidity in the space. The exhaust fan ensures that the rooms have a proper ventilation system and maximum level of sanitation maintained. In the past homeowners used to have only a few fan choices, but countless options have been developed over the years to date. Exhaust fans come in different sizes and shapes, but every last design shares a few common features. Every manufacturer indicates the exhaust fans physical dimensions, which are very important because of the ceiling height constraints. The thing with exhaust fans is that unless it provides a carbon mesh filter to clean impurities in the air, it will need to pump air out through a small duct that has to be several inches across. There are a several basic specifications that an exhaust fan has, this include.

### 2205.1 SOUND LEVEL

It is important that the level of noise is low as failure to this means that the calmness of the space would be disconcerted to a great extent. The exhaust fan industry measures loudness in sones. Exhaust Fans that are considered to be quiet are those that generate 2 sones or less. The loud ones are considered to be those that generate 4 sones. Quieter designs tend to cost more for the same airflow.

### 2205.2 CAPACITY

You must always calculate the volume of the room to determine Cubic Feet per Minute (CFM). The CFM is the minimum airflow required to circulate fresh air into the room 8 times per hour. Every exhaust fan's airflow is measured in cubic feet per minute. Small exhaust fans provide 30 to 50 CFM of airflow, and larger ones providing 200 to 300 cubic feet per minute. Every other room in your house requires certain airflow for adequate ventilation.

### 2205.3 MOUNTING TYPE

Most exhaust fans are fitted directly into a ceiling beam hidden behind the drywall. For retrofits, remove the existing fan to verify that there is enough clearance above the rooms ceiling to install the exhaust fan. The type of exhaust fan you choose is defined by the way it is mounted. Some are mounted on the walls whereas others are placed on a standing placement.

### 2205.4 OPTIONAL FEATURES

Different manufacturers equip their products with varying features which may add up the cost of the exhaust fan. Whenever you begin then purchasing process you have to understand the optional features that suit you and your needs. Some exhaust fans are equipped with light fixtures which are meant to support standard luminous light bulbs. Another optional feature that you ought to consider is the heaters and heat lamps. Heaters and heat lamps are considered most by people living in colder climates. This is because fan heaters use a separate fan to blow warm air away from the unit while heat lamps emit infrared radiation.

These basic components in an exhaust fan have not changed much in the past fifty years. However, they still manage to give homeowners more variety than ever before.

**2300. QUALITY CONTROL WORKS****2301 GENERAL**

All materials to be used, all methods to be adopted and all works to be performed shall be strictly in accordance with the requirements of these Specifications. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with adequate equipment and personnel in order to carry out Quality Control for works and all the required tests as per Specifications and/or as directed by the Engineer. The provision and maintenance of the laboratory shall be as per Clause 120 and/or as directed by the Engineer. The list of equipment and the facilities to be provided shall be got approved from the Engineer in advance.

The Contractor's laboratory shall be manned by a qualified Materials Engineer/Civil Engineer assisted by experienced technicians, and the set-up should be got approved by the Engineer.

The Contractor shall carry out quality control tests on the materials and work to the frequency stipulated in subsequent paragraphs. In the absence of clear indications about method and or frequency of tests for any item, the instructions of the Engineer shall be followed.

For satisfying himself about the quality of the materials and work, quality control tests will also be conducted by the Engineer (by himself, by his Quality Control Units or by any other agencies deemed fit by him), generally to the frequency set forth hereunder. Additional tests may also be conducted where, in the opinion of the Engineer, need for such tests exist.

The Contractor shall provide necessary co-operation and assistance in obtaining the samples for tests and carrying out the field tests as required by the Engineer from time to time. This shall include provision of laboratory equipment, transport, consumables, including labour attendants, assistants in packing and dispatching and any other assistance considered necessary in connection with the tests.

For the work of embankment, sub grade and pavement, construction of subsequent layer of same or other material over the finished layer shall be done after obtaining permission from the Engineer. Similar permission from the Engineer shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

The Contractor shall carry out modifications in the procedure of work, if found necessary, as directed by the Engineer. Works falling short of quality shall be rectified/ redone by the Contractor at his own cost, and defective work shall also be removed from the site of works by the Contractor at his own cost.

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The cost of laboratory building including essential supplies like water, electricity, sanitary services and their maintenance and cost of all equipment, tools, materials, labour and incidentals to perform tests and other operations of quality control according to the Specification requirements shall be deemed to be incidental to the work and no payment shall be made for the same. If, however, there is a separate item in the Bill of Quantities for setting up of a laboratory and installing testing equipment, such work shall be paid for separately.

For testing of soils/soil mixes, granular materials and mixes, bituminous materials and mixes, cement concrete materials and mixes, aggregates, cores etc., samples in the required quantity and form shall be supplied by the Contractor at his own cost.

For cement, bitumen, steel, emulsion, road marking paint, sign boards, geo-synthetics and similar other materials where essential tests are to be carried out in the presence of Engineer at the manufacturer's plants or at laboratories other than the site laboratory, the cost of samples, sampling, testing and furnishing of test certificates shall be borne by the Contractor.

Manufacturer's test certificate together with invoice or delivery challan shall be furnished for every lot of supply apart from tests to be conducted at site laboratory for prime properties of the material like cement, bitumen, etc. Where facilities for testing of materials are not available at site laboratory the same shall be tested at an outside laboratory in the presence of the Engineer. For specialized items such as sign boards, road marking paint, etc. the Engineer may order for third party test from an approved laboratory.

The method of sampling and testing of materials shall be in accordance with the requirements of the relevant Indian Standards and these Specifications. Where they are contradicting, the provisions in these Specifications shall be followed. Where they are silent sound engineering practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contractor. The cost of all tests shall be borne by the Contractor.

The materials for embankment construction shall be got approved from the Engineer. The responsibility for arranging and obtaining the land for borrowing or exploitation in any other way shall rest with the Contractor who shall ensure smooth and uninterrupted supply of materials in the required quantity during the construction period. Similarly, the supply of aggregates and other materials for construction shall be from sources approved by the Engineer. Responsibility for arranging uninterrupted supply of materials from the source shall be that of the Contractor.

#### *2301.1 DEFECTIVE MATERIALS*

All materials which the Engineer has determined as not conforming to the requirements of the Contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials, which have been

subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with any instruction of the Engineer, the Engineer shall have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payments due to the Contractor.

#### *2301.2 IMPORTED MATERIALS*

The Contractor shall furnish a list of materials/finished products manufactured, produced or fabricated outside India which he proposes to use in the work. The Contractor shall not be entitled to extension of time for acts or events occurring outside India and it shall be the Contractor's responsibility to make timely delivery to the job site of all such materials obtained from outside India.

The materials imported from outside India shall conform to the relevant Specifications of the Contract. In case where materials/finished products are not covered by the Specifications in the Contract, the details of laboratories/establishments where tests are to be carried out shall be specifically brought out and agreed to in the Contract.

The Contractor shall furnish to the Engineer a certificate of compliance of the tests carried out along with the BIS approval. In addition, certified mill test reports clearly identified in the lot of materials shall be furnished at the Contractor's cost.

### **2302 CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY**

#### *2302.1 GENERAL*

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer, subject to the permitted tolerances described herein-after.

#### *2302.2 HORIZONTAL ALIGNMENT*

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of  $\pm 10$  mm there from. The corresponding tolerance for edges of the road way and lower layers of pavement shall be  $\pm 25$  mm.

#### *2302.3 SURFACE LEVELS*

The levels of the sub grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in Table 2300-1.

