

SECTION – V**TECHNICAL SPECIFICATIONS WITH PREAMBLE****1 PREAMBLE**

1.1 The Technical Specifications contained herein shall be read in conjunction with the other Bidding Documents as specified in Volume-I.

1.2 Site Information

1.2.1 The information given hereunder and provided elsewhere in these documents is given in good faith by the Employer but the Contractor shall satisfy himself regarding all aspects of site conditions and no claim will be entertained on the plea that the information supplied by the Employer is erroneous or insufficient.

1.2.2 The area in which the work is located is in plain/rolling terrain, and lies in city limits of Greater Mumbai.

1.2.3 General Climatic Conditions

1.2.3.1 The temperature in this region is as under:

- a) During summer months, the maximum temperature is 45⁰C
- b) During winter months, the minimum temperature is 8⁰C

1.2.3.2 The average annual rainfall in the area is above 600 mm.

1.2.4 Seismic Zone

The work is located in Seismic Zone-III as defined in IRC:6-2000.

2 GENERAL REQUIREMENTS

The Technical Specifications in accordance with which the entire work described hereinafter shall be constructed and completed by the Contractor shall comprise of the following:

2.1 Part A - Additional Technical Specifications

The Clauses SP-1 to SP-17 have been added to the 'Specifications for Road and Bridge Works (Fourth revision, August 2001).

- CLAUSE SP-1 PLANT AND EQUIPMENT FOR AGGREGATES AND CONCRETE**
- CLAUSE SP-2 CURING USING LIQUID MEMBRANE FORMING COMPOUND**
- CLAUSE SP-3 ADDITIONAL SPECIFICATIONS FOR BLASTING**
- CLAUSE SP-4 ADDITIONAL SPECIFICATIONS FOR USE OF ROCKFILL IN EMBANKMENT AND BEHIND STRUCTURES**
- CLAUSE SP-5 ADDITIONAL TECHNICAL SPECIFICATIONS FOR ROAD SIGNS**
- CLAUSE SP-6 ADDITIONAL SPECIFICATIONS FOR TRAFFIC MANAGEMENT AND DIVERSION**
- CLAUSE SP-7 GEOTECHNICAL INVESTIGATIONS (EXPLORATORY)**
- CLAUSE SP-8 SPECIFICATIONS FOR INTER-LOCKING CONCRETE PAVING BLOCKS**
- CLAUSE SP-9 EXTERNAL LIGHTING INSTALLATION**
- CLAUSE SP-10 TRAFFIC SIGNALS SYSTEMS**
- CLAUSE SP-11 MAINTENANCE OF WORK ORDER BOOK**
- CLAUSE SP-12 WORKING METHODS AND PROGRESS SCHEDULE**
- CLAUSE SP-13 ADDITIONAL SPECIFICATIONS FOR MAINTENANCE OF RIGHT OF WAY**
- CLAUSE SP-14 ADDITIONAL SPECIFICATIONS FOR USE OF EXPLOSIVES**
- CLAUSE SP-15 ENVIRONMENTAL MANAGEMENT PLAN**
- CLAUSE SP-16 SPECIFICATION FOR PROVIDING ANTICORROSIVE TREATMENT TO M.S. OR HYSD REINFORCEMENT BARS**
- CLAUSE SP-17 ADDITIONAL SPECIFICATIONS FOR PQC**

In the absence of any definite provisions on any particular issue in the

aforesaid Specifications, reference may be made to the latest codes and specifications of IRC, BIS, BS, ASTM, AASHTO and CAN/CSA in that order. Where even these are silent, the construction and completion of the works shall conform to sound engineering practice as approved by the Engineer and in case of any dispute arising out the interpretation of the above, the decision of the Engineer shall be final and binding on the Contractor.

2.2 **Part-B: Amendments/Modifications/Additions to Existing Clauses of General Technical Specifications.**

The Supplementary Technical Specifications shall comprise of various Amendments/Modifications/Additions to the "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS" referred to in Part-C below and Additional Specifications for particular item of works not already covered in Part-C.

2.2.1 A particular Clause or a part thereof in "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS (Fourth Revision, August 2001)", as corrected in the original referred in Part-C, where Amended/Modified/Added upon, and incorporated in Part-B, referred to above, such Amendment/Modification/Addition supersedes the relevant Clause or part of the Clause.

2.2.2 The Additional Specifications shall comprise of specifications for particular items of works not already covered in Part-C.

2.2.3 When an Amended/Modified/Added Clause supercedes a Clause or part thereof in the said Specifications, then any reference to the superseded Clause shall be deemed to refer to the Amended/Modified/Added Clause or part thereof.

2.2.4 In so far as Amended/Modified/Added Clause may come in conflict or be inconsistent with any of the provisions of the said MORTH Specifications under reference, the Amended/Modified/Added Clause shall always prevail.

2.2.5 The following Clauses in the "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS (Fourth Revision, August 2001)" have been amended/modified/added upon:

102,107,108,110,111,112,121,123,201,202,301,304,305,401,406,407,408,
802,803,809,901,903,1007,1008,1009,1010,1012,1013,1014,1101,1118,1119,15
03,1505,1509, 1704,1705,1802,1803,1804,2002,2602,2604,2607,2609,
2706,2708, 2709.

2.3 **Part-C: General Technical Specifications**

The General Technical Specifications shall be the "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS" (Fourth Revision, August 2001) issued by the Ministry of Road Transport and Highways (formerly the Ministry of Surface Transport) Government of India, and published by the Indian Roads Congress.

- 2.4 Where reference is made in the Contract to specific standards codes to be met by the materials, plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards as on date of tender and codes in effect shall apply, unless otherwise expressly stated in the contract. Where such standards and codes are national, or relate to a particular country or region, other internationally recognised standards which ensure a substantially equal or higher performance than the standards and codes specified will be accepted subject to the Engineer's prior review and written approval. Difference between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the engineer determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the documents.

PART A ADDITIONAL TECHNICAL SPECIFICATIONS

**CLAUSE SP1 PLANT AND EQUIPMENT FOR
AGGREGATES AND CONCRETE**

1 AGGREGATE PROCESSING PLANT

Aggregate processing plant to be provided by the Contractor shall conform to the following:

1.1 Type of Plant

Except where aggregates are supplied from commercial sources, a modern and dependable aggregate plant capable of producing satisfactory concrete aggregates in sufficient quantities and the rate necessary to meet the requirements of the construction schedule shall be provided at a location acceptable to the Engineer. Complete facilities shall be provided for proper crushing, washing, classifying, storing, reclaiming and delivering the aggregates to the mixing plant.

1.2 Samples and Test

The aggregate plant shall be operated for a sufficient time in advance of the dates set for first placement of concrete to permit the development of procedures which result in high capacity production of aggregates proven by tests to meet all the requirements of this specification.

1.3 Fines in Sand

The facilitation for fine aggregate production shall be so designed and operated as to retain the necessary quantity of finer fractions. An excess of fines will not be permitted. If natural sand is from marine source, the sand

shall be cleaned of clayey material and washed with potable water before use. All crushing, washing, screening, classifying, blending, batching, or other properties of fine aggregate necessary to meet these specifications shall be performed so as to produce acceptable gradation complying with this specification.

1.4 Drainage of Sand

Aggregates shall not be removed directly from the washing or classifying operations to the aggregate bins in the concrete mixing plant, but shall be stored as required, to permit drainage of excess water and in such a manner as to avoid contamination by foreign materials. Sand shall remain free-draining storage for at least 48 hours prior to use.

1.5 Segregation

The stock piles for aggregates shall be formed so as to prevent segregation, and as approved by the Engineer. The deposition and removal therefrom shall be done in a manner to maintain the uniformity of grading. The side slopes of stock piled aggregates shall be kept flatter than the angle of repose to prevent accumulation of coarser material at the bottom of the slope.

1.6 Volume of Storage

Sufficient live storage of all size fractions of processed aggregates, shall be maintained at all times, to permit continuous placing of concrete at the rates so as to meet the Schedule requirements. If aggregates are stock piled on the ground, the bottom portion of the stock pile within 30 cm of ground shall not be used. The Contractor may also plan to store sufficient quantity of coarse and fine aggregate so that concreting during monsoon can proceed without hindrance as the collection of the same during monsoon may be difficult.

1.7 Approval of Aggregate Plant Layout

Plans and written specifications for the aggregate processing plant including description and capacity data on the processing equipment, and flow charts of the whole processing operation which shall show rates of flow of material at the various crushing and separation points in the processing, as well as the volumes of the stock piles and the number and types of equipment to be used in transporting the aggregates from aggregate plant to the mixing plant shall be submitted to the Engineer in advance of plant erection for his approval.

2 CONCRETE PLANT

A modern dependable batch type mixing plant capable of producing concrete of specified quality and at the rate of output required to meet the schedule requirements, and a balanced complement of transporting, handling and placing equipment shall be provided at locations and in a manner approved by the Engineer. The concrete mixing plant shall be completely installed for a sufficient length of time prior to scheduled date for placement of first concrete, to enable the Engineer to make the necessary physical tests prior to use of the plant for the production of concrete.

2.1 Standby Arrangement

As a standby arrangement to the batching and mixing plant the stationary mixer / mixers of capacity 700 litres of mixed concrete and other appropriate equipment shall be provided.

2.2 Type of Plant

The type of plant to be furnished shall be fully automatic.

The term "automatic" is used to define a plant in which :

- i) Batch weights are set manually on a mix selector
- ii) Mixes are charged automatically by mix selector
- iii) Materials are batched automatically

Ice flaking machine of sufficient capacity shall be installed as a part of batching plant.

2.3 Batchers

Individual weigh batchers shall be provided for all works, requiring the use of more than two separate size groups of coarse aggregates. Cumulative weight batchers may be used for work requiring the use of not more than two separate size groups of coarse aggregates provided the cement is weighed and batched separately from the aggregates. The batchers shall be arranged to permit the convenient addition or removal of material. Batching equipment shall be so constructed and arranged that the sequence and time of discharge can be controlled to produce a reblending and mixing of the aggregates and, wherever possible, mixing of the cement with the aggregates as the materials pass through the charging hopper in to the mixer. This control shall be effected by the controls of the batcher discharge gates. Batchers shall be so interlocked that a new batching cycle cannot be started until all batchers are completely empty.

- i) **Weighing Units**

Every delivering point of aggregates and cement in to the mixer, charging hopper shall have a weighing unit and each weighing unit shall include a visible, springless direct reading dial which shall indicate the scale load at all stages of the weighing operation from zero to full capacity. The scale dials and the weighing equipment shall be in full view of the operator, so that he may conveniently observe the operation of the batcher gates and the discharge of the materials. Provision shall be made for adjustment and change in weights of materials being charged in the hopper.

ii) **Measuring Water & Ice**

Water shall be measured by weight except in situations for which written approval is given by the Engineer to measure by volume. The mechanism for measuring and delivering water to the mixers shall not permit leakage when the valves are closed. Ice shall be measured by weight. The filling and discharge shall be measured by weight. The filling be capable of ready adjustment to permit varying the quantity of the admixtures to be batched. The equipment shall be kept in a clean and fully operating condition.

iii) **Tolerance in Batching, Weighment Errors**

Weighing devices shall be capable of measuring the various ingredients of the following accuracy.

<u>Materials</u>	<u>Percent</u>
Cement	1 (by weight)
Water	1 (by weight)
Aggregate smaller than 40mm size	2 (by weight)
Admixture	1 (by weight or volume)

iv) **Records & Charts**

An accurate record shall be maintained at the batching plant by the contractor for the followings :

- a) The weight of the cement, water and admixture.
- b) The weight of the aggregate for each size shall be recorded separately.
- c) Temperature of the concrete immediately after mixing.
- d) Mixing time of each batch when all the materials are loaded into the mixer.
- e) Time when the concrete is delivered from the mixer.
- f) Ambient temperature.

v) **Recorder Records & Charts**

A recorder shall be provided for each set of units measuring each of the materials delivered to the mixer. The recorder shall produce a continuous visible record, on a single ruled chart, of the weight of the cement, water and each size of aggregates, of the mixing time of each batch after all materials are in the mixer, of the temperature of the concrete and of the time of day at intervals of not more than fifteen (15) minutes. The recorder shall be completely housed and shall be capable of being locked and shall be placed in a position convenient for observation by the plant operator and the Engineer. Each chart shall be so ruled and printed that it may be readily and permanently identified, so that the quantities and time may be read directly without scaling or calculation. A portion of the recorder chart equivalent to at least thirty (30) minutes of plant operation shall be visible after recording. This portion of the chart shall be supported over its entire width on a smooth, firm backing so that notes can be made without puncturing the paper. The recorders and scale dials shall be housed in a room, box or compartment visible at all times and sufficiently tight to exclude objectionable dust coming from the plant operation.

vi) **Cement Weight Recorder**

This shall be provided separate from and in addition to the autographic recorder chart, an automatically printed record of the quantity of cement discharged from the batchers for each batch of concrete. The weight of the cement charged shall be recorded in kilograms, the recording shall be continuous and each batch shall be recorded separately. The interconnecting mechanism from the batcher to the recorder shall be locked and the key thereafter turned over to the Engineer.

vii) **Air Temperature Recorder**

There shall be provided an autographic record of the air temperature. The thermometer shall be placed at a location so as to truly represent the outside air temperature at the site. The recorder itself shall be properly housed.

2.4 Mixers may be stationary mixers of either the tilting or non-tilting type of approved design.

i) **Maintenance**

The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free of hardened concrete. Mixer blades shall be replaced when worn down more than 10 percent of their depth. Should any mixer at any time produce unsatisfactory results, leak mortar or cause wastage of materials, its use shall be promptly discontinued until it is repaired.

ii) **Mixing Time**

The mixing periods specified herein are to ensure proper quality control. The mixing time will be increased when such increase is necessary to secure the required uniformity and consistency of the concrete. Excessive overmixing requiring additions of water will not be permitted. When stationary mixers are used, the mixing time for each batch shall be as follows;

Time shall start when all solid materials are in the mixer drum, provided that all of the mixing water shall be introduced before one-fourth of the mixing time has elapsed. The Engineer, may, however, direct change in mixing time, if he, in his opinion, considers such change necessary.