Table 2300-1: Tolerances in Surface Levels

Sl.No.	Particulars	Tolerance
01	Sub-grade	± 20 mm
02	Sub-base	
	a) Flexible pavement	± 10 mm
	b) Concrete pavement	± 06 mm
	Base-course for flexible pavement	
	a) Bituminous Base/Binder course	± 06 mm
	b) Granular	
03	i) Machine laid	± 10 mm
	ii) Manually laid	± 15 mm
	Wearing course for flexible pavement	
04	a) Machine laid	± 06 mm
	b) Manually laid	± 10 mm
05	Cement concrete pavement	± 05 mm

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than the following limits:

- 10 mm for bituminous wearing course of thickness 40 mm or more
- 3 mm for bituminous wearing course of thickness less than 40 mm
- 5 mm for concrete pavement slab

For checking compliance with the above requirement for sub-grade, sub-base and base course, measurements of the surface levels shall be taken on a grid of points

placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

For checking the compliance with the above requirement for bituminous wearing courses and concrete pavements, measurements of the surface levels shall be taken on a grid of points spaced at 6.25 m along the length and at 0.5 m from the edges and at the centre of the pavement. In any length of pavement, compliance shall be deemed to be met for the final road surface, only if the tolerance given above is satisfied for any point on the surface.

#### 2302.4 SURFACE REGULARITY OF PAVEMENT COURSES

The longitudinal profile shall be checked with a 3 metre long straight edge/moving straight edge as directed by the Engineer at the middle of each traffic lane along a line parallel to the centre line of the road.

The maximum permitted number of surface irregularities shall be as per Table 2200-2.

Table 2300-2: Maximum Permitted Number of Surface Irregularities

	Surfaces of Carriageways and Paved Shoulders				Surfaces of Lay-bys, Survive Areas and all Bituminous Base Courses				
Irregularity	4mm		7mm		4mm		7mm		
Length (m)	300	75	300	75	300	75	300	75	
Number of Surface Irregularities on National Highways /Expressways	15		9	2	1	40	18	4	2
Number of Surface Irregularities on Roads of Lower Category	40		18	4	2	60	27	6	3

Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 m when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

- ❖ for pavement surface (bituminous and cement concrete) 3mm
- ❖ bituminous base courses 6mm



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❖ for granular sub-base/base courses	8mm
❖ for sub-bases under concrete pavements	10mm
❖ for subgrade	15mm

**2302.5 RECTIFICATION**

Where the surface regularity of sub grade and the various pavement courses fall outside the specified tolerances in Clause 902.4, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

- i. Sub grade: Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305
- ii. Granular Sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the Requirements of Clause 40 .
- iii. Lime/Cement Stabilized Soil Sub-base: For lime/cement treated materials where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. However, where the surface is low, the same shall be corrected as described herein below. For cement treated material, when the time elapsed between detection of irregularity and the time of mixing of the material is less than 2 hours, the surface shall be scarified to a depth of 50 mm, supplemented with freshly mixed materials as necessary and compacted as per the relevant specification. When this time is more than 2 hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to Specification. This shall also apply to lime treated material except that the time criterion shall be 3 hours instead of 2hours.
- i) Water Bound Macadam/Wet Mix Macadam Sub-base/Base: Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and re compacted as Clause 402 in the case of Wet Mix Macadam.
- ii) Bituminous Constructions: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat, if needed, and recompacting as per specifications. Where the surface is high, the extra thickness in the affected layer shall be removed and replaced with fresh

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material and compacted to Specifications. For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 min length and not less than 3.5 m in width.

- iii) Dry Lean Concrete Sub-Base: The defective length of the course shall be removed to full depth and replaced with material conforming to Clause 501. The area treated shall be at least 3 m long, not less than 1 lane width and extend to the full depth. Before relaying the course, the disturbed subgrade or layer below shall be corrected by levelling, watering and compacting.
- iv) Cement Concrete Pavement: The defective areas having irregularity exceeding 3 mm but not greater than 6 mm when tested with a 3 metre long straight edge may be rectified by scrubbling or grinding using approved equipment. When required by the Engineer, areas which have been reduced in level by the above operation(s) shall be retextured in an approved manner either by cutting grooves (5 mm deep) or roughening the surface by hacking the surface. If high areas in excess 6 mm or low areas in excess of 3 mm occur, exceeding the permitted numbers and if the Contractor cannot rectify, the slab shall be demolished and reconstructed at the Contractor's expense and in no case the area removed shall be less than the full width of the lane in which the irregularity occurs and full length of the slab. If deemed necessary by the Engineer, any section of the slab which deviates from the specified levels and tolerances shall be demolished and reconstructed at the Contractor's cost.

#### 2302.6 RIDING QUALITY

The riding quality of bituminous concrete wearing surface, as measured by a standard towed fifth wheel bump integrator, shall not be more than 2000 mm per Km.

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**2400 MATERIALS FOR STRUCTURES****2401 GENERAL**

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work.

If any material, not covered in these Specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Engineer.

**2402 SOURCES OF MATERIALS**

The Contractor shall identify the sources of materials like coarse aggregate and fine aggregate and notify the Engineer regarding the proposed sources prior to delivery. Samples of materials from the source shall be tested in the presence of Engineer for conformity to specifications. It shall also be ensured that the variation in test results of different samples is within acceptable limits.

For manufactured items like cement, steel reinforcement and pre-stressing strands, the contractor shall intimate the Engineer the details of the source, testing facilities available with the manufacturer and arrangements for transport and storage of material at site.

If directed by the Engineer, the contractor shall furnish samples and test results of recently received material. The Engineer, at his discretion, in case of doubt, may require the contractor to test the materials in an independent laboratory approved by the Engineer and furnish test certificates. The cost of these tests shall be borne by the contractor.

The sampling and testing procedures shall be as laid down in the relevant Indian Standards and where they are not available; the same shall be carried out as per the directions of the Engineer. Only materials from sources approved by the Engineer shall be brought to the site. If the material from the approved source proves unacceptable at any time, the contractor shall identify new sources of acceptable materials conforming to specifications.

If any proprietary items are proposed to be used in the works, they shall be governed by the provisions of Clause 119.2 of these Specifications.

**2403 BRICKS**

Burnt clay bricks/concrete bricks shall conform to the requirements of IS: 1077, except that the minimum compressive strength when tested flat, shall not be less than 8.4 MPa for individual bricks and mean strength not less than 10.5 MPa for a

group of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp corners and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of  $\pm 5$  percent.

## 2404 STONES AND BLOCKS

### 2404.1 STONES

Stones shall be of the type specified. They shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stones with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water of more than 5percent of their dry weight when tested in accordance with IS: 1124.

The length of stone shall not exceed three times its height and the width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

### 2404.2 BLOCKS

Solid concrete blocks made of cement and suitable aggregates shall conform to relevant provisions of IS: 21 85 Part 1 in respect of dimension, mix, manufacturing, curing, drying and physical requirements. The minimum compressive strength of solid concrete blocks when tested as per IS: 2185 Part 1 shall not be less than 10.5 MPa. Hollow light weight concrete blocks shall not be used in works.

The thickness of concrete block shall not be less than 200 mm and the width shall not be less than 200 mm. The density of concrete block shall not be less than 2.2 ton/cu.m.

## 2405 CAST IRON

Cast iron shall conform to IS: 210. The grade number of the material shall not be less than 1 4.

## 2406 CEMENT

Cement to be used shall be any of the following types with the prior approval of the Engineer.

- i. Ordinary Portland cement, 33 Grade, conforming to IS: 269.

- ii. Ordinary Portland cement, 43 Grade, conforming to IS: 8112.
- iii. Ordinary Portland cement, 53 Grade, conforming to IS: 12269.
- iv. Sulphate resisting Portland cement, conforming to IS: 12330.
- v. Portland Pozzolana cement (fly ash based) conforming to IS: 1489 (Part 1)
- vi. Portland slag cement conforming to IS: 455
- vii. Rapid Hardening Portland cement, conforming to IS: 8041"
- viii. Low heat Portland cement conforming to IS: 12600

Cement of 33 grade conforming to IS: 12269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 450 Kg/cum of concrete (excluding any mineral admixture).

Cements of 43 and 53 grades conforming to IS: 8112 and IS: 12269 respectively may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced.

Sulphate resisting cement conforming to IS: 12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS: 456 are: sulphate concentration in excess of 0.2 percent in surrounding soil or 300 ppm (0.03 percent) in ground water. Cement conforming to IS: 12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 450 kg/cum (excluding any mineral admixture).

Alternatively, Portland slag cement conforming to IS: 455 with slag content more than 50 percent can be used instead of sulphate resisting cement when the sulphate content in the surrounding soil is less than 1 percent or the sulphate content in the ground water is less than 2500 ppm.

Cement conforming to IS: 8041 shall be used only for precast concrete products after specific approval of the Engineer.

Total chloride content shall be 0.1 percent by mass of cement for the cement to be used in structures other than prestressed concrete structures and 0.05% by mass of cement in prestressed concrete structures. Also, total Sulphur content calculated as sulphuric anhydride ( $\text{SO}_3$ ) shall in no case exceed 3.5 percent.

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Where chloride is encountered along with sulphates in soil or ground water, ordinary Portland cement with C3A content from 5 to 8 percent shall be preferably used in concrete, instead of sulphate resisting cement.

Manufacturer's test certificate shall be submitted to the Engineer by the contractor for every consignment of cement. The certificate shall cover all the tests for chemical requirements, physical requirements and chloride content as per relevant codes as applicable.

Independent tests of samples drawn from the consignment shall be carried out at the site laboratory or in an independent laboratory approved by the Engineer, immediately after delivery. The following properties shall be tested:

- ix. Compressive strength.
- ii) Setting time.

The cost of the tests shall be borne by the Contractor.

Cement in bags in local storage for more than 3 months after completion of tests, may be re-tested for compressive strength and setting times (initial and final) before use and may be rejected if it fails to conform to any of the requirements.

Lot size for independent testing of cement at site shall be the quantity received at site on any day, subject to a maximum of 500 tonnes.

#### 2407 COARSE AGGREGATES

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not contain pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregates having positive alkali-silica reaction shall not be used.

All coarse aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, Parts I to VI II.

The contractor shall submit for the approval of the Engineer, the entire information indicated in Appendix A of IS: 383.

Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Section 1700 of these Specifications.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 percent. The coarse aggregate shall satisfy the requirements of grading as given in Table 2400-1:

Table 2400-1: Grading Requirements of Coarse Aggregate

IS Sieve Size	Percentage Passing for Graded Aggregate of Nominal Size		
	40mm	20mm	12.5mm
63	-	-	-
40	95 - 100	100	
20	30 - 70	95 - 100	100
12.5	-	-	90 - 100
10	10 – 35	25 – 55	40 – 85
4.75	0 - 5	0 - 10	0 - 10

## 2408 FINE AGGREGATES

For masonry work, sand shall conform to the requirements of IS:21 16.

Natural sand crushed stone sand or crushed gravel sand or a suitable combination of naturals and, crushed stone or gravel, shall be used as fine aggregates in plain, reinforced and prestressed concrete works. The fine aggregates shall be dense, durable, clean and free from veins and adherent coating and other deleterious substances. They shall not contain dust, lumps, soft or flaky materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel.

Mechanized sand washing machines should be used to remove impurities from sand. Fine aggregates having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VII I).

The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

Fine aggregate for structural concrete shall conform to the following grading requirements:

Gradation table of Fine Aggregates as per IS: 383 – 1970, Table 4

Table 2300-2  
Percentage passing for

IS Sieve Designation	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90 – 100	90 – 100	90 – 100	95 – 100
2.36mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18 mm	30 – 70	55 – 90	75 – 100	90 – 100
600 micron	15 – 34	35 – 59	60 – 79	80 – 100
300 micron	5 - 20	8 – 30	12 – 40	15 – 50
170 micron	0 - 10	0 – 10	0 - 10	0 – 15

Note: When the grading falls outside the limits of any particular grading zone of sieves other than 600-micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. However for crushed stone sand, the permissible limit on i 50-micron IS Sieve is increased to 20 percent. Reference shall be made to Clause: 4.3 of IS: 383.

## 2409 STEEL

### 2409.1 CAST STEEL

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS: 1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. To increase the corrosion resistance properties, 0.3% to 0.5% copper may be added.

### 2409.2 STEEL FOR PRESTRESSING

The prestressing steel shall conform to any one of the following standards:

- Plain hard drawn steel wire conforming to IS:1785 (Part I) and IS:1785 (Part II)
- Cold drawn indented wire conforming to IS:6003



- c) High tensile steel bar conforming to IS:2090
- d) Uncoated stress relieved strands conforming to IS:6006
- e) Uncoated stress relieved low relaxation seven ply strand conforming to IS: 14268

Data in respect of modulus of elasticity, relaxation loss at 1000 hours, minimum ultimate tensile strength, stress strain curve etc. shall be obtained from the manufacturer. Pre-stressing steel shall be subjected to acceptance tests prior to actual use in the works.

### 2409.3 REINFORCEMENT/ UNTENSIONED STEEL

#### 2409.3.1 Reinforcing Bars

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, the reinforcement/Untensioned steel as the case may be, shall consist of the following grades of reinforcing bars.

Table 2400-3: Grades of Reinforcing Bars

Grade Designation	Bar Type Conforming to Governing Specifications	IS Characteristic Strength MPa	Elastic Modulus GP
Fe 240	IS:432 Part I Mild Steel	240	200
Fe 415	IS:1786 High Strength Deformed Steel Bars (HSD)	415	200
Fe 500 or Fe 500D	IS:1786 High Strength Deformed Steel Bars (HSD)	500	200
Fe 550 or Fe 550D	IS:1786 High Strength Deformed Steel Bars (HSD)	550	200
Fe 600	IS:1786 High Strength Deformed Steel Bars (HSD)	600	200

*Note: If any grade of steel given in the above table is not available steel of next higher grade may be used.*

All steel shall be procured from 'Original producers' who manufacture billets directly from iron ores and roll the billets to produce steel conforming to IS: 1 786.

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No re-rolled steel shall be incorporated in the works. However, in case the original producers give certificate that they are unable to supply the steel within the required time period or that they are not producing bars of the required diameter, the Engineer may allow the procurement of steel from other suppliers, provided that the reinforcement is manufactured from billets procured from the original producers. In such cases, the manufacturer's certificate alone shall not be considered as sufficient and the steel shall be got tested by the Engineer in the NABL accredited laboratories only, as a third party check. It shall be ensured that all the test results conform to IS: 186 requirements.

Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bars shall be discarded. Bars with cracked ends shall be discarded.

For the steel procured from original producers also, the Engineer / Employer may carry out occasional checks on materials through third party as mentioned above, for confirming the test results shown in the certificates, in case of any doubt regarding the quality of steel supplied.

#### 2409.4 STRUCTURAL STEEL

Unless otherwise permitted, all structural steel shall, before fabrication, comply with the requirements of the following Indian Standards:

IS: 226: Structural Steel (Standard Quality)

IS: 961: Structural Steel (High Tensile)

IS: 2062: Weldable Structural Steel

IS: 8500: Weldable Structural Steel (medium and high strength qualities)

IS: 1148 : Hot rolled rivet bars (upto 40 mm dia for structural purposes)

IS: 1149 : High tensile rivet bars for structural purposes

IS: 1161 : Steel tubes for structural purposes

IS: 4923 : Hollow Steel sections for structural use

IS: 11587 : Structural weather resistant steel

IS: 808 : Specifications for Rolled Steel Beam, Channel and Angle Sections

IS: 1239 : Mild Steel Tubes

IS: 1730 : Dimension for Steel Plate, sheet and strip for structural and general

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Engineering purposes.

IS: 1731 : Dimension for Steel flats for structural and general engineering purposes

IS: 1732: Dimension for round and square steel bars for structural and general Engineering purposes.

IS: 1852: Rolling and cutting tolerances for hot rolled steel products

The use of structural steel not covered by the above standards may be permitted with the specific approval of the Engineer. Refer to Section 1900 of these Specifications for further details.

## 2410 WATER

Water used for mixing and curing shall be clean and free from oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

In case of doubt regarding development of strength, the suitability of water proposed to be used for the production of concrete shall be ascertained by carrying out tests for the compressive strength of concrete and initial setting time of cement using the same water.

The sample of water taken for testing shall represent the water proposed to be used for concreting, taking into account seasonal variations, if any. The sample shall not receive any treatment before testing other than that being given to the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used, shall not be less than 90 percent of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS: 516.