Capacity of Mixer (Cubic Metre)	Time of Mixing (Min.)
Upto 2.00 Cubic Metre	1 ½
Upto 3.00 Cubic Metre	2
Upto 4.00 Cubic Metre	2 ½

Stationary mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Provision also shall be made to assure that each batch is discharged completely before the mixer is recharged.

2.5 Provision for Inspection

The complete plant assembly shall include provisions to facilitate the inspection of all operations at all times.

2.6 Maintenance of Records

All records and charts of the batching and mixing operations shall be prepared as specified herein and promptly turned over to the Engineer.

2.7 Sampling Facilities

Suitable facilities shall be provided for readily obtaining representative samples of aggregate from each of the batchers, and suitable devices for obtaining representative samples of concrete for slump tests, unit weight, air content, and uniformity tests to be made by the Engineer, shall be provided. All necessary platforms, tools and equipment for obtaining samples shall be furnished at the start of work.

2.8 Concrete Specimens

Concrete specimens will be prepared from the mixes used in the work and tested to determine the adequacy of control of the materials entering into the concrete mix. Preparation, storage and testing of the specimens will be

performed by the Engineer. Suitable facilities when demanded shall be provided within the plant for the Engineer and his assistants to carry out the necessary control work.

2.9 Test Weights

Standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device shall be provided. Periodic tests shall be made in the presence of the Engineer in such a manner and at such intervals as may be directed by the Engineer. Upon completion of each such test, and before further use of the measuring, weighing or recording devices, such adjustments, repairs, or replacements shall be made as may be required to secure satisfactory performance.

2.10 Approval of Concrete Plant Layout

Plans and Technical data for the concrete plant proposed for use to produce the quantities and quality of concrete for completion of the concrete works under this specification shall be submitted to the Engineer well in time.

CLAUSE SP-2 CURING USING LIQUID MEMBRANE FORMING COMPOUND

1 GENERAL

Liquid membrane forming compounds are permitted to be used by the Engineer for curing concrete for part or whole of the total curing period as specified in sections dealing with concrete construction. These membranes reduce the loss of water from concrete during early hardening period and some types of compounds also help in reducing the temperature-rise of concrete exposed to the radiation from the sun. These specifications cover the type and use of such compounds. However, the use of the same will need specific permission from the Engineer, who may require a number of tests to be carried out for establishing the conformity of the product to these specifications and to establish that the curing compound and its method of use does not have any unacceptable effect on the quality of concrete. The cost of the initial acceptance testing and the quality control testing will be borne by the contractor.

All equipment, material etc., needed for curing and protection of concrete shall be at hand and ready for installing before actual concrete begins. Detailed plans, methods and procedures whereby the various phases of curing and protection shall be firmly established, shall be settled and got approved in writing from the Engineer-in-charge sufficiently in advance of the actual concreting. The equipment and method proposed to be utilised shall provide for adequate control and avoid interruption or damage to the work of other agencies.

2 CURING COMPOUND

1. The curing compound shall be conforming to ASTM-C-309-81, Type-2, white pigmented compound. The solids dissolved in vehicle shall be either class 'A' (no restrictions) or Class 'B' (resin as defined in ASTM D-883) as approved by the Engineer.
2. White pigmented compound (Type-2) shall consist of finely divided white pigments as vehicle solids, ready mixed for immediate use without alteration. The compound shall present a uniform white appearance when applied uniformly to a fresh concrete surface at a specified rate of application. It shall be of such consistency that it can be readily applied by spraying to provide uniform coating at temperatures above 4°C. If two coats are to be applied then it should be applied at an interval of approximately one hour. They shall adhere to freshly placed concrete that has stiffened or sufficient to resist marking during the application and to damp hardened concrete and shall form a continuous film when applied at a rate of ***5 m² / litre***. When dry, the covering shall be continuous flexible and without visible breaks or pin holes and shall remain as unbroken film at least 28 days after application. It shall not react deleteriously with the concrete.
3. The compound shall meet with the requirement of water retention test as per ASTM designation C-156-80. The loss of water in this test shall be restricted to not more than 0.55 kg/m² of exposed surface in 72 hours.
4. The white pigmented compound (Type 2) when tested as specified in accordance with method E-97 of ASTM shall exhibit a day light reflectance of not less than 60% of that of magnesium oxide.
5. It shall fulfil the requirement of drying time when tested in accordance with ASTM-C-309-81. The compound applied shall be dry to touch in not more than 4 hours. After 12 hours it shall not be tacky or tack off (peel off) concrete when walked upon nor it shall impart a slippery surface.
6. The liquid compound should be of a sprayable consistency.

3 SUPPLY AND TESTING

3.1 Acceptance Testing

Prior to the approval of the brand / trade name of compound and the source of supply and manufacturer acceptance testing shall be carried out to demonstrate the conformance of the compound to clause 5502. In addition,

testing shall be performed to demonstrate that no adverse / undesirable change in quality of concrete or concrete surface takes place as a result / by-product of the use of the compound. These tests should be designed to check properties such as loss of strength at 28 days of surface layer, or of concrete cube, change in surface texture, change in adhesion to subsequently applied layer like plaster, flooring, tiling etc. The type and number of tests are to be as specified by the Engineer.

3.2 Routine Testing

1. The liquid membrane forming curing compound should be brought in the manufacturer's original clear containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the compound, the type of compound and class of vehicle solids, the nominal percentage of volatile material and batch or lot number. The lot numbers will be assigned to the quantity of compound mixed, sampled and tested as single product. The manufacturer shall exercise the care in filling the container so that all are equally representative of the compound produced.
2. Curing compound to be used on site shall be got tested at least 14 days in advance so that the result of water retention tests, reflectance test, drying etc, are available before it can be permitted for use. All of the filled containers represented by the approved sample shall then be sealed to prevent leakage, substitution or dilution. The Engineer-in-charge or authorised representative should mark each container represented by the samples with a suitable identification mark for later identification and correlation and shall be kept in store with double lock arrangements. One key shall be kept with the Contractor and the other with Engineer. Random samples shall be collected from every batch of the compound. Frequency of random sampling shall be done as directed by the Engineer. The Contractor shall provide samples and labour for collecting samples free of cost. Testing shall be carried out by agency approved by the Engineer and in presence of his representative.

4 METHOD OF APPLICATION

The compound shall be sprayed using mechanical sprayer of approved design to ensure uniform and continuous membrane on the concrete surface. The coverage shall be at the rate specified by the manufacturer or at the rate of 4 m² per litre or as specified by the manufacturer and approved by the Engineer. Field trials shall be conducted to decide effective coverage rate, which depends upon surface finish. The Engineer after verification of the field trials and based on the actual experience shall order the rate of application as needed for achieving the proper curing. With a view to ensure thorough and complete coverage, approximately one half of the compound for a given areas should be applied by moving the spray gun back and forth in one direction and the remaining half at right angles to this direction. In case the application is still not found uniform, the Contractor shall have to

apply the second coat as an when directed by the Engineer. If a second coat is to be applied, it should be applied approximately after an interval of one hour. The curing compound shall generally be applied as soon as the bleeding water or shine disappears, leaving dully appearance.

If surface treatment by roughing, hand brushing etc., is required (e.g. as in case of road pavements) the curing compound should be applied immediately after the same. Equipment for spraying curing compound shall be of pressure tank type (5 to 7 kg/cm²) with provision of continuous agitation. A curing jumbo with multiple travelling spray fans shall be provided for effective spray. Spraying on concrete lining shall be done in such a way that the green concrete is not disturbed or damaged or any foot impression left. Necessary schemes or spraying by mechanised means shall be got approved by the Engineer-in-charge. However, in emergency for very small areas / patches) it can be applied with wire or bristled brush.

CLAUSE SP3

ADDITIONAL SPECIFICATIONS FOR BLASTING

1 General

The specifications for excavation in rock are covered by MORT&H "Specifications for Road & Bridge Works" (4th Revision August 2001). The following specifications are additional supplementary to the same.

2 Control Blasting

The rock blasting shall be controlled so that vibration generated during the blasting do not cause damage to the building and installation around built up areas as given in the table below. Similarly the rock pieces should not fly off the pits and thus damage the buildings and installation and life and limb of people around. Apart from the general precautions mentioned in the MORT&H Specifications, following protective measures and limits for use of explosives are suggested as guidelines. The contractor shall carefully check the site conditions and submit the details of the scheme they propose to adopt for controlling the blast.

3 Protective Measures

The following precautionary measures (single or in combination) as required by site conditions shall be adopted by the contractor while carrying out controlled blasting.

- i) Short delay blasting with light charges shall be used.

- ii) The blast hole shall be covered with 0.6 to 1.0 Sqm mild steel plate of minimum 6mm thickness.
- iii) Reinforcement rod mesh not less than 20mm dia at 150 mm centres in both directions shall be placed over the steel plates.

Steel plate and reinforcements shall be inspected after every blasting operation and all twists shall be removed before reuse to the satisfaction of the engineer.

The thickness of the covering plate and the kind of dead weight is to be duly approved by the Engineer.

When blasting is necessary adjacent in partially or completely built structures the Contractor shall take all precautions necessary to prevent flying rock from causing damage to the structures.

4

Blasting Within Certain Limit

No blasting shall be allowed for any of the excavation until freshly placed concrete of nearby structures has reached a minimum strength of 7 N/Sq. m.

Normally blasting shall be resorted to only after 7 days of concreting work in case of OPC (10 days in case of PPC) in adjacent structures.

In no case shall blasting be allowed closer than 15m to any structure after concrete placing has started.

The Contractor shall submit the scheme with charges and delay detonators he proposes to use for blasting, for approval of the Engineer.

Permissible Standards:

Depending on the type of structures and the dominant excitation frequency, the permissible peak particle velocity (ppv) due to blast induced ground vibrations adjacent to the structures shall not exceed the values given below in the table:

Table : Permissible Peak Particle Velocity (PPV) at the foundation level of structures in Blasting Areas in mm/s is recommended as below.

Type of Structure	Frequency Hz. PPV (mm/sec)
Buildings / Structures not belong to the owner :	
i) Domestic houses / Structures	5

Type of Structure	Frequency Hz. PPV (mm/sec)
(Kuchha, Brick and Cement)	
ii) Industrial Buildings (RCC and Framed Structures)	10
iii) Objects of historical importance and sensitive structures	2
(B) Buildings belonging to owner with limited span of life :	
i) Domestic houses / structures (Kuchha, brick and Cement)	10
ii) Industrial building (RCC and framed structures)	6

It is generally recommended that where the blasting is to be done, within 20 metres of the nearest point of permanent building, the area shall be line drilled on periphery before blasting.

The Contractor shall be responsible for all damage caused by blasting whether to permanent or temporary structures and shall replace or repair the structures at his own cost. Contractor will have to design the charge per delay to restrict the PPV as indicated above.

5 Precautions after Blasting

After the blast, the Supervisor must carefully inspect the work and satisfy himself that all the charges have disappeared from the face.

If it is suspected that part of the blast has failed to fire or is delayed, sufficient time shall be allowed to elapse before entering the danger zone. When fuse and blasting caps are used, a safe time should be allowed and then the Supervisor alone shall leave the shelter to inspect the blasting zone.

None of the drillers are to work near the misfired hole until one of the two following operations have been carried out by the Supervisor.

(i) The Supervisor should very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper or jet of water or compressed air (Using a pipe of soft material) and withdraw the fuse with the primer and a fresh detonator with fuse should be placed in these holes and fired out, or (ii) the hole may be cleared or 30m of tamping and its direction then be ascertained by placing a stick in the hole. Another hole may then be drilled at

least 60 cms away and parallel to it and about 30 cms less in depth, this hole shall then be charged and fired. The balance of the cartridges and detonators found in the muck shall be removed.

Before leaving his work, the Supervisor of the concluding shift shall inform the Supervisor of the relieving shift of any case of misfires and should point out the position with a red cross denoting the same and also stating what action, if any, he has taken in the matter.

The Supervisor should also at once report at the office of the Contractor and the Engineer all cases of misfire, the cause of the same and what steps were in connection with these.

The names of the day and night shift Supervisors must be noted daily in the Contractors office.

If a misfire has been found to be due to a defective detonator or dynamite the whole quantity or box from which the defective article was taken, must be thoroughly inspected by the Contractor.

Drilling in holes not completely exploded by blasting shall not be permitted.

6 Personnel

Excavation by blasting will be permitted only under the personal supervision of competent and licensed blasters and trained workmen.

All Supervisors and workman in-charge of preparation, handling storage and blasting work shall be adequately insured by the Contractor.

Storage shall be in charge of a very reliable person approved by the Engineer, who may, if necessary conduct police enquiry's as to his reliability, antecedents etc. The Contractor shall have to produce a security for the person in-charge of the explosive, if and when required by the Engineer, or the civil authorities of the district.

The Contractor shall make sure that his Supervisor and workmen are fully conversant with all the rules to be observed in storing, handling and use of the explosives. It shall be ensured that the Supervisor in charge is thoroughly acquainted with the details of the handling of explosive and blasting operations.

7 To establish the safe charge per delay contractor will have to demonstrate by necessary instrumentation for the approval of the Engineer.

CLAUSE SP4 ADDITIONAL SPECIFICATIONS FOR USE OF ROCKFILL IN EMBANKMENT & BEHIND STRUCTURES

Contractor

1 General

These special additional specifications are supplementary to MORT&H Specification no. 313 (4th revision 2001) and supersedes those provisions to the extent modified hereunder.

2 Scope of Application

Material can be used only in the following circumstances by the approval of the Engineer:

- (i) Where height of embankment is more than 3 m (including formation level) the lowest 1m thickness can be constructed by rock fill.
- (ii) For all heights, the sloped portion beyond shoulder can be constructed using with provision that under all circumstances, minimum 500 mm thick earthen cushion shall be available between formation level and top level of rock fill.
- (iii) Behind the structures irrespective of height of embankment up to bottom of subgrade.

3 Material

The maximum size of stones shall not exceed 300 mm in any direction. The voids between rocks shall be filled by smaller fragments.

4 Spreading and Compaction

The method of compaction as specified in MORT&H specification and / or as directed by the Engineer, should ensure that no boulders are loosely packed and can move or rock after compaction. The top layer of as well as the sides of the retaining normal earthfill on one side shall be fully blinded with filter media comprised of crushed aggregate and sand. The grading and layering of filter media shall be such as to form effective filter layer through which particles of inner soil fill of embankment are not able to migrate into the in the process of settlement / consolidation or due to movement of water. The layering shall confirm with the layers of adjacent rockfill so as to facilitate simultaneous compaction.