The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not be more than 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water.

The test blocks shall be prepared and tested in accordance with the requirements of IS: 4031(Part 5). pH value of water shall not be less than 6. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted.

**2411 TIMBER**

The timber used for structural purposes shall conform to IS: 883.

**2412 POLYTHENE MEMBRANE**

Polythene or polyethylene sheet is commonly used as a damp-proof membrane with over site concrete for all but severe conditions of dampness. It is recommended that the sheet should be at least 0.25 mm thick (1200 gauge). The sheet is supplied in rolls 4 m wide by 25 m long. When used under concrete over site the sheet should be laid on a blinding layer of sand or compacted fuel ash spread over the hardcore.

**2413 CONCRETE ADMIXTURES****2413.1 GENERAL**

Admixtures may be added to the concrete before or during mixing with a view to modifying one or more of the properties of concrete in the plastic or hardened state.

**2413.2 MINERAL ADMIXTURES**

Any of the following mineral admixtures may be used as part replacement of Portland cement with the approval of the Engineer.

Fly ash: conforming to of IS: 3812-3

Granulated slag: Ground granulated slag obtained by grinding granulated slag conforming to IS: 12089.

Silica fume: Silica fume is very fine, non- crystalline SiO<sub>2</sub>, obtained as a by-product of Silicon and Ferro - Silicon alloy industries and shall conform to IS:15388

**2413.3 CHEMICAL ADMIXTURES****2413.3.1 Information Required from the Manufacturer**

Chemical admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and fully fledged laboratory facilities for the manufacture and testing of concrete.

The contractor shall provide the following information concerning each admixture, after obtaining the same from the manufacturer:

- 
- a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
  - b) The chemical names of the main ingredients.
  - c) The chloride content, if any, expressed as a percentage by weight of the admixture.
  - d) Values of dry material content, ash content and relative density which can be used for Uniformity Tests.
  - e) Whether it leads to the entrainment of air when used as per the manufacturer's recommended dosage, and if so to what extent.
  - f) Confirmation regarding its compatibility with type of cement.
  - g) Whether it increases the risk of corrosion of reinforcement or other embedment.
  - h) Whether it affects the durability of concrete adversely.

#### 2413.4 PHYSICAL AND CHEMICAL REQUIREMENTS

Admixtures shall conform to the requirements of IS: 9103. In addition, the following conditions shall be satisfied.

- a) "Plasticizers" and "Super-Plasticizers" shall meet the requirements indicated for "Water reducing Admixture".
- b) Except where resistance to freezing and thawing and to disruptive action of deicing salts is required, the air content of freshly mixed concrete in accordance with the pressure method given in IS :1199, shall not be more than 2 percent higher than that of the corresponding control mix and in any case not more than 3 percent of the test mix.
- c) The chloride content of the admixtures shall not exceed 0.2 percent when tested in accordance with IS: 6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section 1700 of these Specifications shall also not be exceeded.
- d) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

The tests that shall be performed along with permissible variations areas follows:

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- i) Dry Material Content : within 3 percent and 5 percent of liquid and solid
  - ii) Ash content: within 1 percent of the value stated by the manufacturer.
  - iii) Relative Density (for liquid admixtures): within 2 percent of the value stated by the manufacturer.
- e) All tests relating to concrete admixtures shall be conducted periodically at an independent laboratory and the results compared with the data given by the manufacturer.

## 2414 STORAGE OF MATERIALS

### 2414.1 GENERAL

All materials shall be stored at proper places so as to prevent their deterioration, intrusion of foreign matter and ensure their satisfactory quality and fitness for the work. The storage space must also permit easy inspection, removal and re-storage of the materials. All such materials, even though stored in approved godowns/places, must be subjected to acceptance test prior to their immediate use.

### 2414.2 BRICKS

Bricks shall not be dumped at site, but shall be stacked in regular tiers as they are unloaded, to minimize breakage and defacement. Bricks selected for use in different situations shall be stacked separately. Sufficient supply of bricks as required for the works shall be available at site at any time.

### 2414.3 AGGREGATES

Aggregate stockpiles may be made on ground that is hard, well drained and devoid of vegetation. Coarse aggregates, unless otherwise agreed by the Engineer in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). In case of aggregates placed directly on the ground the material in the stock pile only up to a level of 30 cm above the ground level shall be taken out and used initially. Remaining material shall be permitted to be used in the final stages of work only after it has been fully cleaned.

### 2414.4 CEMENT

Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in

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perfectly dry and water-tight sheds and shall be stacked to a height of not more than eight bags. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirement at site. The containers shall be cleaned at least once every 3 months.

Cement shall be used in the sequence in which it is delivered at site. Each consignment shall be stored separately so that it may be readily identified and inspected. Any consignment or part of a consignment of cement which has deteriorated in any way during storage shall not be used in the works and shall be removed from the site by the Contractor at his own cost.

The Contractor shall prepare and maintain proper records at site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Engineer at all times.

The Contractor shall submit a monthly return to the Engineer showing the quantities of cement received and issued during the month and in stock at the end of the month.

#### *2414.5 REINFORCEMENT/UNTENSIONED STEEL*

The reinforcement bars, shall be stored above the surface of the ground upon platforms, skids or other supports, and shall be protected from mechanical injury and from deterioration by exposure.

#### *2414.6 WATER*

Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion of foreign matter or growth of organic matter. Use of water from shallow, muddy or marshy sources, shall not be permitted. The intake pipe shall be suitably enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

#### *2415 TESTS AND STANDARD OF ACCEPTANCE*

All materials, even though stored in an approved manner shall be subjected to an acceptance test in accordance with the relevant IS specification prior to their immediate use.

Independent testing of cement for every consignment shall be done by the Contractor at site or in the laboratory approved by the Engineer before use. Any cement with lower quality than that shown in manufacturer's certificate shall be

debarred from use. In case of imported cement, the same series of tests shall be carried out before acceptance.

#### *2415.1 TESTING AND APPROVAL OF MATERIAL*

The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.

The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction as per requirements of conditions of contract and the relevant specifications. The testing of all the materials shall be carried out by the Engineer for which shall make all the necessary arrangements and bear the entire cost.

Test which cannot be carried out in the field laboratory have to be got done at the Contractor's cost at any recognized laboratory/testing establishments approved by the Engineer.

#### *2415.2 SAMPLING OF MATERIALS*

Samples provided to the Engineer for inspection are to be in labeled boxes suitable for storage. Samples required for testing and approval must be supplied well in advance by at least 48 hours or before the minimum period required for carrying out the relevant tests. Delay to works arising from the late submission of samples, will not be acceptable as a reason for delay in completion of the works.

If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall be borne by the Contractor.

#### *2415.3 REJECTION OF MATERIALS NOT CONFORMING TO THE SPECIFICATIONS.*

Any stack or batch of material(s) of which sample(s) does (do) not conform to the prescribed tests and quality shall be rejected by the Engineer and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any rectifications.

#### *2415.4 TESTING AND APPROVAL OF PLANT AND EQUIPMENT*

All plants and equipment used for preparing, testing and production of materials for incorporation into the permanent works, shall be in accordance with manufacturer's specifications and shall be got approved by the Engineer before use.



**2500 QUALITY CONTROL TESTS DURING CONSTRUCTION****2501 GENERAL**

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the Clauses for the relevant items of work.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in Table 2100-1 and Table 2100-2 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. 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.