- 5** The rates are applicable to completed construction as measured by taking levels before and after compaction upto top of blinding / filter media 300 mm thick and are inclusive of all materials, void filling materials, blinding materials & filter *media*.

CLAUSE SP5 ADDITIONAL TECHNICAL SPECIFICATIONS FOR ROAD SIGNS

1 General

The Colour, configuration

The Colour, size & location of all traffic signs for the project road shall be as specified in the drawings and in the absence of any details or any missing details, the signs shall be provided as directed by the Engineer.

1.1 The sign shall be reflectorised as shown on the drawings or as directed by the Engineer. The signs shall be of retro reflective type and made of prismatic reflected sheeting as per Cl. 1.3 fixed over aluminium sheeting as per these specification.

1.2 The cautionary and mandatory signs shall be fabricated through process of screen-printing. In regard to informatory signs with inscriptions, the message shall be of cut out letters made in the transparent overlay film pasted over the base sheeting with pressure sensitive or as instructed by the manufacturers or as directed by the Engineer.

2 Material

The various materials and fabrication of the traffic signs shall conform to the following requirements:-

2.1 Concrete :- Concrete shall be of the grade shown on the contract drawings or otherwise as directed by the Engineer.

2.2 Reinforcing Steel :- Reinforcing steel shall conform to the requirement of IS : 1786 unless otherwise shown on drawing.

2.3 Bolts, nuts, washers :- High strength bolts shall conform to IS: 1367 whereas precision bolts, nuts etc. shall conform to IS : 1364. The bolts and nuts shall be galvanised (zinc coated, 0.55 kg/sqm minimum single spot) and galvanising shall conform to relevant IS specifications.

2.4 Plates and supports: Plates and support sections for the signposts shall conform to IS: 226 and IS: 2062 or any other relevant IS specifications. The plates and supports shall be galvanised (zinc coated, 0.55 Kg per Sqm. minimum single spot.) and galvanising shall conform to relevant IS specifications.

2.5 Aluminium:- Aluminium sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium alloy conforming to IS: 736 – Material designation 24345 or 1900. The back of the sheet will be painted with two coats of Epoxy paint.

2.6 The thickness of sheet shall be 3 mm for all types of signs.

3 Structural Details

The structural details for supports shall be as per the contract drawings and or as directed by the Engineer.

4 Retro-reflective sheeting

4.1 General requirements

The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface, which has the property of retro-reflective over its entire surface. It shall be weather resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure (stating retained reflection of 80 %) facing the sun for three years and its having passed these tests shall be obtained from a reputed laboratory, by the manufacture of the sheeting.

The reflective sheeting shall be of wide angle prismatic lens type of ASTM-Type – IX.

- 4.2** The retro-reflective sheeting shall be of wide angle Prismatic lens type, consisting of cube corner lenses and pressure sensitive adhesive and should be applied to the sign substrate at room temp. 18 C, transparent, waterproof plastic having smooth surface. The coeff of retro reflective as determined in accordance with ASTM standard E- 810 shall give the minimum values as indicated in table given below.

TABLE SP-16

Minimum Coefficient of Retro-reflection for retro-reflective sheeting Prismatic lens type (candelas / lux / sqm)

TABLE – 1

**Minimum Coefficient of Retro-reflection for retro-reflective sheeting
Prismatic lens type (candelas / lux / sq. m)**

Obse. Angle (in deg.)	Entrance Angle (in deg.)	White	Yellow	Green	Red	Blue
0.1	-4	660	500	66	130	30
0.1	+30	370	280	37	74	17
0.2	-4	380	285	38	76	17
0.2	+30	215	162	22	43	10
0.5	-4	240	180	24	48	11
0.5	+30	135	100	14	27	6
1.0	-4	60	60	8	16	3.6
1.0	+30	45	34	4.5	9	2

When totally wet, the sheeting shall not show less than 90% of the values of retro reflectance indicated in Table 1. At the end of 7 years, the sheeting shall retain at least 75% of its original retro reflectance.

5 Messages / Borders

5.1 The messages (legends, letters, numerals etc.) and borders of Cautionary / Regulatory sign boards shall be screen printed. Screen printing shall be processed and finished with materials in a manner specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. The messages (legends, letters, numerals etc.) and borders of information signs, shall be of cut letters made in transparent overlay film pasted over the base sheeting with pressure sensitive adhesive or as instructed by the manufacturers or as directed by the Engineer.

5.2 For screen printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than the values of corresponding colour in Tables-1.

5.3 Cutout messages and borders, wherever used, shall be made in transparent film applied on base sheeting with pressure sensitive adhesive with the coefficient of retro reflection shall not be less than the values of corresponding colour in Table-1. For the background colour of the sign the coeff of retro reflection shall not be less than that specified in Table -1 for the respective colours.

6 Colour

Colour shall be as specified and shall conform to the requirements of Table 2. Conformance to colour requirements shall be determined spectrophotometrically in accordance with ASTM E 1164, with instruments

utilizing either 45/0, or 0/45 illumination/viewing conditions and tolerances as described in ASTM E 1164 for retroreflective materials.

Table 2

Colour	x	y	x	y	x	y	x	Reflectance		
								Limit (y)		
								y	Min	Max
White	.3 0	.3	.3 5	.35	.33	.37	.28	.32	40. 0	
Yellow	.4 8	.4 2	.5 4	.45	.46	.53	.42	.48	24. 0	45.0
Red	.6 9	.3 1	.5 9	.31	.56	.34	.65	.34	3	15
Blue	.0 7	.1 7	.1 5	.22	.21	.16	.13	.03	1.0	10.0
Green	.0 3	.3 9	.1 6	.36	.28	.44	.20	.79	3.0	9.0

The four pairs of chromaticity coordinates determine the acceptable colour in terms of CIE 1931 standard colorimetric system measured with standard illumination source D65- these colours are equivalent to those listed in ASTM D4956 using source C

The colour shall be durable and uniform in acceptable hue when viewed in daylight or under normal headlights at night.

7

Adhesives

The sheeting / film shall have a pressure sensitive adhesive of the aggressive tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type material of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate. In case of pressure sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications.

8

Fabrication

8.1

Surface to be reflectorised shall be effectively prepared to receive the retro reflective sheeting. The aluminium shall be de-greased either by acid or hot alkaline etching and all scale / dust removed to obtain a smooth plain surface before the application of retro reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be

handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting / primer. There shall be no opportunity for metal to come in contact with grease oil or other contaminates prior to the application of retro reflective sheeting.

- 8.2** Complete sheets of the material shall be used on the signs except where it is unavoidable; at splices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. The transparent overlay film in which cutout messages have been made shall be bonded with sheeting in the matter specified by the manufacturer.

9 **Warranty and Durability**

The contractor shall obtain from the manufacturer a seven year warranty for satisfactory field performance including stipulated retro reflectance of the retro reflective sheeting of Prismatic lens type and that of transparent film and submit the same to the Engineer. In addition, a seven year warranty for satisfactory in field performance of the finished signs with retro reflective sheeting of Prismatic lens type, inclusive of the screen printed or cutout letters / legends, transparent film and their bonding to the retro reflective sheeting shall be obtained from the contractor / Supplier and passed on to the Engineer. The contractor / Supplier shall also furnish a certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty.

Warranties should be given in original and should have legal jurisdiction in India. Warranties given by power of attorney holders will not be acceptable.

Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning, shall show no appreciable discoloration, cracking, blistering or dimensional change and shall not have less than 50 % of the specified minimum reflective intensity values (Tables 1) when subjected to accelerated weathering for 1000 hours, using type E or EH weatherometer (AASHTO Designation M-268).

10 **Installation**

- 10.1** Sign posts, their foundation and sign mountings shall be so constructed as to hold these in a proper and permanent position. Sign supports shall be of Galvanised structural steel and shall be firmly fixed to the ground by means of properly designed foundation or as shown in the contract drawings. The work of foundation shall conform to clause 801.4.4.

10.2 All components of signs and supports, excluding the back side of aluminium sheet and the reflective portion shall be thoroughly descaled, cleaned and galvanised (zinc coated, 0.55 Kg/Sqm. minimum single spot.) and shall conform to relevant IS Specifications.

10.3 The signs shall be fixed to the posts by welding and/or bolts and washers as shown in the drawing. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

11 Foundation for Support

11.1 Foundation for supports of sign boards with single support shall be by making excavation in all type of strata to the sizes and level as shown in relevant drawings and fixed with M-20 grade cement concrete during installation.

11.2 Foundation for supports of sign boards with two or more supports shall be made by boring holes in all types of strata to the sizes levels as shown in relevant drawings and fixed with M-20 grade cement concrete during and installation. All concrete works will be carried out as per relevant MORT&H Specification.

12 Measurement for Payment

The measurement of standard cautionary and mandatory sign boards shall be in numbers of sign boards supplied and fixed and this shall constitute full payment for supply of all materials for the sign board and its supports and foundations, fabrication and installing in ground or embankment etc. as per specifications. Informatory sign boards with board area exceeding 1 Sqm. shall be measured by area of the reflectorised sheet in square meters.

13 Rate

The contract unit rate shall be payment in full for the cost of making the road sign including supports and foundations, including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications. In case of overhead sign boards supported on overhead gantry the rate shall not include the support gantry, its foundation and erection which shall be paid separately.

CLAUSE SP6 ADDITIONAL SPECIFICATIONS FOR TRAFFIC MANAGEMENT AND DIVERSION

The contractor shall prepare and submit to Engineer within one month of the date of commencement of work, a detail traffic diversion plan as per the requirement of traffic authorities. The contractor shall have to carry out the modifications in the traffic diversion plan at various stages of work as required. The contractor shall maintain liaison with the traffic police /

authorities so as to ensure smooth flow of traffic at all stages of the work without causing inconvenience to the traffic.

1 Traffic Rotaro

The contractor shall provide traffic rotaro showing traffic direction made up of four bliners mounted on M.S. Frame of 5-x50x6mm size 250 Hz frequency electrically operated at both ends of the cordoned area for help and guidance of road users. Necessary arrangements for supply of electricity shall be made by the contractor.

2 Road Delineates

Road delineates as per IRC-79 and as per relevant drawings and as directed by Engineer shall be fixed at suitable intervals to have a suitable guidance to the road users at the night time for smooth flow of traffic. Delineators shall be fixed firmly in the ground. Also red flags, cat eye reflectors shall be fixed on the barricades. Alternative arrangements shall also be kept ready in case of failure of electricity.

- 3** Signs, lights, barriers and other traffic control devices shall be provided and maintained in a satisfactory condition till such time they are required as directed by the Engineer, so as to ensure smooth and safe traffic on the road throughout the length.

CLAUSE SP7 GEOTECHNICAL INVESTIGATIONS (EXPLORATORY)

1. SCOPE OF PROPOSED INVESTIGATIONS

The exploratory Geotechnical Investigations are required to be conducted at three locations along the alignment of Jogeshwari – Vikhroli Link Road. The proposed structures include Seepz Flyover and 2 Subways located at km 2+980 and 4+300.

The scope of the geotechnical investigation is discussed below and is given in the Bill Of Quantities.

The present scope of work includes drilling of 23 numbers of exploratory boreholes, collection of disturbed and undisturbed samples, conducting Standard Penetration Tests and Vane Shear Tests and all other required laboratory tests.

The given scope of work is only provisional and may be increased or decreased, as found necessary, by the Engineer during the course of the investigation. No claim for revision of rates due to change in scope of work shall be acceptable. For any additional items contractor shall submit rate analysis and shall get the same approved from the engineer before commencement of work.

2. SPECIFICATIONS

2.1 FIELD WORK

a) Boreholes

The borehole diameter shall be of adequate size (atleast 150 mm) to obtain 100mm diameter undisturbed samples from the borehole. The borehole depths are likely to vary depending on location. The probable maximum depth is likely to be about 15 to 20m.

Field testing in boreholes includes Vane Shear Tests and Standard Penetration Test as stipulated by the engineer during execution. Sampling in boreholes includes undisturbed and disturbed sampling of all types of materials, rock cores and groundwater. All field and laboratory testing shall be conducted in accordance with relevant IS Codes and as stipulated by the Engineer.

b) Drilling In Soils Other Than Rock

The boreholes should be drilled at the locations indicated on the drawing to be furnished by the Engineer.

Rotary drilling rig preferably hydraulically operated, with drill pipes and drill bits, swivel type double tube core barrels of M-series with matching diamond bits/triple tube core barrels or type as required by the Engineer, undistributed soil samplers like push sampler/piston samplers, SPT equipment, drilling mud chemicals, all consumables and all other accessories and spares as required for investigations in all kinds of soils and rocks shall be mobilised by the contractor. The rotary drill method shall be preferred to shell and augur method while boring in soil. Calyx type drilling rigs shall not be allowed under any circumstances. The method of advancing the borehole in soil overburden by establishing the sides of the boreholes by drilling mud (Bentonite) is considered preferable to casing of the borehole. Drilling should be carried out in such a manner as to limit disturbance of the soil to be sampled or tested to a minimum. Washing tools should have proper side jets and under no circumstances will bottom discharging tools be permitted. The insert casing shall be sufficient to allow for in-situ sampling and testing with standard sampling and testing tools.

Electronic theodolite and other necessary survey equipment shall be mobilised along with necessary personnel for operation of the same for positioning of the borehole locations and measuring ground levels.

All personnel required for round-the-clock operations including a graduate engineer in each shift should be available at site. All such personnel mobilised for each shift of 12 hours shall have minimum of three years of experience in the same type of job. The project in-charge shall be a post-graduate geotechnical engineer with minimum of five years of experience in the same type of job.

The borings shall be carried out in accordance with relevant Indian Standard

Code of Practice and the requirements stated herein. The boring, sampling and in-situ testing shall be carried out in a manner approved by the Engineer who shall have the right to order alternative procedures if he is not satisfied with the quality or accuracy of the work.

The observations during boring shall be put down in such a manner, so that each change in strata is accurately determined to the satisfaction of the Engineer. During the boring operation, particular attention shall be paid to the disturbed material washed up or brought up by the shell and auger, and these shall be described in the boring logs. These disturbed materials should be preserved in polythene bags with tags stating borehole reference, depths, nature of soil etc.