Table 2500-1: Control Tests and their Minimum Frequency for Sub-Bases and Bases  
(Excluding Bitumen Bound Bases)

Sl No.	Types of Construction	Test	Frequencies
01	Granular Sub - Base	Gradation	One test per 400 cum
		ii) Atterberg limits	One test per 400 cum
		iii) Moisture content prior to compaction	One test per 400 cum
		iv) Density of compacted layer	One test per 1000 sq.m
		v) Deleterious constituents	As required
		vi) CBR	As required

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02	Water Bound Macadam	i) Aggregate Impact Value	One test per 1000 cum of aggregate
		ii) Grading of aggregate	One test per 250 Cum
		iii) Combined Flakiness and Elongation Indices	One test per 500 cum of aggregate
		iv) Atterberg limits of binding material	One test per 50 cum of binding material
		v) Atterberg limits of screenings	One test per 100 cum of aggregate
03	Wet Mix Macadam	i) Aggregate Impact Value	One test per 1 000 cum of aggregate
		ii) Grading of aggregate	One test per 200 cum of aggregate
		iii) Combined Flakiness and Elongation Indices	One test per 500 cum of aggregate
		iv) Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 200 cu.m of aggregate
			One set of three tests per

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1000 sq.m

v) Density of compacted layer

*Note : Daily, weekly, monthly reports on test results shall be prepared indicating the location of sampling and testing, deviation from the specified values for materials and works and remedial action taken in respect of removal of defective work shall certified be prepared by the Contractor. The test record shall be certified by the Engineer that these tests were done in his presence and testing carried as per prescribed methodology.*

2501.1 Tests on Earthwork for Embankment, Sub grade Construction and Cut Formation

2501.1.1 Borrow Material

Grid the borrow area at 25 mm (or closer, if the variability is high) to full depth of proposed working. These pits should be logged and plotted for proper identification of suitable sources of material. The following tests on representative samples shall be carried out for every 3000 cum for each source:

- a) Sand Content [18:2720 (Part-4 )]: 2 tests per 3000 cu.m of soil.
- b) Plasticity Test [18:2720 (Part-5)]: Each type to be tested, 2 tests.
- c) Density Test [18:2720 (Part-8)]: Each soil type to be tested, 2 tests.
- d) Deleterious Content Test [18:2720 (Part-27)]: As and when required by the Engineer.
- e) Moisture Content Test [18:2720 (Part-2)]: Two tests.
- f) CBR Test on materials to be incorporated in the subgrade on soaked Unsoaked samples [18:2720 (Part-1 6)]: One CBR test (average of three Specimens) or closer as and when required by the Engineer.

2501.2 Compaction Control

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Control shall be exercised on each layer by taking at least one set of ten measurements of density for each 3000 sq.m of compacted area, or closer as required to yield the minimum number tests results for evaluating a day's work on statistical basis.

The determination of density shall be in accordance with IS: 2720 (Part-28). Test locations shall be chosen only through random sampling techniques. If non-destructive tests are carried out, the number of tests shall be doubled. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased.

However, for earthwork in shoulders (earthen) and in the sub grade, at least one set of ten density measurements shall be taken for every 2000 Esq. for the compacted area in other respects, the control shall be similar to that described earlier.

#### 2501.3 Cut Formation

Tests for the density requirements of cut formation shall be carried out in accordance with Clause 2401.2.

#### 2501.4 Tests on Sub-bases and Bases (Excluding Bitumen Bound Bases)

The tests and their frequencies for the different types of bases and sub-bases shall be given in Table 2400-1. The evaluation of density results and acceptance criteria for compaction control shall be on lines similar to those set out in Clause 2401.2

#### 2501.5 Quality Control Tests for Concrete Road Construction

##### 2501.5.1 Dry lean Concrete Sub-base

###### 2501.5.1.1 Sampling and Testing of Cubes

Samples of dry lean concrete for making cubes shall be taken from the un compacted material from different locations immediately before compaction at the rate of 3 samples for each 1000 sq.m or part thereof laid each day. The sampling of mix shall be done from the paving site.

Test cubes of 150 mm size shall be made immediately from each mix sample.

Cubes shall be made in accordance with the methods described in IS: 516 except that the cubes shall be compacted by means of a vibratory hammer with the moulds placed on a level and rigid base. The vibrating hammer shall be electric or pneumatic type fitted with a square or rectangular foot having an area of between 7500 to 14000 sq.mm. The compaction shall be uniformly applied for  $60 \pm 5$  seconds with a downward force of between 300N and 400N on to each of the three layers of the lean concrete material placed into the mould. The surface of each compacted layer shall be scarified before the next layer is added to give key for the next layer. The final layer shall be finished flush with the top of the cube mould.

The dry lean concrete shall be cured in accordance with IS: 516.

#### 2501.6 In-situ Density

The dry density of the laid material shall be determined from three density holes at locations equally spaced along a diagonal that bisects each 2000 sq.m or part thereof laid each day and shall comply with the requirements as per Clause 501.7.5. This rate of testing may be increased at the discretion of the Engineer in case of doubt or to determine the extent of defective area in the event of non-compliance. Density holes at random may be made to check the density at edges.

##### 2501.6.1 Thickness

The average thickness of the sub base layer as computed by the level data of sub-base and sub grade or lower sub-base shall be as per the thickness specified in the contract drawings. The thickness at any single location shall not be 8 mm less than the specified thickness. Such areas shall be corrected as stated in section 400. Areas which cannot be repaired should be replaced over full width. The extent of deficient area should be decided based on cores.

#### 2501.7 Frequency of Quality Control Tests

The frequency of quality control tests for levels, alignment and materials shall be as given in Table 2500-1.

#### 2501.8 Pavement Concrete

##### 2501.8.1 Sampling and Testing of Beam and Cube Specimens

At least three beams and three cube specimens, one set of three each for 7 day and 28 day strength tests shall be cast for every 150 cu.m (or part thereof) of concrete placed during construction. On each day's work, not less than three pairs of beams and cubes shall be made for each type of mix from the concrete delivered to the paving plant. Each pair shall be from a different delivery of concrete and tested at a place to be designated by the Engineer in accordance with the testing procedure as outlined in Clause 502.

Groups of four consecutive results from single specimens tested at 28 days shall be used for assessing the strength for compliance with the strength requirements. The specimens shall be transported in an approved manner to prevent sudden impact causing fractures or damage to the specimen. The flexural strength test results shall prevail over compressive strength tests for compliance.

## 2501.9 Summary of Control Tests

Table 2500-2: Frequency of Quality Control Tests for Pavement Concrete

SI No	Levels, alignment and texture	
	i) Level tolerance	Clause 1902.3
	ii) Width of pavement and position of paving edges	Clause 1902.2
	iii) Pavement thickness	Clause 1902.3 and 1903.5.2.4
	iv) Alignment of joints, widths, depth of dowel grooves	To be checked @ one joint per 400 m length or a day's work
	v) Surface regularity both transversely and longitudinally	Once a day or one day's work without disturbing the curing
	vi) Alignment of dowel bars and their accuracy/tie bars.	To be checked in trial length as per Clause 502.6.7 and once on every 2 km
	vii) Texture depth	Table 500-3

## 2 Quality of materials and concrete shall be as under :

1 ) Cement Physical and chemical tests		IS:269	Once for each source of supply and occasionally when called for in case of long/ improper storage. Besides, the Contractor also will submit daily test data on cement released by the manufacturer
		IS:455	
		IS:1489	
		IS:8112	
		IS:12269	
2) Coarse	i) Gradation	IS:2386	One test for every day's work of each fraction and

And Fine of coarse			fine aggregate, initially; (may be relaxed later at the discretion of the Engineer)
	ii) Deleterious constituents	IS:2386 (Pt-2)	-do-
	iii) Water absorption	IS:2386	Regularly as required subject to a minimum  (Pl. 3) of one test a day for coarse aggregate and two tests a day for fine aggregate. This data shall be used for correcting the water demand of the mix on a daily basis.
3) Coarse Aggregates	i) Los Angeles Abrasion value or Aggregate Impact value test	IS:2386 (Pl. 4)	Once for each source of supply and subsequently on monthly basis.
	ii) Soundness	IS:2386 (Pl. 5)	Before approving the aggregates and every month subsequently
	iii) Alkali aggregate - reactivity	IS:2386 (Pl. 7)  IS:456	-do-
4) Water	Chemical Tests	IS:2386	Once for approval of source of supply, subsequently only in case of doubt.
5) Concrete	i) Strength of concrete	IS:516	2 cubes and 2 beams per 150 cu.m or part. thereof (one for 7 day and other for 28 day strength) or minimum 6 cubes and 6 beams per day's work

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		whichever is more
ii) Core strength on hardened concrete	IS:516	As per the requirement of the Engineer, only in case of doubt.
iii) Workability of fresh concrete-Slump Test	IS:1199	One test per each dumper load at both batching plant site and paving site initially when work starts. Subsequently sampling may be done from alternate dumper.
iv) Thickness determination		From the level data of concrete pavement surface and sub-base at grid points of 5/6.25 m x 3.5 m
v) Thickness measurement for trial length		3 cores per trial length
vi) Verification of level of string line in the case of slip form paving and steel forms in the case of fixed form paving		String line or steel forms shall be checked for level at an interval of 5.0 m or 6.25m The level tolerance allowed shall be $\pm 2$ mm. These shall be got approved 1-2 hours before the commencement of the concreting activity.



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**2600 LANDSCAPING****2601 DEFINITION**

The process of making a garden or other piece of land more attractive by designing and adding ornamental features planting trees and shrubs. The addition of plants, changes to the existing terrain and the construction of structures are all part of landscaping. Turfing, sodding, plantation of plants and trees, changing of geographical ground for beautification are the feathers of landscaping

**2601.1 TURFING**

Turfing, of ground base with 30 x 30 cm turfs (locally available layer of green grass carpet) and laid.

Collected sods (shallow or rooted plants) by uprooting using shovels ensuring that the roots are intact. Well in advance of the sodding operation, thoroughly make smooth the surface to be covered. It is important to obliterate all irregularities. Place the sods closely in contour lines & apply 5 cm layer of topsoil and compact by hand.

Cut turfs (30x30cm) with sharp-edged shovels. Use khukuri/knife to cut the turfs to shape. Well in advance of the turfing operation, thoroughly make smooth the surface to be covered. It is important to obliterate all irregularities. On gravel-filled ground apply 5 cm layer of topsoil mixed with compost and compact by hand.

Place the turfs closely, without gaps in between. On slopes greater than 25°, fix turfs with wooden pegs about 30 cm long and 3-5 cm dia hammered through the turfs to stop it from sliding. Once the slope has been satisfactorily covered, compact the turf with the wooden hammer. Finally water the fresh turfs thoroughly.

**2601.2 Measurement:** the length and breadth of the completed work shall be measured correct to 10 mm and area calculated nearest to two places decimal. In case of plantation in contour the finished work shall be measured in running meter.

**2601.3 Rate:** the rate shall include the preparation, collection, and transportation of turfs/sods/greenery plants to the site, preparation of the site and placing them and also including any other equipment required for the complete operation.

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**LIST OF INDIAN AND FOREIGN STANDARDS**  
REFERRED TO IN THE SPECIFICATIONS

Number Designation Title

**(A) STANDARDS**

- IS: 73-1 992 Paving Bitumen Specification (Second Revision)
- IS: 77-1 976 Specification for Linseed Oil, Boiled, for Paints (Second Revision)
- IS: 102-1962 Ready Mixed Paint, Brushing, Red Lead, Non Setting, Primming
- IS: 104-1979 Ready Mixed Paint, Brushing, Zinc Chrome, Primming (Second Revision)
- IS: 123-1962 Specification for Ready Mixed Paint, Brushing, Finishing, Semi-Gloss. For General Purposes, to Indian Standard Colours (Revised Revision)
- IS: 164-1981 Specification for Ready Mixed Paints for road marking (First Revision)
- IS: 217-1988 Specification for Cutback Bitumen (Second Revision)
- IS: 226-1975 Structural Steel (Standard Quality) (Fifth Revision)
- IS: 269-1989 Specification for 33 Grade Ordinary Portland Cement (Fourth Revision)
- IS: 278-2009 Galvanized Steel Barbed Wire for Fencing-Specification
- IS: 280-2006 Mild Steel Wire for General Engineering Purposes (Fourth Revision)
- IS: 345-1952 Wood Filter Transparent Liquid
- IS: 356-1991 Ester Gum (Second Revision)
- IS: 383-1970 Specification for Coarse and Fine aggregates from Natural Sources for Concrete (Second Revision)
- IS: 460-1985 (Part 3) Specification for Test Sieves: Part III Methods of Examination of Apertures of Test Sieves (Third Revision)
- IS: 503-1963 Alloy Austenitic Manganese Steel Castings
- IS: 516-1959 Methods of Test for Strength of Concrete
- IS: 712-1984 Specifications for Building Limes (Third Revision)
- IS: 736-1986 Wrought Aluminum and Aluminum Alloys, Plates for General Engineering Purposes (Fourth Revision)
- IS: 783-1985 Code of Practice for Laying of Concrete Pipes (First Revision)

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- IS:784-2001 Prestressed Concrete Pipes (Including Fittings) - Specifications  
(Second Revision)
- IS:814-2004 Covered Electrodes for Manual Metal Arc Welding of Carbon and  
Carbon Manganese Steel (Fifth Revision)
- IS:816-1969 Code of Practice for Use of Metal Arc Welding for General  
Construction in Mild Steel (First Revision)
- IS:817-1966 Code of Practice for Training and Testing of Metal Arc Welders  
(Revised Revision)
- IS:822-1 970 Code of Procedure for Inspection of Welds
- IS:877-1989 Methods of Sampling and Test for Activated Carbons, Powered  
And Granular (Second Revision)
- IS:919-1993(Part-1)ISO Systems of Limits and Fits Part 1 Bases of Tolerance,  
Deviation and Fits (Second Revision)
- IS:919-1993(Part-2)ISO Systems of Limits and Fits Part 2 Tables of Standard  
Tolerance Grades and Limit Deviations for Holes and Shafts  
(First Revision)
- IS:961-1975Structural Steel (High Tensile) (Second Revision)
- IS:1077-1992Common Burnt Clay Building Bricks (Fifth Revision)
- IS:1079-1 994Hot Rolled Carbon Steel Sheets and Strips-Specifications (Sixth  
Revision)
- IS :1124-1974 Method of Test for Water Absorption, Apparent Specific Gravity  
And Porosity of Natural Building Stones (First Revision)
- IS:1129-1972 Recommendation for Dressing of Natural Building Stones (First  
Revision)
- IS :1148-1982 Hot Rolled Rivet Bars(upto 40 mm dia for Structural Purposes  
(Third Revision)
- IS:1149-1 982 Hot Tensile Steel Rivet Bars for Structural Purposes (Third  
Revision)
- IS: 1182-1983 Recommended Practice for Radiographic Examination of Fusion  
Welded Butt Joints in Steel Plates (Second Revision)
- IS:1199-1959 Method of Sampling and Analysis of Concrete
- IS:1203-1978 Determination of Penetration
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IS:1205-1978Determination of Softening Point

IS:1212-1978Determination of Loss on Heating

IS:1216-1978Determination of Solubility in Carbon Disulphide Trichloroethylene

IS:1217-1 978Determination of Mineral Matter

IS:1239:(Part 1)-1990 Steel Tubes, Tubular and Other Wrought Steel Fittings  
Specification: Part 1 Steel Tubes

IS: 1363-2002 Hexagonal Head Bolts, Screws and Nuts of Product Grade 'c'  
(Part 1, 2 & 3)

IS:1364-2002Hexagonal Head Bolts, Screws and Nuts of Product Grade 'A' & 'B'  
(Part 1 2 &3)

IS: 1 365-2005Slotted Countersunk, Flat Head Screws (Common Head  
Style) Product Grade A (Fourth Revision)

IS:1 367-1997Technical supply conditions for Threaded Steel Fasteners

IS:1 393-1961Code of Practice for Training and Testing of Oxy Acetylene  
Welders

IS:1477-1 971Code of Practice for Painting of Ferrous Metals in Buildings Fly ash  
Based (Third Revision)

(Parts 1 & 2) Calcined Clay Based (Third Revision)

IS:1489- 1991Specification for Portland pozzolana Cement(Third Revision)

(Part 1) Flyash Based (Third Revision)

(Part 2) Calcined Clay Based (Third Revision)

IS:1498-1970Classification and Identification of Soils for General Engineering  
Purposes (First Revision)

IS:1514-1 990 Methods of Sampling and Test for Quick Lime and Hydrated Lime  
(First Revision)