The work of drilling in soil shall be carried out in such a manner that disturbed as well as undisturbed samples of soil can be conveniently collected at the required depths/intervals, and penetrometer tests can be carried out if required. The Contractor shall adopt such a method, which will permit the collection of samples indicating the grain size distribution of natural strata without loss of fines, covering the entire depths.

Water samples shall be collected from the boreholes. Water samples shall be collected prior to addition of Bentonite to boreholes. If this is not possible then prior to collection of water samples, the borehole shall be dewatered by about half a metre depth and water allowed rising back prior to sampling. Ground water level for each borehole shall be checked during boring operation and shall be recorded in borelog.

The drilling operations may be interrupted for collecting the samples, probing and conducting penetrometer tests etc. The casing pipes shall not be removed unless directed by the Engineer. Even after removal of the casing, a piece of pipe should be left in the borehole to identify the location.

The Contractor shall ensure that sand-blow conditions do not develop while drilling, sufficient surcharge of water or drilling mud should be maintained all throughout the drilling operation.

In the exploration programme the contractor shall associate with the provisions of IS:1892.

c) Undisturbed Soil Samples

In overburden undisturbed samples shall be recovered from the borings at intervals not exceeding 3m and at every change of strata. The undisturbed sampling shall conform to IS Code 2132 (1972). Undisturbed samples shall be collected in returnable tubes of 100mm internal diameter. Attempts should be made to collect undistributed soil sample of 500mm to 600mm in length.

The sample tube shall have a proper identification mark painted on it (e.g. borehole reference, depth, location, arrow mark indicating bottom end of the sample tube etc.). The moisture in undisturbed samples shall be carefully preserved by sealing both ends of the sample tube by applying a double coat of cotton waste and paraffin wax.

d) Disturbed Soil Samples

Disturbed soil samples shall be collected from boreholes. These shall include soil samples collected from the split spoon samples and also from the cutting edges of UDS. The samples shall be stored in plastic bags.

e) Drilling in Rock

In general, boreholes should be taken to relatively hard strata. Should rock be encountered in soil borings, it shall be proven by core drilling for a penetration of at least 3 m, or as directed by the Engineer. Rock cores shall be retrieved in minimum NX size by using swivel type double or triple tube core barrels with a suitable core catcher and diamond bit. Single tube core barrels or calyx type drills will not be permitted. Drilling mud or any other fluid likely to aggravate core slips shall not be used.

If required, in all types of rock, the borings will be extended more than the depths specified above, as directed by the Engineer. When drilling in all types of rock, instructions given in IS 4078, 4464, 5313 and 6926 shall be followed.

During the drilling operation, particular attention should be paid to get the core recoveries and rock quality designations of the highest standards. Percentage core recovery and RQD should be indicated continuously from the depth starting from the level of highly weathered rock. If the core is broken by handling or during drilling, the fresh broken pieces shall be placed together and counted as one piece. This has to be done as the cores come out during drilling, with the permission of Engineer.

Soil samples and rock cores collected continuously to full depth of boreholes should be clearly marked with good quality oil paint. They shall be designated by number, arrows, depths, borehole to which it belonged etc. for the purpose of identification at a later date. Sketch pens or marker pens shall not be used for writing numbers on core pieces.

When bedrock is encountered, drill hole shall continue atleast three metres in sound rock to ensure the continuity of the strata. If weathered or soft rock is met with, drill hole shall continue 5 metres into the rock layer. However if heavily shattered rock due to various weathering process or weak rock zone susceptible to erosion when subjected to action of flowing water or any other types of rock which can not be recommended as a founding strata is met with continuing 6 to 7 metres then the drilling shall continue through the weak

zone well into the sound rock below the top weak zone. Such incidences shall be brought to the attention of the Engineer and no borehole shall be terminated without the approval of the Engineer.

The characteristics/strength of rock with respect to weathering, hardness, joints and bedding and rock quality designation (RQD) as presented in Tables 2,3,4 and 5 in Appendix I of IRC 78-1983 shall be followed and the same shall be indicated in the borelogs.

Drilling through rock being a specialised work, every care shall be taken to notice and record any small change during drilling. The time required to drill through a certain depth, amount of core recovery, physical condition, length of pieces of core, joints, colour of water residue, weathering, and evidence of disturbance and other effects shall be carefully noticed and entered in the drill/core log. The directions given in IS 5319 – “Guide for Core Drilling Observation” may be followed while preparing the corelogs.

The core boxes provided by the Contractor shall be sturdy and of good quality jungle wood and shall be made according to the sketch on Page 6 of IS 4078 (1980) with locking arrangements and compartments. The core boxes shall be painted both inside and outside with oil paints and sprayed with insecticide to prevent damage by insects. Each and every core piece extracted from the core barrel shall be placed in core boxes in the proper sequence of occurrence from top downwards. The starting and finishing depth of each run shall be recorded on the core box compartments in oil paint as the cores are placed. They shall be sequentially numbered on the four sides and the lid. The name of the project, drill hole reference, and the depth of the core obtained shall be prominently painted on the lid with oil paint.

The depth of cores below ground level shall be indicated at about every 1.5m interval by writing the depth in indelible ink on wooden spacers that shall be inserted in their correct positions in the box. Similarly, the exact depth of any change in stratum and failure to recover the core etc. shall be recorded. The labeling of core samples of rock shall be done in accordance with the Appendix D of IS 4078 of 1980 or as directed by the Engineer.

Each core box shall house samples not more than 6 m long in total. While placing the core samples in the wooden boxes, it should be ensured that the direction and sequence of core placement is not altered. The core run shall be restricted to 500 mm to 600mm length at a time and the core sample removed as directed by the Engineer. The cores and core boxes shall be transported to a storing place as indicated by the Engineer

The Contractor shall submit five copies of cabinet size (160mmx120mm) colour photographs of the selected cores as specified by the Engineer.

An arrangement should be made for collection of wash water by installing a

top socket with a cross pipe at the top of the casing before the start of rock drilling. The side of the casing should be well packed near the top of the hole to prevent leakage. Wash water should be collected in buckets and allowed to settle. A record of wash water shall be maintained indicating colour, change in colour and type of wash water (i.e. thick slurry or clean water)

The number of revolutions per minute for the rock drilling shall be kept low (about 200 RPM) for "NX" size bits, with suitable reduction gear and bit pressure kept to a minimum without rod vibration on "chatter". The rate of penetration for every 250 mm shall be observed during rock drilling and recorded.

Field borelogs shall be submitted to the engineer after completion of each borehole at site or as demanded by the engineer.

2.2 IN-SITU TESTING

The item covers conducting in-situ test and may include;

- Standard Penetration Tests
- Field Vane Shear Tests

a) Standard Penetration Test in Boreholes

The Standard Penetration Test [SPT] shall be carried out in boreholes at intervals as directed by the Engineer. Intervals shall not exceed 3 m according to Indian Standard Code of Practice.

For details of the sampling tube (spoon) and equipment and procedure for conducting a penetrometer test, the IS Code 2131 (1963) shall apply. The driving monkey should be provided with suitable arrangement for controlling the height of fall. It should be ensured that blowing in of fine sand is avoided while conducting penetrometer tests. For this purpose, it may be necessary to use mud (Bentonite) circulation or create surcharge pressure.

For SPT the blow count shall be recorded at intervals of 150mm, for a total penetration of 60mm. The SPT blow count shall be reckoned as the total number of blows for the second and third penetration increments of 150mm.

Every attempt shall be made to recover the full sample from the standard split spoon sampler. Where sample recovery is poor or nil, a representative sample shall be preserved from the sludge pump/bailer sample.

Whenever a sample recovery is recorded, the following details shall be noted along with usual record of blow counts. This information shall be recorded for each borehole, in a format approved by the Engineer.

- Penetration and blow counts (meters)
- Recovery (meters)
- Logging of silt and fine sand, if any, observed.

➤ Description of soil sample.

In the case of stiff to medium clay where a sample is recovered in the form of a "cake" a suitable length of cake shall be wrapped with a layer of bandage cloth and coated with paraffin wax to preserve the sample.

The identification tag for the sample shall be carefully secured to the plastic container in which samples are preserved.

b) Field Vane Shear Test

Field Vane Shear Test shall be conducted as stipulated in the relevant IS codes. During boring operation, when soft clay layers are encountered the same shall be brought to the notice of the Engineer who shall decide whether Vane Shear Tests are to be conducted in such strata.

2.3 LABORATORY TESTING

All the specified laboratory tests shall be conducted in a nationally accredited laboratory in consultation with the Engineer. Such laboratory should have recognition from the Department of Science and Technology, Ministry of Scientific and Industrial Research. The relevant Indian Standard Codes of Practices for Soil Testing shall be followed.

For preparing the laboratory test schedule, a list of all soil and rock core samples collected from each borehole shall be submitted to the Engineer with records of borelogs and in-situ tests in duplicate. One of the copies shall be returned to the Contractor indicating the tests to be conducted. All the consolidation and permeability tests on collected samples shall be conducted at the laboratory of reputed institutes like IIT or as approved by the engineer.

The results including plots and tables shall be submitted along with the report. Test observations and calculations shall be made available to the engineer if demanded.

2.3.1 Preparation of Test Specimens

Preparation of test specimens for the various tests shall be carried out as per the procedures laid down in the various relevant Codes of Practice.

In case of soft to firm cohesive undisturbed soil samples, test samples for all types of shear tests shall be prepared strictly by hand trimming or soil lathe. Care shall be taken against bending of soil samples at the time of horizontal ejection of the samples from the sampling tubes. Samples shall be ejected

from the sampling tubes preferably in the same direction of travel in which the samples entered the sampling tubes.

Similarly test specimens for consolidation tests shall also be prepared to the required size by hand trimming only and the ring of the consolidation apparatus shall be inserted by pressing gently with the hands and carefully removing the material around the ring. In no case the ring shall be forced into the soil. Great care shall be taken during the trimming of the sample from the top and the bottom of the ring. The test specimen shall be prepared in the same orientation as that of the actual strata so that the laboratory test load compresses the soil in the same direction relative to the soil strata as the applied load in the field.

2.3.2 Index Property Tests

Laboratory tests shall be carried out in consultation with the Engineer and as per relevant parts of IS:2720 to find out the following index properties:

- a) Natural Moisture Content
- b) Sieve and Hydrometer analyses
- c) Atterberg Limits
- d) Specific gravity
- e) Bulk and Dry Density

The soil samples to be tested shall be selected by the Engineer.

2.3.3 Unconfined Compression Test

Rock samples having L/D ratio not less than 2 shall be prepared and tested under soaked condition for uniaxial crushing strength as per IS:9143 and IS:9221. The stress-strain relationship and modulus of elasticity shall also be reported. Bulk and dry densities, porosity, water absorption, specific gravity shall also be determined on rock samples as per IS:1124.

2.3.4 Triaxial Test

Unconsolidated, undrained triaxial test shall be conducted on the undisturbed samples selected by the Engineer. The test shall be conducted as per IS:2720 (Part X). Each test shall be conducted on a minimum of three specimens at different cell pressure (1.0, 2.0 and 3.0 kg/cm²).

The moisture content before and after the test and the bulk and dry densities of each specimen shall be determined. The rate inserted by the tenderer in the bill of quantities for the triaxial compression test shall include for all the above items.

The stress-strain diagrams as well as the Mohr circle envelopes shall be included in the report.

2.3.5 Consolidation Test

Consolidation test shall be conducted on undisturbed samples as per IS:2720 (Part XV) selected by the Engineer. The loading on the test specimens shall be applied in the following stages : 0, 0.1, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0 kg/sq.cm. Unloading of the test specimens shall be done in suitable stages. The co-efficient of consolidation (Cv), the coefficient of volume compressibility (Mv), compression index (Cc) and the coefficient of permeability (k) shall be determined and reported.

2.3.6 Chemical Analysis

Chemical analysis of soil and water samples shall be carried out for pH value, sulphate content (SO₃) and chloride content (Cl) in ppm and percentage.

3. MEASUREMENT AND PAYMENT

The depth of borehole shall be measured from the existing ground level. Where the borehole is in a watercourse the depth of borehole shall be measured from the watercourse bed level. The boring / drilling for a complete borehole to its required depth is paid for only once. The Contractor shall not be entitled for additional payment if the same rig or a different type of rig is brought to the location of the hole for completing either bedrock drilling or any other balance activity left incomplete in any interim stage of the work.

The quoted rates shall include for all ancillary equipment, water, electricity, etc. required for completion of the work.

4. CODES AND STANDARDS

All field and laboratory work shall be carried out strictly in accordance with IS Codes of Practice and these specifications, unless otherwise approved by the Engineer in writing. In case of conflict, the IS Codes of Practice shall prevail unless otherwise instructed in writing by the Engineer.

5. REPORTING REQUIREMENTS

The work includes the preparation and submission of an Investigation Report containing plans showing the location of boreholes including coordinates and levels, plans showing boreholes, project details and description of work carried out, borelogs, corelogs, field test results and laboratory test results. Report should also contain interpretation of test results, recommendations for founding levels and bearing capacities, potential settlements and ground improvement.

The recommendations shall especially cover the Foundation types, founding levels and bearing capacity for the structures as identified in the project

description and as shown in the drawings. The foundation types and founding levels shall be clearly identified.

Report shall also cover Safe Bearing Capacity and settlement analysis for shallow foundations, retaining walls and ground improvement techniques.

The report shall include comments on aggressive chemical content of soil and groundwater and recommendations for deciding level of protection necessary for concrete and steel buried parts.

6. COMPLETION TIME

The entire work including preparation and submission of the Report shall be completed as per the schedule agreed prior to commencement of work. Contractor shall submit a detailed construction program before commencing the work showing the deployment of rigs.

Liquidity Damages @ 1% of the value of work remaining to be executed for each day of delay in work including submission of report, shall be applicable. This shall be subject to a maximum of 10% of the total value of work.

CLAUSE SP 8

SPECIFICATIONS FOR INTER-LOCKING CONCRETE PAVING BLOCK

Quality

The block for the paving works shall be as per IS : 2187 part-II – Paving Blocks. The blocks shall be 60 mm thick of quality concrete grade M40 having specified size and type with grey or red or combination of them.