IS:1597-1992 Construction of Stone Masonry - Code of Practice - Part 1 - Rubble  
(Part 1) Stone Masonry (First Revision)

IS:1732-1989 Dimensions for Round and Square Steel Bars for Structural and

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General Engineering Purposes (Second Revision)

IS:1745-1 978 Specification for Petroleum Hydrocarbon Solvent(Second Revision)

IS: 1785-1983(Part-1) Specification for Plain, Hard Drawn Steel Wire for Prestressed Concrete: Part 1 Cold Drawn Stress Relieved Wire(Second Revision)

IS:1785-1 983(Part-II) Specification for Plain, Hard Drawn Steel ' Wire for Prestressed Concrete: Part 2 As Drawn Wire (First Revision)

IS:1786-1985 High Strength Deformed Steel Bars and Wires for Concrete Reinforcement (Third Revision)

IS:1834-1984 Specification for Hot Applied Sealing Compounds for Joints in Concrete (First Revision)

IS:1838-1983(Part 1) Specification for Preformed Filler for Expansion Joint in Concrete Pavement and Structures (Non-Extruding and Resilient Type):Part 1Bitumen Impregnated Fibre (First Revision)

IS:1838-1984(Part 2) Specification for Preformed Filler for Expansion Joint in Concrete Pavement and Structures (Non-Extruding and Resilient Type ):Part 2CNSL Aldehyde Resin and Coconut Pith

IS:1852-1 985 Rolling and Cutting Tolerances for Hot Rolled Steel Products (Fourth Revision)

IS:1875-1 992 Carbon Steel Billets, Blooms, Slabs and Bars for Forgings (Fifth Revision)

IS:1888-1982 Method of Load Test on Soils(Second Revision)

IS:1892-1979 Code of Practice for Sub Surface Investigation for Foundations (First Revision)

IS:1966-2003 Laboratory Glassware-Straight Bore Glass Stopcocks for General Purposes(First Revision)

IS:1977-1996 Low Tensile Structural Steels -Specifications(Third Revision)

IS:1995-1984 Overall Internal Heights for Lathe Tool Posts (First Revision)

IS:2004-1991 Carbon Steel Forgings for General Engineering Purposes (Third Revision)

IS:2016-1967 Specification for Plain Washers (First Revision)

IS:2062-2006 Hot Rolled Low, Medium and High Tensile Structural Steel (Sixth Revision)

IS:2090-1983 Specifications for High Tensile Steel Bars used in Prestressed Concrete(First Revision)

IS:2116-1980 Specification for Sand for Masonry Mortars (First Revision)

IS:2131-1981 Method for Standard Penetration Test for Soils (First Revision)

IS:2132-1986 Code of Practice for Thin Walled Tube Sampling of Soils (Second Revision)

IS:2185-2005(Part-1) Concrete Masonry Units-Specification: Part 1 -Hollow and Solid Concrete Blocks

IS:2250- 1981 Code of Practice for Preparation and Use of Masonry Mortars (First Revision)

IS:2269-2006 Hexagon Socket Head Cap Screws (Fifth Revision)

IS:2339-1963 Aluminum Paint for General Purposes in Dual Container

IS:2386-1963 Methods of Test for Aggregates for Concrete

(Part 1) Particle size and shape

(Part 2) Estimation of Deleterious Materials and Organic Impurities

(Part 3) Specific Gravity, Density, Voids, Absorption and Bulking

(Part 4) Mechanical Properties

(Part 5) Soundness

(Part 6) Measuring Mortar Making Properties of Fine Aggregates

(Part 7) Alkali Aggregate Reactivity Test

(Part 8) Petro graphic examination

IS:2502-1963 Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS:2506-1985 General Requirements for Screed Board Concrete Vibrators (First Revision)

IS:2514-1963 Specification for Concrete Vibrating Tables

IS: 2720 Methods of Test for Soils

(Part 1 )-1983 Preparation of Dry Soil Samples for Various Tests (Second Revision)

(Part 2)-1973 Determination of Water Content (Second Revision)

(Part 4 )-1985 Grain Size Analysis (Second Revision)

(Part 5)-1985 Determination of Liquid and Plastic Limits (Second Revision)

(Part 8)-1983 Determination of Water Content Dry Density Relation using Heavy Compaction (Second Revision)

(Part 16)-1987 Laboratory Determination of CBR

(Part 27)-1977 Determination of Total Soluble Sulphates (First Revision)

(Part 28)-1974 Determination of Dry Density of Soils in-place by the Sand Replacement Method (First Revision)

(Part-37)- 1976 Determination of Sand Equivalent Values of Soils and Fine Aggregates

(Part 40)-1977 Determination of Free Swell Index of Soils

IS 2527 1984 for Gutter and Rainwater Downpipe

IS:2751-1979 Code of Practice for Welding of Mild Steel Plain and Deformed Bars for Reinforced Concrete Construction (First Revision)

IS:2911 (Part-1) Code of Practice for Design and Construction of Pile Foundation Concrete Piles, Section 3 Driven Precast Concrete

IS: 2925-1984 Specification for Industrial Safety Helmets (Second Revision)

IS:3025:.(Part 17)-1984 Methods of Sampling and Test (Physical And Chemical) for Water and Waste water: Part 17 Non-Filterable Residue (Total Suspected Solids) (First Revision)

IS:3025:(Part 1 8)-1 984 Methods of Sampling and Test (Physical and Chemical) for Water and Waste Water- Part 18 Volatile and Fixed Residue (Total Filterable and Non-Filterable) (First Revision)

IS:3025:(Part 22)-1986 Methods of Sampling and Test (Physical and Chemical) for Water and Waste Water- Part 22 : Acidity (First Revision)

IS:3025:(Part 23)-1986 Methods of Sampling and Test (Physical and Chemical) for Water and Waste Water- Part 23: Alkalinity (First Revision)

IS:3025:(Part 28)-1984 Methods of Sampling and Test (Physical and Chemical) for Water and Waste Water- Part 28: Sulphite (First Revision)

IS:3025 (Part 32)-1988 Methods of Sampling and Test (Physical and Chemical) for Water and Waste Water- Part 32: Chloride (First Revision)

IS:3073-1967 Assessment of Surface Roughness

IS:3138-1966 Specifications for Hexagonal Bolts and Nuts

IS:3400 (Part 3)-2004 Methods of Test for Vulcanized Rubbers: Part 3 Abrasion Resistance using a Rotating Cylindrical Drum Device (First Revision)

IS:3400 (Part 2)-2004 Methods of Test for Vulcanized Rubbers: Part 2 Rubber Vulcanized or Thermoplastic-Determination of Hardness (Hardness between 10 IRHD and 100 IRHD) (Third Revision)

IS:3400 (Part 4 )-2004 Methods of Test for Vulcanized Rubbers: Part 4 Accelerated Ageing (Second Revision)

IS:3400 (Part .10)-2004 Methods of Test for Vulcanized Rubbers: Part 10 Compression Set at Constant Strain (First Revision)

IS:3400 (Part 14)1984 Methods of Test for Vulcanized Rubbers: Part 14 Adhesion Of Rubber to Metal (First Revision)

IS:3400 (Part 20)-2004 Methods of Test for Vulcanized Rubbers: Part 20 Resistance to Ozone Cracking-Static Strain Test (First Revision)

IS:3589-2001 Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter)-Specification (Third Revision)

IS:3613-1974 Acceptance Tests for Wire Flux Combination for Submerged Arc Welding (First Revision)

IS:3658-1999 Code of Practice for Liquid Penetrate Flow Detection (Second Revision)

IS:3764-1992 Code of safely for excavation work ( First Revision)