Grading of sand for bedding

IS Sieve size	Passing (%)
9.52 mm	100
4.75 mm	95 – 100
2.36 mm	90 – 100
1.18 mm	50 – 95
600 micron	25 – 60
300 micron	10 – 30
150 micron	0 – 15
75 micron	0 – 10

Grading of sand for the joint filling

IS Sieve	Passing (%)
2.36 mm	100
1.18 mm	90 – 100
600 micron	60 – 90
300 micron	30 – 60
150 micron	10 – 30
75 micron	0 – 10

Sub-base & Base

Over the prepared and consolidated subgrade a layer of Sub-base using crushed aggregate shall be laid to falls and slopes to a compacted thickness of 100 and compacted with C-10 tonne roller. Over the prepared sub-base, a layer of 3mm and down fine sand shall be laid and compacted to 25mm in thickness and to required falls and slope to the satisfaction of the Engineer.

Layers

The blocks shall be laid on top of the prepared base in required pattern as directed by the Engineer. On completion of the laying work, approved fine

screened sand shall be spread over the paving and the joints filled with fine sand compacted as directed by the Engineer. Extra sand on the surface shall be removed by brush. When required, edge blocks shall be cut clean and sharp with approved tools and as per manufacture's instructions. The cut edges shall be rubbed smooth before laying. Compaction with a power vibrating plate (Wacker model VPH 70) shall be used suitably as recommended by the approved proprietary manufacturer. Any blocks damaged during laying shall be replaced. The entire work of the installation and materials shall meet the approval of the Engineer.

CLAUSE SP-9 EXTERNAL LIGHTING INSTALLATION

1 Scope

This specification covers supply, testing at works and site, erection, testing and commissioning and handing over of complete street lighting and area lighting installation.

2 Standards

The following standards and rules shall be applicable:

- 1) IS: 1913 General and Safety requirements for light fittings.
- 2) IS: 1944, 1970 Code of practice for lighting public thoroughfares.
- 3) IS: 3528 Water proof electric lighting fittings
- 4) IS: 3553 Water tight electric lighting fittings
- 5) IS: 1239 M.S. Tubular and other wrought steel pipe fittings
- 6) IS: 2149 Luminaries for street lighting
- 7) IS: 3043 Code for practice for earthing
- 8) Indian Electricity Act and Rules
- 9) National Electric Code, Part 5
- 10) CIE Publication No. 68

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Code of Practice or the British Standard Code of Practice in the absence of Indian Standard.

3 General

The street lighting installation for the project shall be carried out by use of outdoor type, weatherproof luminaries, to be mounted on tubular steel poles or galvanized iron poles or FRP coated steel poles.

Electric power supply at 415 volt, three phase, four wire, 50 Hz to be tapped from the street lighting Feeder Pillar.

The electric power shall be distributed to the street lighting poles through electric cables laid below ground or through PVC sleeve embedded into concrete and shall be distributed equally on three phase of the electric power supply system.

Individual control MCB/Fuses with Pole junction box shall be provided on each pole. The terminal box shall be weather proof, having gasketed cover.

The street light poles shall be earthed individually with pipe electrode type earth station as detailed in the drawing using 25 mm diameter galvanized iron pipe 2.5 m long.

Electric cable required for the street lighting installation shall be 1100 Volt grade, PVC insulated and sheathed, armoured cable having stranded Aluminium conductor of rating as mentioned in the drawing.

For automatic ON/OFF operation of the street lights, L & T make automatic timer, type TSQ-T (Day dial – 1 x 24 hour) or equivalent shall be provided in the street light feeder pillar.

All street lights shall be controlled from the outdoor type street light control pillars the locations of which are shown on the drawings.

4 Lighting Poles

The street lighting installation for the project shall be carried out by use of outdoor type, weatherproof luminaries, to be mounted on tubular steel poles or galvanized iron poles or FRP coated (coating thickness to be 2.0 mm minimum) as steel poles. The street light poles shall be fabricated from heavy duty cold rolled steel tubes conforming Yst 240 or Yst 310 of IS:116T- 1977 as appropriate tubular, swaged welded poles.

The street light pole shall be swaged poles made from steel of ultimate tensile strength of 410 MPa (42 Kgf/mm²). The pole height above ground shall be 9.2 Mtrs. Hot dip galvanized inside and outside conforming to BS 729 Part I, BS 5135, IS 475G-1984, IS 2629-1985, IS:2633-1972. The galvanizing shall be 65 microns and shall be recorded and results finished while bidding.

The street light poles shall be provided with suitable size base plate/sleeve, and necessary fixture mounting bracket at top.

The terminal box shall be provided with Epoxy terminals and fuses to be mounted on the pole with damp.

Pole shall have large diameter entries for outgoing wires and one earth stud.

The pole fabrication shall conform to the drawings and where such drawing is not available, the Contractor shall make such drawing and get it approved before fabrication.

The pole foundation shall house as shown on the drawings.

For fixing earth wire one bolt shall be welded to the pole and provided with suitable nut washer and spring washer.

The pole shall be manufactured as per IS 2713 (Part II) 1980 and test certificates shall be submitted to Engineer-in-Charge for approval.

5 Pole Terminal Box

The junction box enclosure shall be made up of cast Aluminium or FRP weather proof, splash proof, vandal proof enclosure suitable for mounting on pole externally with suitable clamping arrangement. The enclosure shall have recessed hinged door with neoprene gasket and locking arrangement.

Each enclosure shall be adequately sized to house terminal blocks to loop in and out 2 Nos. 4C x 25/35 mm² cables, Neutral link and 2 Nos., 10 A MCB s/HRC Fuses with base. All above components to be rigidly mounted on back plate.

Suitable size removable type gland plate at the bottom shall be provided for loop in and out of 2 Nos., 4c x 25 mm² armoured cables by means of heavy duty compression type brass gland with brass cone and ring arrangement for effective earthing/bonding of cable armour and pole body. Non Fading/Non Chalking point colour to the approved shade shall be provided in case of FRP coated poles. The box shall have earth terminal on inside and outside for connecting earthwire.

3C x 2.5 mm² lead wire shall be multi strand copper conductor, Special heat resistant PVC/PVC insulated cable to be provided from the pole terminal box to the street light fittings.

6 Pole Bracket

The pole bracket shall be suitable for erection of street light fittings with Sodium Vapour/Mercury Vapour Lamp, on the pole top.

Pole bracket shall be made from 60 mm diameter 'B' class galvanized iron pipes.

A stopper shall be provided with 3 nos., holes at 120 degrees for proper fixing of the bracket on the pole top as shown on the drawing.

7 Street Lighting Fittings Suitable for Son-T (+) Lamps

Street light fittings shall be integral type and suitable for 250W/150W SON-T (+) lamps and of following makes:

Philips
Crompton Greaves
KESELEC
WIPRO
GEWISS

The body and the control gear housing shall be in single piece and made from full die cast housing made out of LM6 aluminium. The body shall be phosphated, primer coated and finished with hammer and tone Grey epoxy powder coated on the outside and white inside.

The fitting shall be complete with control gear tray including Electronic igniter, PF improvement capacitor, copper wound heavy duty polyester filled ballast, earthing terminal, connector block etc. 250W hi-pressure metal halide lamp In IP 54 shall have an average 100 lux and uniformity factor of >0.5.

The Control gear tray shall be detachable so as to remove the same for maintenance without disturbing the fitting fixed on the pole.

The fitting shall have porcelain 3-pin BC/ES or GES screwed type (depending on the lamp) lamp holder fitted on a special bracket so as to raise or lower the same to achieve cut-off or semi cut-off light distribution.

Electro chemically brightened and anodized, scratch free, pot mirror type reflectors with smooth and glossy surface for optimum light reflection shall be provided. It should be possible to remove the reflectors for cleaning without disturbing the lamps.

The cover shall be made from toughened, heat resistant glass uniform thickness and moulded. The cover shall be fixed with to the fitting toggle switches and with

neoprene rubber/synthetic/felt gasket impregnated with insect repellent solution.

The fitting shall be fixed to pole bracket or directly on the pole as the case may be, with fixing clamps.

The fitting shall be insect and weather proof conforming to IS 10322 and IP 65 protection rating.

8 Street Light Control Pillar

The control pillar shall be suitable for outdoor installation and all relevant codes of practices shall be applicable. The pillar shall be weather proof and water proof and shall be as per the details shown on the drawing.

The control pillar shall be made from 2.5 mm CRCA sheet steel/or FRP enclosure of adequate thickness.

The control pillar shall have 2 separate compartments with separate doors. One compartment shall be for incoming supply switch gears and energy meter etc., and for BSES/MSEB/TATA use and shall have sealing arrangement. The other compartment for consumer use shall have control and power switchgears for outgoing. All the equipment in the pillar shall be erected on 2mm thick galvanized iron plate, and this plate shall be properly connected to the earth bar.

All power and control wiring inside the control pillar shall be with stranded copper conductor wires with lugs clamped at both the ends.

For termination of incoming and outgoing cables, epoxy insulators with studs and locknuts shall be provided.

A detachable gland plate made out of 3 mm thick galvanized iron/aluminium sheet shall be provided at the pillar bottom.

Toner control for switching streetlights ON/OFF to be provided.

Contractor to provide KWH meter and CT's as approved by the power supply company and get the same calibrated before installation. Certificate shall be submitted after commissioning the equipment.

Cables at feeder pillar shall be terminated at the bottom gland plate, by heavy duty compression type of gland plate, earthing tags for effective earthing of cable armour and PVC cable shroud shall be provided.

Feeder pillar foundation shall be M30 Grade Concrete, 600 mm above ground level.

9 Pole Foundation

The pole foundation shall be of concrete grade M30 and size shown in the drawing with necessary excavation in all types of soil, murum or rock.

A circular shaped plinth of size shown on the drawing above ground level shall be provided. The plinth shall be plastered smoothly and painted with 2 coats of Cement paint from all sides and the pole terminal box shall be embedded in the plinth in such a way that the outer cover is flushed with the plinth plaster. The plinth shall be of concrete grade M30 and it shall be cast along with foundation.

10.1 Pipe Type Earthing for Light Feeder Pillar

A GI Pipe of 38 mm. dia. 3.5 meter long shall be provided with a funnel on the top

of pipe. A funnel with wire mesh that is used for pouring of water shall be screwed to the pipe. The pit shall be free from hard rock and surrounding soil shall be damp. Alternate layers of a homogenous mix of charcoal and low resistivity soil shall be provided for refilling the earthen pit. The depth of earthing pit should be 3.5 meter. The lower part of pipe (about 1.5 meter) shall have holes of 12 mm dia. At the interval 150 mm. Earthing resistance shall not exceed more than 3 Ohms.

10.2 Earthing

One number with 25 mm diameter 2.5 metre long galvanized iron pipe electrode with perforation holes shall be provided for each pile. For earthing of the poles and pillars 2 nos. 8 SWG galvanized iron earth wires from each earthing electrodes shall be connected with nuts and washers to the earthing bolts welded to the electrode and pole.

For earthing poles on RCC structures, 8 SWG GI-earth wire shall be laid along with the cable inside the duct provided in structure to be terminated at pole terminal box. The earthen pit shall be provided at both ends at ground level, to connect with the solid earth.

For earthing of the pole terminal box an earth wire of size 12 SWG galvanized iron shall be provided and connected between earth nut bolt on the pole and the pole and the pole terminal box.

For earthing of the lighting fittings third core of the lead wire shall be used and connected between pole terminal box to the fittings.

10.3 Earthen pits

Solid block masonry chamber plastered smooth inside shall be constructed upto 450 mm resting on PCC below ground. A Cast Iron Chamber Frame with concealed hinged CI cover with lifting look shall be embedded in concrete on top of the chamber.

An earthing lead shall be brought out by fixing GI strip of 50 x 6 mm and by using 9 mm dia GI/Brass nut bolt, and set of washers. Suitable GI Clamps shall be provided on the GI pipe inside chamber for taking tap off for earthing leads.

CLAUSE SP-10 TRAFFIC SIGNALS SYSTEMS

1.0 GENERAL

- 1.1. Traffic signals on each approach of the junction shall be installed at the junctions shown in Drawing Volume. The layout of each junction together with the initially proposed phase and stage proposals is shown in the drawings.
- 1.2. The Contractor shall be responsible for supply of all equipment, its installation and testing and full maintenance during the defects liability period.
- 1.3. The Specification for the traffic signals, signal heads is almost identical to that prepared for the Mumbai ATC system. This has been done to ensure that the signals will be functionally compliant with Mumbai ATC and, in future may be incorporated within an ATC system. No specific requirement exists for inbuilt

ability for ATC communication, but the possibility of an ATC mode of control is included.

- 1.4.** The specification is designed to ensure that both equipment and installation are to a high standard. It will be expected that the equipment will be imported from an international supplier of traffic signals and associated systems. The international supplier will associate with a local company with relevant experience in installation and maintenance of traffic signals. He will provide training to the local company and will supervise installation and testing and assist with the performance of the maintenance requirements, as appropriate. Bidders should include in their bids a detailed proposal for interworking between international supplier and local company to demonstrate that a high standard will be provided. Failure to provide a sufficiently high standard proposal may result in the whole bid being rejected.
- 1.5.** There are also a number of closely spaced junctions where linking of signals to provide co-ordination and optimize traffic flow would be desirable. The signal controller specification allows for the use of cable less linking to achieve this requirement. At some locations, it may be preferable to adopt a cable linking approach and this will be finalized during the contract.
- 1.6.** It is appreciated that some of the pedestrian phases in particular, may need to be grouped together to reduce the requirement for phase drives. Bidders should review each design proposed and comment upon the phasing arrangements related to the capacity of his particular controller. After the contract is awarded, the Engineer will review in detail with the contractor each design, the need for linking, the method of achieving linking, and detector requirements and locations. This review will take into account the specific facilities provided by the contractor's equipment. After the review, confirmed designs will be agreed for implementation.
- 1.7.** This specification is divided into 5 sub-sections as follows:

 - 1 – Introduction
 - 2 – General Technical Specification
 - 3 – Traffic Signals
 - 4 – Installation, Spares and Tools
 - 5 – Maintenance and Warranty
- 1.8.** The contractor shall be fully responsible for design and installation to meet the requirements of this specification and provision of a fully working and effective system. Where it appears to Bidders that there may be omissions or lack of clarity in the specifications, they shall identify these and propose a means to overcome the omission or lack of clarity. Once the contract is awarded, the Engineer will not entertain any proposals by the contractor for additional work to make good omissions which were not clarified before contract award and the contract shall be consider to include the provision of a fully working system.