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IS:3784-1994	Textiles –cloth, cotton, bleached for general purposes Specification (First Revision)
IS 3812 -1981	Specification of Fly ash for use as Pozzolana and Admixture (First Revision).
IS:4031:(Part 5)-1988	Methods of Physical Tests for Hydraulic Cement: Part 5 Determination of Initial and Final Setting Times (First Revision)
IS:4078-1 980	Code of Practice for Indexing and Storage of Drill Cores (First Revision)
IS:408 1-1986	Safety Code for Blasting and Related Drilling Operations (First Revision)
IS:41 38-1977	Safety Code for Working in Com pressed Air (First Revision)
IS:4260-1986	Recommended Practice fo r Ultrasonic Te sting of Butt Welds In Ferritic Steel (Second Revision)
IS:4434-1978	Code of Practice for In-Situ V'arie,' Shear Test for Soils (First Revision)
IS:4453-2009	Subsurface Exploration by Pits, Trenches, Drifts and Shafts- Code of Practice (Second Revision)
IS:4656-1968	Specification for Form Vibrators fo r Concrete
IS:4826-1979	Hot Dipped Galvanised Coating on Round Steel Wires (First Revision)
IS:4853-1982	Recommended Practice for Radiographic Inspection of Fusion
IS:4923-1997	Welded Butt Joints in Steel Pipes (First Revision)
IS:4925-2004	Hollow Steel Sections for Structural Use(Second Revision)
IS:4926-2003	Concrete Batching and Mixing Plant-Specification (First Revision)
IS:4968-1976	Ready Mixed Concrete - Code of Practice(Second Revision)
(Part-1 ,2&3)	Method for Subsurface Sounding for Soils
IS:4984- 1995	Specification for High Density Polyethylene Pipes for Potable Water Supplies (Fourth Revision)
IS:5334-2003	Magnetic Particle Flaw Detection of Welds-Code of Practice

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(Second Revision)

IS:5435-1987 General Requirements For Cold Bituminous Macadam Mixing Plants (First Revision)

IS:5640-1970 Method for Determining the Aggregate Impact Value of Soft Coarse Aggregate

IS:6003-1983 Specification for indented Wire for Prestressed Concrete (First Revision)

IS:6066-1983 Specification for Uncoated Stress Relieved Strand for Prestressed Concrete (First Revision)

IS:6241 - 1971 Methods of test for Determination of Stripping Value of Road Aggregates

IS:6603-2001 Stainless Steel Bars and Flats - Specification (First Revision)

IS:6610-1972 Specification for Heavy Washers for Steel Structures

IS:6639-1972 Specification for Hexagonal Bolts for Steel Structures

IS:6761-1994 Fasteners-Countersunk Head Screws with Hexagonal Socket Specification (First Revision)

IS:6909-1990 Specification for Super sulphated cement

IS:6911 -1992 Stainless Steel Plate, Sheet and Strip (First Revision)

IS:6925-1973 Methods of Test for Determination of Water in Concrete Admixtures

IS:7205-1974 Safety Code for Erection of Structural Steelwork

IS:7269-1974 Numbering of Aircraft Engines, Engine Cylinders, Combustion Chambers and Direction of Rotation of Engines and Propellers

IS:7273-1974 Method of Testing Fusion Welded Joints in Aluminium and Aluminium Alloys

IS:7292-1974 Code of Practice for In-Situ Determination of Rock Properties By Flat Jack

IS:7293-1974 Safety Code for Working with Construction Machinery

IS:7307 (Part 1)-1974 Approval Tests for Welding Procedures Part-1 Fusion Welding

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Of Steel

IS:7308-1999 Non Coniferous Logs-Specification (First Revision)

IS:7310(Part-1)-1974 Approval Tests for Welders Working to Approved Welding Procedures Part 1: Fusion Welding of Steel

IS:7317-1993 Code of Practice for Uniaxial Jacking Test for Deformation Modulus of Rock (First Revision)

IS:7573-1975 Hockey Shoes

IS:7746- 1991 Code of Practice for In-Situ Shear Test on Rock (First Revision)

IS:7966-1976 Specification for Dental Modelling Wax

IS:8500-1991 Structural Steel- Micro alloyed (Medium and High Strength Qualities) Specification

IS:8812-1978 (Part 1) Methods for Chemical Analysis of Hard Solders for Jointing Aluminium and Aluminium Alloys Part 1 Determination of Silver, Copper, Zinc, Antimony, Iron and Bismuth

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**THANK YOU**

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**APPENDIX – 1500/1(As per MORT&H SPECIFICATION)**  
INFORMATION TO BE SUPPLIED BY THE  
MANUFACTURERS OF PROPRIETARY SYSTEMS

**01 GENERAL**

- 1.1 The information which the manufacturer is required to supply shall be in such detail as to obviate unsafe use of the equipment due to the intention of the manufacturer not having been made clear or due to wrong assumptions on the part of the user.
- 1.2 The user shall refer unusual problem or problems of erection/assembly not keeping with the intended use of the equipment, to the manufacturer of the equipment.

**2 INFORMATION REQUIRED**

The manufacturers of proprietary systems shall supply the following

- a) Description of basic functions of equipment
- b) List of items of equipment available, giving range of sizes, spans and such like, with the manufacturer's identification numbers or other references.
- c) The basis on which the safe working loads have been determined and whether the factor of safety given applies to collapse or yield.
- d) Whether the supplier's data is based on calculations or tests. This shall be clearly stated as there may be wide variations between results obtained by either method.
- e) Instructions for use and maintenance, including any points which require special attention during erection, especially where safety is concerned.
- f) Detailed dimensional information, as follows :
  - (i) Overall dimensions and depth and widths of members;
  - (ii) Line drawings including perspectives and photographs showing normal uses;
  - (iii) Self weight;
  - (iv) Full dimensions of connections and any special positioning arrangements
  - (v) Sizes of members, including tube diameters and thicknesses of materials;
  - (vi) Any permanent camber built into the equipment; and
  - (vii) Sizes of holes and dimensions giving their positions.
- g) Data relating to strength of equipment as follows :
  - (h) Average failure loads as determined by tests;

- (iii) Recommended maximum working loads for various conditions of use;
- (iv) Working resistance moments derived from tests;
- (v) Working shear capacities derived from tests;
- (vi) Recommended factors of safety used in assessing recommended loads and deflections based on test results;
- (vii) Deflections under load together with recommended pre-camber and limiting deflections;
- (viii) If working loads depends on calculations, working stresses should be stated. If deflections depend on the theoretical moments of inertia or equivalent moments of inertia rather than tests, this should be noted;
- (ix) Information on the design on the loading against wind and other horizontal loadings; and
- (x) Allowable loading relating to maximum extension of bases and/or heads.

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**ADDITIONAL SPECIFICATION FOR PRE-FABRICATED STRUCTURE**

The following minimum requirement shall be met for pre-fabricated structure:

**Foundation**

Simple light weight bearing structure foundation to the following specification shall be prepared:

- The length and breadth of the plinth shall be 100mm more than the specified dimensions in the approved layout of the structure.
- The plinth shall be 300mm above the ground level and extend a minimum of 100 mm below the ground level
- Random Rubble Masonry Wall of 450mm width and 450mm depth shall be constructed along the periphery of the plinth
- Anchoring pockets should be filled with 150mm thick M15 concrete for drilling dash fasteners as per the approved layout
- 300 mm thick compacted backfill with RBM shall be carried out inside the peripheral boundary
- 50mm M15 Concrete will be laid on top of the plinth

**Clear Height**

- External Wall height shall be 3m and false ceiling height shall be 2.6m from the floor level

**Steel Frame**

- The steel frame shall be MS Hollow Sections, pre-fabricated having nut and bolt arrangements and two coat of red oxide primer
- The Columns (minimum 75x75x2.5), trusses and purlins (minimum 50x50x1.8) shall be square hollow sections
- The base plates and joint plates shall be a minimum of 10 mm thickness and clits of 5mm thickness

**Wall Paneling**

- External and Internal Wall paneling shall be erected with cement aerated concrete panels of required sizes, fixed on GI Channels and Steel Structure

**Roofing Sheets**

- Roofing sheets shall be minimum 0.45mm thick provided with all accessories

**False Ceiling**

- False Ceiling shall be pre-laminated gypsum tiles fixed on frame adequately designed

**Painting**

- All joints shall be filled with wall putty for smooth surface finish before applying cement primer. External wall shall be painted with weather shield paint and internal walls shall be painted with water based distemper