- 1.9.** This contract for traffic signal equipment is associated with and is part of the contract for civil construction of the highways and junctions. The signals contractor shall ensure that the ducts and other civil provisions included in the civil works are appropriate and adequate for his purposes. The Engineer will not entertain any requests for additional works to make good shortages in the civil works that were not identified at the bidding stage.
- 1.10.** It will be expected that the signal contractor will liaise with the civil contractor during the contract period to ensure that adequate civil provision is made and that work on site proceeds in an orderly and appropriate manner. In particular it will be expected that the signals contractor will ensure that he does not commence works on site until the site is ready and his equipment can be installed without risk of subsequent damage by completion of unfinished civil works.
- 1.11.** All the plant provided under the contract shall be subject to the approval of the Engineer. The contractor shall be responsible for obtaining approval in good time to allow completion of the contract within the construction period. The granting of approval by the Engineer shall not relieve the contractor of his responsibilities under the Contract.
- 1.12.** Contractors are not required to provide any traffic engineering expertise or to be involved with any signal timing calculations and the like. This information will be provided by the Engineer. The Contractor will however, be expected to provide sufficient technical input from an experienced traffic signal expert to assist with the initial determination of the optimum method of provision of control and linking at each junction and for ensuring that the agreed control methods function as required when installed.
- 1.13.** The contractor will be expected to provide the expertise to configure the junction signal controllers for initial installation and for up to two reconfigurations for each junction during the contract. The contractor will also be expected to provide expertise in the use of a handset or equivalent for the modification of the traffic signal timings. A member of the contractor's staff with this expertise should be available as reasonably required during the contract to accompany the Engineer to site to tune and modify the traffic signals timings based upon actual traffic flow.
- 1.14.** The contractor shall ensure that from the time of testing and installation of the first signal controlled junction, all necessary equipment is available in Mumbai to configure and re-configure the controller. There shall also be a fully trained member of the contractor's staff available to provide a reconfiguration service as and when required.
- 1.15.** Under the contract the contractor shall supply to the employer two handsets or equivalent equipment necessary to set and change timings and controller operation on site. These shall be for the exclusive use of the Employer and the

Contractor shall ensure that he has sufficient sets also available for his own use.

- 1.16.** The contract includes the full maintenance of the traffic signals and all equipment supplied from the date of installation and operation of the first part of the equipment until the expiry of 12 months from the completion of the Tests on Completion. It is intended that this maintenance service proceeds in parallel with the Warranty and will ensure that all equipment is maintained to a high standard for a year after completion. The standard of maintenance required is defined in Section 5 of this specification. The Employer may wish to extend the maintenance services after the completion of this contract, but that will require the agreement to a new contract.
- 1.17.** The contract also includes the provision of spare parts that may be expected to be required for two years of normal operation of the equipment. Any special test equipment that may be required for 'first line' maintenance is also included. The spares and test equipment may be utilized by the contractor during the performance of maintenance services, but at the completion of the maintenance services, the contractor shall hand over the full inventory of spares and test equipment to the Employer in as new condition. This means that the Employer will expect to receive the full amount of spares for two years normal maintenance.

2.0 GENERAL TECHNICAL SPECIFICATION

2.1 Technical Requirements

2.1.1 Standards:

All equipment supplied to meet this Specification shall be designed and constructed to International Standards. Bidders are however permitted to use National Standards, providing that they prove that those standards are relevant in all respects.

Bidders shall state which standards apply to their equipment. In order that effective Bid evaluation can be accomplished, they shall supply English language translations of any National standard.

2.1.2 Design and Construction

A high standard of construction is essential and the system offered shall be in all respects suitable for the purpose intended and for all the environmental conditions specified.

The Contractor shall accept all responsibility for the satisfactory quality, design and workmanship of the system and every part of the system whether manufactured by him or supplied to him by other manufacturers.

The system shall be designed to operate continuously.

The system shall be designed with correct sequence interlocks to prevent hazards to the equipment, operator and maintainer. The interlocks shall ensure that the correct switching and operating procedures are followed.

Attempts at incorrect procedures shall not inhibit the equipment from correct operation in sequence.

The manufacture or purchase of the equipment shall not commence without the approval of the Engineer.

The Contractor shall be responsible for obtaining all approvals and licenses required for the equipment supplied under this Contract.

The Contractor shall provide a schematic block diagram of each system and each sub-system indicating how the functional requirements of the Specification are met.

2.1.3 Approval of Components and Materials:

All components and materials shall be subject to the approval of the Engineer.

Components and materials to National Standards and appropriate to the environment specified will normally be approved by the Engineer.

Where approval is given to a component or material, this shall not constitute approval of the use to which it is put.

Components having alternative suppliers shall be used.

Approval of components having no alternative supplier may be given by the Engineer, subject to the Contractor being able to demonstrate that he would be able to maintain a supply of the component, or a direct equivalent, at a reasonable cost and delivery period for at least 10 years.

Electro-mechanical components will not normally be approved by the Engineer unless the Contractor demonstrates that there is no solid state alternative to meet the requirement.

2.1.4 Materials and Workmanship:

All equipment, including cables and ancillary items provided, shall be new, state-of-the-art and field proven. They shall be modified only to the extent to meet the requirements of the Specification.

All equipment, including cable and ancillary items, shall have been manufactured not more than 12 months before delivery to site.

Maximum use shall be made of standard equipment, including computers, peripherals, sub-assemblies and consumable components, particularly those that are readily available in Mumbai.

All equipment, including proprietary equipment and equipment used for installation and maintenance, shall be designed to ensure the safety of the operators and the public.

All materials shall be chosen to minimize the risk of fire or damage due to fire.

Where equipment is accessible to the public, it shall be completely enclosed in a strong housing to minimize the risk of vandalism.

2.1.5 Modules:

Modules are defined as units that may be removed from a system by the separation of connectors or an interface.

The equipment practice used in the construction of the modules shall be submitted to the Engineer for approval.

Where an equipment practice has been approved, this shall not constitute approval of the components and circuits used therein.

The number of different types of modules shall be kept to a minimum.

Identical modules shall be interchangeable within the overall system. The Contractor will be required to demonstrate interchangeability during Acceptance Testing.

It shall be possible to remove and replace modules with the power switched on without causing damage to the system or to the equipment interfaced to it.

As far as possible, access to power switches shall be restricted to maintenance engineers.

Printed circuit boards (PCB's) shall be of a high industrial standard and shall be tropicalized.

Plug-in boards shall be keyed to prevent insertion in the wrong position.

Components may be mounted on each side of a PCB.

Multi-layer PCB's shall only be used with the approval of the Engineer.

Provision shall be made to facilitate the use of hand tools and test probes, where adjustment or measurements are required to be carried out on site.

Contact materials shall have a long life and shall provide reliable operation. They shall be designed to withstand long periods of storage, insertion, extraction and switching operations and shall not be required to exceed their current or voltage rating.

Correct alignment of contacts shall be ensured at all times.

Fasteners and locking devices, to the approval of the Engineer, shall be used to ensure that plug-in components and connectors do not become loose due to vibration or accidental movement.

The fasteners shall be captive. Quick release, hand operated fasteners shall be used wherever possible. Where tool operated fasteners must be employed, only standard head shapes shall be used.

Connectors and terminals shall be made by specialist manufacturers. They shall be made of no-tracking, moulded material with anti-vibration terminals. All live metal parts shall be protected to avoid accidental contact. The current rating of the connectors and the terminals shall not be lower than that of the cable or wire which they receive.

There shall be a separate terminal for each conductor, including spares.

Terminal blocks shall be identified in accordance with the drawings. The method of identification shall be submitted to the Engineer for approval.

Connectors and terminals shall be neatly arranged. Space shall be left for the future addition of terminals.

The average life of indicating lamps and light emitting diodes shall not be less than 10,000 hours. A means shall be provided to test lamps or LED's without interfering with normal operation. Fault indicators shall be able to be reset only after the fault has been cleared.

2.1.6 Cables:

The Contractor shall ensure that the cables provided meet all environmental, installation and operating parameters.

Cables shall not have been manufactured more than 12 months before delivery to site. Cables shall bear the name of the manufacturer and the date of manufacture.

Cables shall be delivered with the manufacturer's seal intact. Seals and manufacturer's test certificates shall be retained for inspection and records. The Engineer's permission shall be obtained before any cable is unwrapped and installed.

All cable shall be delivered on drums with the cable ends sealed. When cable is cut from the drum, the cable end left shall be sealed. Cut lengths of cable shall immediately be terminated or sealed

No damaged cable shall be installed. Minor repairs to the outer sheath may be approved by the Engineer.

All cable installed in buildings shall have low smoke zero halogen compound outer sheaths.

During installation, care shall be taken to ensure that no damaging stress is placed on the cable. Where cables are pulled, a mechanical fuse shall be used; it shall be set to break at the maximum stress of that cable, as specified by the cable manufacturer.

All cables, except power cables, shall have at least 25% spare cores, with a minimum of two spare cores, after completion of the installation.

The number of flexible cable harnesses shall be kept to a minimum. These shall be properly located and secured to avoid being damaged by housing doors or other moveable objects.

All cables, except those laid in trenches or ducts, shall be supported throughout their length on trays or racks and secured by cable clamps of the correct size.

Supporting and fixing materials and methods shall be subject to the approval of the Engineer.

The installation of loose, non-protected cables will not be permitted on any structure.

The arrangement of the cable installation shall be designed to prevent electrical interference between communication cables and power cables.

Joints in communications cable, other than those at scheduled terminations, shall not be made.

Joints in power and similar cables shall not be made without the approval of the Engineer.

Cable ducts may be provided by others, to the extent shown on the drawings. The Contractor shall note that these ducts may not be for his exclusive use. The provision of all other ducts and conduits, including the local extension of cable routes provided by others, shall be the responsibility of the Contractor.

Where cables pass through cable holes and ducts, they shall be sealed to prevent the ingress of vermin and water.

Insulating grommets shall be provided to protect conductors wherever they pass through metal parts.

Compression glands shall be used for all cable entries into enclosures. Spare gland holes, fitted with blanking plugs, shall be provided for each enclosure.

Each cable shall be securely and indelibly labeled at each end showing its destination and drawing reference number. Details of the proposed cable identification system shall be submitted to the Engineer for approval.

The "as-built" drawings shall show the location and the identification of each cable in all enclosures and dropouts and at all major sections of trays, racks and trunking.

2.1.7 Design for Ease of Maintenance:

To ease maintenance and enhance the safety of maintenance personnel, equipment shall be constructed of lightweight material, as far as is possible.

Modules shall be compact and their mass kept to a minimum.

Special tools shall not be required for the installation of modules.

It shall not be possible to install modules incorrectly.

The materials and components, excluding items with a limited life as approved by the Engineer, shall be designed to have a life of 15 years in the specified environment.

2.1.8 Housing:

All street equipment shall be installed in weatherproof housings, correctly sealed to meet the specified environmental tests. They shall be dust proof to at least IP55 standard.

Equipment installed in buildings shall be housed in cabinets constructed of high quality steel or other material approved by the Engineer. Access doors shall be of rigid construction and shall be capable of being "lifted off" for ease of access to the interior.

Where applicable, separate access doors with door stays and doorstops shall be provided for operational and maintenance purposes.

Withdrawable chassis shall be carried on rollers and slides, fitted with travel stops.

The use of self-tapping screws shall be avoided and they shall not be used to secure covers or guards which have to be removed for maintenance purposes.

All housings and cabinets shall be fitted with identical, robust locks, which require a special key to open them. It shall not be possible to gain access to a housing without this key. The number of keys to be supplied shall be agreed with the Engineer.

External surfaces of the housings and cabinets shall be free from irregularities. All welds shall be neat, clean and smooth.

Each housing shall be provided with a switched socket outlet for mains operated tools and test equipment.

2.1.9 Power Supply:

Unless otherwise specified, systems shall operate from the normal Mumbai electricity supply. Bidders should note that this is subject to considerable fluctuation in both voltage and frequency and their equipment should be designed to continue to operate during normal fluctuations.

Equipment shall be powered directly from the electricity supply. The use of supply transformers, other than those forming an integral and internal part of a unit, will not be permitted. The supply to each major item of equipment shall be taken via a suitably rated miniature circuit breaker.

When the system has been set to the correct voltage, it shall operate correctly over a range of at least +/- 10% of that voltage.

The system shall operate correctly at any supply frequency within the range of at least +/- 10% of the nominal frequency and during supply interruptions not exceeding 50msecs.

When the supply voltage or frequency is outside the stated limits, the system may shut down safely and methodically. The system shall shut down before the fluctuation causes any mis-operation of the equipment. When the supply returns within the limits, the system shall restart and continue running without external intervention or degradation in performance. The shut down and restart procedures shall not be affected by the period during which the supply is outside the limits.

The equipment shall withstand random transient over voltages, as detailed below, without damage and without the performance being affected.

- | | | | | | | |
|-------|-------|--------|-----|---------|-----|------------|
| (i) | +100% | supply | RMS | Voltage | for | 10msec. |
| (ii) | +200% | .. | .. | .. | .. | 1msec. |
| (iii) | +300% | .. | .. | .. | .. | 0.02msec. |
| (iv) | +500% | .. | .. | .. | .. | 0.005msec. |

2.1.10 Electrical Interference:

The Contractor shall make adequate provision to prevent the system causing electrical interference to other apparatus and to ensure that the system is not so affected.

2.1.11 Electrical Protection Requirement:

All cabling and wiring shall meet the requirements of the Mumbai electricity supply authority and any other local regulations.

All metal work not required to carry current shall be connected to an earth (ground) point, except where otherwise dictated by transmission requirements. Such metalwork shall include cases, screens, cores, cable glands, cable conduits and cable sheaths.

If no other value is specified, the insulation resistance between any two conducting parts, not intended to be in electrical contact, shall be not less than 100 megohms, when measured with a voltage appropriate to the equipment. Where "n" such paths are effectively connected in parallel, the insulation resistance of the combination shall not be less than 100/n megohms.

Insulating bushes shall be provided to protect conductors wherever they pass through holes in metal parts.

Mains transformers shall be double wound and with an earthed (grounded) screen.

Access to equipment with voltages above 120vDC or 50vAC shall be protected by an earthed metal cover, which shall be fixed by means of screws or other quick release devices. A sign in red bearing the words "DANGERv (AC or DC)" in Hindi and English or a symbol denoting electrical hazard shall be fixed to the cover.

Terminal strips and terminals shall be clearly and indelibly marked. Terminals carrying electrical power shall be segregated from terminals carrying control signals. Not more than two cable cores shall be retained by any terminal.

The Contractor shall provide, to the approval of the Engineer, adequate protection for the system from damage lightning, whether by direct strike or induction.

2.1.12 Tests and Inspection:

All equipment supplied shall be subject to Acceptance Tests or Inspection, which shall be witnessed by the Engineer, at the premises of the Contractor or his sub-contractor in Mumbai. On the satisfactory completion of the tests or inspection, the Engineer will issue an Acceptance Certificate. The Contractor shall provide acceptance test and inspection schedules, for the approval of the Engineer, 10 weeks before the date agreed with the Engineer for the test or inspection.

The Acceptance Tests and Inspection shall demonstrate:

- (i) that the individual items of equipment comply with the Specification and with the technical descriptions and guarantees included in the Contract documents.
- (ii) that the system as a whole performs all the operational aspects required by the Specification within the permitted tolerances. Unless otherwise agreed, this test shall include a period of 100 hours of continuous operation, during which the equipment shall function satisfactorily in all respects.

No modification shall be made to the system or any part thereof, without the approval of the Engineer, once the Acceptance Certificate has been issued.

The Contractor shall provide all cable, services and equipment, required for the Acceptance Tests and Inspections, free of charge.

On receipt of the Acceptance Test Certificate, the Contractor shall transport the accepted equipment from his factory to the site. Where special containers are required in order to meet environmental conditions in transit, these shall be provided by the Contractor at his own expense.

On completion of the installation, Tests on Completion shall be carried out which shall demonstrate the operational function of the whole system and all the requirements of the Specification. The Contractor shall provide the Test Schedules for the approval of the Engineer 4 weeks before the date agreed with the Engineer for the tests and inspections to commence.

In addition to the Acceptance Tests and the Tests on Completion, the contractor shall undertake tests on all equipment and cabling at appropriate stages during installation. The details of the tests to be undertaken shall be proposed to the Engineer for approval 6 weeks before the first installation works commences.

The Contractor shall provide all test equipment and instruments required for the tests, together with documentary evidence that these instruments have been recently calibrated. All instruments shall be submitted to the Engineer for his approval.

Measurements, recorded during the tests shall be submitted to the Engineer for approval and record.

After completion of the Tests on Completion and with the system fully operational, the reliable performance of the system, or a section thereof, shall be proved by way of a Period of Satisfactory Operation which shall entail the equipment operating for thirty days without defect of any kind such as to affect the safe and proper usage of the system. If any such defect appears it shall be remedied forthwith by the Contractor and the Period of Satisfactory Operation shall start again after recommissioning.

2.1.13 Marking and Labelling:

The Contractor shall uniquely mark or label all systems and modules in accordance with a code to be agreed with the Engineer.

The markings and labeling of the main items shall be clearly visible.

The marking or labeling of encased units shall be visible once the cover or case is removed.

Components shall be marked with the circuit reference either adjacent to the component or annotated on a diagram or photograph in the relevant handbook or manual.

Markings required for controls, maintenance or warnings shall be adjacent to the part concerned.

Markings shall maintain legibility throughout the life of the equipment in the specified environmental conditions.

2.1.14 Paints and Finishes:

Finishes and painting procedures shall be submitted to the Engineer for approval. The Engineer will select the colour and style in which all the items shall be finished from the manufacturer's range.

The finish shall be uniform, free from brush marks and irregularities.

Steel plates, poles and the like shall be galvanized or zinc plated before painting.

2.1.15 Corrosion:

The Contractor shall ensure that all adequate precautions are taken against corrosion, particularly at interfaces between materials.

All fasteners and screw fittings, forming part of a closure system, shall be of non-corroding material or shall be suitably plated to a high standard.

All hardware to be installed on the streets, such as posts, masts, cabinets and housings, shall be designed to withstand the environment and shall be protected against corrosion by hot dipped galvanizing or plating and painting to a standard approved by the Engineer.

2.1.16 Case of Conflict:

In the case of conflict between technical requirements of this Specification and any other requirements, the following order of precedence shall apply:-

- (i) Government Regulations and Local Ordinances.
- (ii) Conditions of Contract, Part I.
- (iii) The Specification.
- (iv) Approved International Standards.

2.2 Documentation

2.2.1 General:

The Contractor shall provide sufficient documentation to reflect "as-built" conditions and to facilitate operation, maintenance, modification and expansion of the system or any of its individual components, to the satisfaction of the Engineer.

The documentation shall be a detailed presentation and shall include illustrations where applicable. For each unit, it shall include, but shall not be limited to:-

- general description
- functional description
- functional block diagram
- operating instructions
- maintenance and repair procedures
- test procedures
- schematic drawings and circuit diagrams
- software flow charts
- as-built drawings
- parts lists

The Contractor shall submit to the Engineer for approval, a record keeping system, which shall ensure that all changes or modifications are fully documented immediately that they occur. A master record shall be set up and maintained by the Contractor for each unit of equipment. The master record shall be handed over to the Engineer upon completion of the Contract.

The numbers of each document required are given in the Schedule of Prices.

2.2.2 Presentation of Documentation:

Documentation shall be written in English.

All documentation shall be subject to the approval of the Engineer.

All documentation shall be prepared in a clear, concise manner with appropriate illustrations and tabulations supporting the text.

In preparing the documentation, care shall be taken to ensure that expertise with apparently simple features is not assumed.

All documentation shall be produced in uniform style on A4 sheets. All diagrams in the final documentation shall be page height, bound and correctly referenced to the text. They shall fold clear of the text for ease of use where necessary.

All documentation shall carry a title, issue code number and date.

All documentation shall be indexed with a complete subject index.

The relevant documentation shall be submitted to the Engineer prior to testing (including Acceptance Testing), installation, commissioning, operation and

maintenance. The number of copies of each document at each stage shall be agreed with the Engineer.

Re-issues shall be provided when changes or modifications are made in equipment hardware or software. The Contractor may issue individual sheets or portions of the documentation that are affected by the change or modification. Each re-issue or revision shall carry the same title as the original, whilst the issue number shall be changes sequentially.

In the final documentation, there shall be no revision numbers. Any section that has been revised shall be re-issued so that it becomes the first issue of the final documentation.

Each volume shall have a stiff cover and spine and be protected by plastic or other material to withstand frequent handling. The binding arrangement shall permit the manual to be laid flat when opened.

2.2.3 Sample Documentation:

The Bidder shall submit representative samples of documentation. These samples shall cover equivalent types of hardware and software to that proposed.

The Contractor shall revise the sample documentation as required to meet the approval of the Engineer.

2.2.4 Types of Documentation:

(a) Standard Documentation

Standard documentation is that provided by a manufacturer to cover "off the shelf" production items.

The Contractor shall provide the standard documentation for all equipment, components, hardware, software and programming languages to be used in the Contract.

(b) Project Documentation

Project documentation is that prepared especially for the Contract. It shall include details of all special equipment, software, the overall system configuration, its operation and maintenance.

All project documentation shall include a complete index with appropriate cross-references to other manuals.

(c) Systems Manuals

Standard documentation and project documentation may be included in the systems manuals supplied.

The systems manuals shall consist of:

- operators' manuals
- technical operations manuals
- systems hardware manuals
- systems software manuals
- maintenance manuals

(d) *Operators' Manual*

The operators' manual shall comprise a concise set of procedures that an operator requires in order to operate the system. Technical detail and description shall be kept to a minimum.

(e) *Technical Operations Manual*

The technical operations manual shall cover systems operation in more detail than the operators' manual.

The manual shall detail specific procedures to be followed for both hardware and software operations. Instructions shall be detailed but easily understandable.

The manual shall cover all installed equipment. It shall include descriptions of all procedures for starting up and shutting down the system, loading operating programs, monitoring operation, modifying system operation, diagnosing faults and running test programs.

(f) *Systems Hardware Manual*

The systems hardware manual shall provide a complete technical description of all units in the system, their servicing and maintenance.

The technical description shall start with the overall system function and proceed, in logical stages, to the circuit description of each unit.

Complete and accurate diagrams and drawings shall be provided to support the text. Test voltages, waveforms and other aids to assist the understanding of a unit's function shall be included on the drawings as well as circuit references to simplify the identification of parts.

Test and calibration procedures shall be described. A list of test equipment, instruments and tools required shall be provided, together with their operating instructions, as necessary.

The manufacturer's recommended procedures for preventative maintenance shall be given.

Procedures for the diagnosis, location and repair of faults shall be given.

Instruction on the removal and re-installation of units shall be given.

Instructions shall be provided for the maintenance of units by specialized technicians in a modern electronic workshop.

A detailed list of all parts shall be provided. The list shall refer to the circuit reference on the appropriate drawing as well as the manufacturer's name and part number.

(g) *Systems Software Manual*

The system software manual shall describe the system programs and the system database records in detail.

The description of the overall software structure shall be written in such a way that a competent programmer would be able to understand the functions of the program.

The documentation shall include:

- a system outline showing the sequence of events in the program and the functions responsible for each event.
- a description of the program structure showing the relationship between modules and components of the program.
- the procedure diagram showing in sequence the operation and decisions which occur.

All supplied software shall be covered in the manual. The manufacturer's utility software may be described by standard documentation.

(h) *System Maintenance Manual*

A System Maintenance Manual shall be supplied covering all items of equipment and systems supplied under the contract. This may be supplied as one manual or different manuals for different parts of the equipment.

The Manual may refer to the other manuals supplied, but shall be designed to be used without extensive reference to other manuals.

The Manual shall cover both routine maintenance and 'First Line Maintenance' or maintenance down to board and unit replacement level.

Routine Maintenance shall be covered in a comprehensive manner dealing with all routine maintenance covered in one manual. This shall include a chart showing what should be undertaken at what frequencies.

First Line Maintenance shall also be comprehensively covered dealing with fault diagnosis, testing and repair. It shall include details of the use of any test equipment supplied under the Contract. It shall also provide details of arrangements to obtain replacements of spare components, boards and units used or to arrange for their repair. It shall also detail the desirable stock levels for each item, related to the speed with which spares can be obtained from foreign or local

sources, to ensure that the full system can continue to be kept at a fully functioning level.

2.2.5 As-Built Drawings:

Immediately following the issue of the Completion Certificate, the Contractor shall submit to the Engineer plans and drawings, in the form of reproducible positives, of the as-built condition of the system.

These plans and drawings shall indicate accurately the address and location of all cables and equipment.

The information on the drawings shall be fully comprehensive and shall include details of all cable ducts, drawpits, etc., forming part of the system, whether or not they were supplied under the Contract.

The location drawings shall be supplemented where necessary by detailed drawings of such items as cabinet foundations, wiring diagrams, etc.

The as-built drawings shall be prepared, in draft form, on a progressive basis as the equipment is installed.

The draft drawings shall be made available for inspection by the Engineer at all reasonable times. Interim payments will not be authorized for installed equipment until the details of the equipment have been incorporated in the draft as-built drawings.

2.3 Training

2.3.1 General:

The Contractor shall provide training, together with all instructional notes, drawings, training aids etc., for operating staff and technical staff.

The Contractor shall provide competent engineers/instructors to carry out classroom and on-the-job training.

All normal training shall be carried out in Mumbai. It will be expected that it will be conducted in English, but the Engineer may require a competent technical interpreter to be available. This will be agreed in advance of the training taking place.

The training shall be designed to ensure that the appropriate staff are fully able to use and maintain the system to effectively control traffic in the controlled area. It shall be conducted primarily when the main control centre equipment is operational and central signal monitoring is to commence. The detailed timing and course content will be subject to the approval of the Engineer.

It will be expected that the Contractor will provide supplementary training as may be reasonably required during the contract as more equipment is installed and staff expertise increases.

Bidders shall provide an outline training program with their bids. This shall include proposed course content, timing and the level of previous training and experience that will be assumed for the staff.

With the Engineer's approval, the Contractor may make use of the commissioned equipment for technical training. For pricing purposes, bidders can assume that the training venue will be provided at no cost by the Employer.

2.3.2 Operating Staff:

The operating staff will be trained partly in the classroom and partly on-the-job.

Training shall be scheduled to commence not earlier than the date of issue of the Completion Certificate for the central monitoring system.

The number of training sessions, their duration and the number of trainees per session shall be proposed by Bidders, based upon their experience with their proposed systems. It will be expected that the Contractor will make competent staff available as required after the formal training for a period of at least one month to advise operators and assist with the operation of the system.

The training shall concentrate on the system facilities available to an operator. The technical content of the syllabus shall be kept to a minimum.

The Contractor shall submit the syllabus to the Engineer for approval and shall agree the dates of the proposed training.

2.3.3 Technical Personnel:

The Contractor shall train the Employer's technical personnel to maintain the system and undertake normal technical activities associated with its operation and use.

The technical training shall be split into two parts, for technical operating staff and for maintenance staff. Some sections of the two parts may be common such as overall technical and operational descriptions. It cannot, however be assumed that the same staff will attend both and the training shall be designed such that different staff can attend both parts, or some of the same staff can attend both parts.

The training for technical operating staff shall include all technical operation issues, including those relating to the set up and use of the system for its intended function of traffic control. It can be expected that the technical operating staff will have been trained previously on the general principles of traffic control and will be familiar with standard software for signal timing calculation. The training provided by the contractor shall cover the specific requirements of his system to ensure that the staff are able to fully utilize the facilities provided to control the traffic in Mumbai in the optimum fashion. This shall include both the initial set up of the system and any subsequent activities necessary to ensure that the traffic operation is kept at an optimum level.

The Technical Operating staff course shall also include all other aspects of system operation so that then can assist the operational staff as required. It shall also include requirements for modification and extension of the system including changing the signal operation and control philosophy and planning and implementing installation and tuning of new signals.

The training of the Maintenance staff shall cover all aspects of routine and first line maintenance of the system including the use of the test equipment and diagnostics provided through to management of a spare parts inventory and ordering new spares.

2.4 Quality Assurance

2.4.1 General:

The Contractor shall have an established Quality Assurance (QA) Department approved by an independent QA Authority, to inspect and approve all equipment before delivery to site.

Bidders shall submit details of their QA Department for the approval of the Engineer at the time of Bid.

The cost of such inspections shall be borne by the Contractor.

When the Contractor's QA arrangement has been approved, the inspectors authorized by the Engineer shall then be responsible for carrying out or supervision of all tests detailed in the Specification. The tests shall be documented and all equipment delivered to site shall be accompanied by the relevant documentation stating that the equipment has been tested in accordance with the Contract requirements.

The QA Inspectorate and the Engineer shall both have the right to inspect and reject if necessary, any of the equipment being supplied at any stage of the Contract.

2.4.2 Requirements for Approval:

In order to obtain the approval of the Engineer, the Contractor's QA Inspectorate shall have authority over and shall be responsible for:-

- inspection staff
- type and calibration of test equipment
- inspection records
- testing facilities
- inspection stamps and other marks of identification
- inspection of sub-contractors

The Inspectorate shall be controlled by a Chief Inspector who shall be directly responsible to the Directors of the overall organization.

2.4.3 Rejection by Engineer:

The Engineer will have the right to reject any materials or equipment that does not comply with the Contract, even though it may have been previously approved by the Inspectorate.

2.4.4 Test Houses:

A supplier's Inspectorate should have adequate testing facilities to control its own processes. Tests, however, may be carried out by approved independent inspectorates and it may not be necessary for the Contractor to be equipped for all tests. In all cases, approval will only be granted by the Engineer for specific classes of test and when certain conditions may be imposed.

2.4.5 Concessions:

In certain cases, the Engineer may grant permission for the use of materials or components which differ from the drawings or specification. Requests for concession are to be submitted in writing by the Inspectorate to the Engineer

2.5 Design Submission and Approval.

The Contractor shall provide a Functional Specification for the approval of the Engineer. This shall provide comprehensive details of the manner in which the Contractor intends to meet all requirements of the specification. The document shall include a description of each item of plant, outline operating procedures, the facilities and services provided and an indication of maintenance arrangements.

As a minimum, the Functional Specification shall include the following:

System Overview:-	in the form of block diagram accompanied by descriptive text.
Functions:-	describing how the equipment proposed will meet the facilities and objectives of the specification. This section shall include all display and report formats, outline operating procedures, alarms and security measures.
Interfaces:-	details of all inputs and outputs to the plant and communication links between the various items including hardware, protocol and data content.
Attributes:-	details of the adaptability, availability maintainability and usability of the plant together with information on training and documentation to be provided.
Design:-	specifying broad details of software design, development procedures and proposals for factory and on site testing.

Junction equipment:- specifying the specific equipment and method of control and linking, if appropriate, to be installed at each junction

Cross-references shall be given throughout the Functional Specification to those parts of this Specification that are addressed by various paragraphs.

A draft of the Functional Specification shall be submitted to the Engineer within three months of award of contract for comment and discussion purposes. The Functional Specification shall be reviewed and updated as a result of the comments and a final agreed version shall be submitted for approval not later than one month after the comments are received.

2.6 Environmental Conditions

2.6.1 Climatic Conditions:

The climatic conditions normally experienced in Mumbai are as follows:-

(i)	Temperature	
	Average Daily Range	10 °C
	Average Maximum Shade Temperature	34 °C
	Minimum Shade Temperature	20 °C
	Maximum Shade Temperature	38 °C
(ii)	Rainfall	
	Wettest Month	400mm
	Average Annual	1400mm
(iii)	Wind	
	Maximum Hourly Wind Speed	133kph
	Maximum Gust Speed	230kph
(iv)	Relative Humidity	
	Minimum Average	48%
	Maximum Average	94%

2.6.2 Ambient Conditions for Equipment Rating and Design:

The ambient conditions under which equipment will be required to function at the rated level and on which type tests will be based, unless otherwise stated in the Specification, are as follows:-

Shade temperature	40 °C
Relative Humidity	95%

However, equipment will be required to operate at higher temperatures and humidity under short term abnormal conditions.

The Contractor shall ensure that all equipment and plant supplied shall be suitable for prolonged operation under these conditions.

2.7 Environmental Testing

2.7.1 Testing Requirements:

The Contractor shall arrange for the environmental tests detailed below to be carried out by his Inspectorate or by an independent test house on all equipment, other than that to be used in buildings in normal office conditions.

The Contractor shall supply documentary evidence that a sample of each type of equipment has complied with these tests.

The tests may be witnessed by the Engineer. The Contractor shall give the Engineer at least one month's notice of the commencement of the tests.

Alternatively, the Contractor shall submit certificates to the Engineer for tests carried out on similar equipment. The tests shall have been at least as arduous as those detailed below.

Where equipment would normally be installed in an air conditioned environment, it shall, if necessary, be protected against failure of the air conditioning system. This protection may be obtained by automatically switching off the equipment in the event of air conditioning failure.

Where equipment is normally installed in an additional housing, the environmental tests may be carried out with the equipment in that housing.

2.7.2 Environmental Tests:

(a) *Dry Heat*

The tests shall be carried out in accordance with IEC68-2 Test Bb, excluding the storage test. With the equipment switched off, it shall be exposed to a temperature of 50deg.C for a period of 16 hours.

The equipment shall perform in accordance with the Specification :-

- before being introduced into the test chamber,
- after the period of exposure and before the recovery period,
- at 5deg.C decrements during the recovery period,
- after the recovery period.

A visual inspection shall be made before and after the test.

(b) *Damp Heat*

The tests shall be carried out in accordance with IEC 68-2 Test Db. The temperature shall be raised to 35deg.C and the relative humidity to 99%. The equipment shall be subjected to one cycle of 12 hours "soak" followed by 12 hours recovery.

The equipment shall perform in accordance with the Specification before it is introduced into the test chamber, at maximum temperature and humidity and after recovery.

A visual inspection shall be made before and after the test.

(c) *Solar Radiation*

The equipment shall be exposed to a background temperature of 50deg.C

Radiation from an infra red source or a complete solar radiation source shall be directed at an angle of 0.8 radians to the plane of the top surface of the equipment.

Radiation shall be adjusted to achieve a temperature of 85deg.C measured on a matt black surface touching the upper surface of the equipment.

The equipment or the radiation source shall be moved to allow a period of two hours exposure on each of three sides of the equipment.

The equipment shall function in accordance with the Specification throughout the tests.

A visual inspection shall be made before and after the test.

(d) *Driving Rain*

The equipment shall be pre-heated to a temperature of 55deg.C for 4 hours with exposure to the water spray following not more than 15 minutes. later.

The tests shall be carried out in accordance with IEC 68-2-17. The equipment shall be mounted in its normal attitude and the equipment shall be switched off during the period of the test.

After the test, the equipment shall be visually inspected. No water shall have reached any electrical circuit or component. The accumulation of water within the cabinet shall not exceed 10 millilitres. Any ingress of water shall be reported to the Engineer.

(e) *Bump Test*

The test shall be carried out in accordance with IEC 68-2 Test Eb.

The equipment shall be visually inspected and functionally checked, packed for transportation, put under test and then rechecked both visually and functionally.

The test shall consist of 1000 bumps, each with a peak acceleration of 98m. per sec.sq. and a pulse duration of 16msec.

(f) *Vibration*

The test shall be carried out in accordance with IEC 68-2 Test Fc.

The equipment shall be mounted in its normal operational position and be subjected to vibration in the vertical plane and in the two horizontal planes.

The equipment shall be subjected to an acceleration level of 0.3g +/- 10% over a frequency range of 5 - 150Hz for a period of 2 hours in each plane. Endurance conditioning at resonant frequencies shall 10 minutes.

The equipment shall perform in accordance with the Specification throughout the test.

2.8. Electromagnetic Compatibility:

The Contractor shall ensure that all equipment is adequately protected against electromagnetic interference. This may be due to: -

- transient voltage spikes on the power supply,
- radio interference on the power supply,
- induced fields from power lines to communications cable,
- radiated interference from radio or radar transmitters,
- ignition interference from passing vehicles,
- electrostatic discharge.

3.0 TRAFFIC SIGNALS

3.1 Introduction

The Traffic Signal Controller shall provide solid state lamp switching and a conflict monitoring facility to ensure that conflicting, dangerous or disallowed traffic signal displays are not shown.

The controller shall consist of a rack mounted, controller logic module, housed in a zinc electroplated steel cabinet which provides a frame for termination to field cables.

3.2 Controller Firmware

The controller design shall be based on modern high performance microprocessor and all logical functions necessary external to the microprocessor shall be performed by solid state devices.

Timing functions shall be based on digital techniques implemented by the microprocessor system.

Site specific configuration data shall be stored in a single easily installed memory unit (EPROM). This shall comprise non-volatile time settings and data tables required to configure the operation for the particular junction or intersection.

The data stored in the memory unit shall be protected by checksum test.

The site specific configuration data shall be prepared on a PC based configuration platform.

Data in the site specific data EPROM, shall correspond to a hardware programmed intersection number and revision level in the controller housing, for the controller to start operation when mains power is applied.

The controller shall check the volatile memory for integrity at power up. All the data stored in volatile memory will be cleared if any corrupted locations are detected. In such a case the controller will use the non-volatile time settings stored in the memory unit. The data in any battery backed RAM will also be verified by a checksum test, and also by range checking to ensure that the data has not been corrupted.

3.3 Controller Functionality: Basic Facilities

Phase Facilities - The standard controller shall allow expansion from 8 phases up to a maximum of at least 24 phases. Each phase output shall be configurable to be either a vehicle phase or a pedestrian phase, within the limits of a maximum of 16 vehicle phases and 8 pedestrian phases, or combination thereof.

Each phase output shall provide 3 triac drives (or similar), which may be used for switching either vehicles or pedestrian lantern displays, Red/Amber/Green for vehicle phases and Red/Wait/Green for pedestrian phases. The pedestrian phases will be configured for either flashing red aspect or black it out during pedestrian clearance.

The solid state switches used shall be able to drive loads consisting of resistive and inductive elements. That is, the lamp switching outputs shall be able to drive Tungsten, Quartz Halogen, LED and Neon lamp loads, or combinations of these. All phase outputs must be rated accordingly.

3.4 Phase Drives - Software Control

The controller software shall provide control for a minimum of 16 vehicle phases and 8 pedestrian phases or combination thereof.

The number of vehicle and pedestrian phases are specified by separate entries in the controller site specific data. Each lamp switching output may be configurable via the controller EPROM, to drive a vehicle phase or a pedestrian phase.

3.5 Phase Drive - Configuration

Each phase must be configurable to any of the normal displays described below. The normal displays are:-

- a) Red (Red & Amber), Green, Amber (3-aspect vehicle phase);
- b) Red, Green, Flashing Red (pedestrian phase).
- c) Flashing Amber (to main roads), Flashing Red (to side roads), Flashing Red Man to pedestrians.

The displays defined are the default colours exhibited by the phases. Special colour sequences shall be capable of being generated, by condition tables in the site specific data for special controller applications, such as secret sign control etc.

3.6 Protection of Conflicting Phases

The simultaneous appearance of conflicting phases shall be prevented. The bidder shall provide information on how this is accomplished.

The bidder shall also confirm if simple green-green conflict monitoring is provided, or a more extensive monitoring function covering other dangerous combinations is possible.

3.7 Phase - Appearance Criteria

Any phase shall be configurable in the site specific data, to be introduced automatically or only upon demand.

Each phase shall be displayed for a fixed or variable duration according to traffic flow or demand, in accordance with the data entered in the controller configuration EPROM. Typically the duration of phase green displays will be determined by the duration of the stage(s) in which the phases receive right of way.

The controller configuration EPROM shall provide for filter green arrow for left turning traffic. The filter green left arrow may have an associated vehicle phase and can be configured such that it will not terminate until right of way for the associated vehicle phase is granted. Where a filter green arrow phase is defined as having 3 aspects, it should not be possible for the phase to terminate from green to red without an intermediate amber.

The controller configuration EPROM shall provide for filter green arrow for right turning traffic. The filter green right arrow may have an associated vehicle phase, and can be configured such that it will not terminate until right of way for the associated vehicle phase is terminated. Where a filter green arrow phase is defined as having 3 aspects it shall not be possible for the phase to terminate from green to red without an intermediate amber.

The controller configuration EPROM shall provide for Flashing Filter Amber for left turning traffic. The filter amber left turn arrow may have an associated vehicle or pedestrian phase and can be configured such that it will not terminate until right of way for the associated vehicle or pedestrian phase is terminated.

3.8 Stage/Phase - Timing Intervals

The controller configuration EPROM shall provide comprehensive stage phase timing interval facilities compatible with the system design. The bidder shall provide details of the timing intervals offered.

3.9 Stages/Signal Groups

The Controller shall provide facilities for a number of stages / signal groups which may include an all red stage. The available phases are allocated to these stages / signal groups in any combination subject to the method of control, the traffic requirements and safety considerations as required to meet the individual sites requirement.

The controller shall provide a minimum of 7 stages, within which any combination of phase displays are permitted in any stage. Phases shall be able to be specified for simultaneous appearance within a stage, for appearance after a special delay, or for early termination within a stage. It shall also be possible for phase displays to overlap a number of stages. Specified phases shall also be able to provide Leaving Amber and All Red displays independent of the running stage.

Each stage shall be capable of conditional and alternative phase displays, as defined by condition table entries in the controller site specific configuration data.

Complex phase/staging designs shall be possible with the appearance of phases in multiple stages being conditional on specified conditions at the junction, such as presence of particular demands, or the state of special control signals, etc.

Conditioning - Each stage shall be configurable to appear automatically or upon demand from specified detector inputs within the controller.

Sequence - In vehicle actuated mode, stages shall appear as demanded. When all demands are present, stages shall normally appear in cyclic order. During computer, cableless linking or manual modes stages shall normally appear as called. When the controller is operating in the cableless linking mode the sequence of stages shall correspond to the specified plan data stored in the traffic signal controller and must be fully configurable by operator entries from an operator terminal, (with the appropriate level of security, password or pin number).

For other modes of operation the sequence of stages shall normally be cyclic, with the sequence specified by the appropriate plan data. The controller shall allow a minimum of 4 different stage sequences to be specified, with the current sequence chosen according to prevailing conditions for that time of day.

The controller shall provide facilities for a number of phase equipment's any or all of which may be either:-

- i) fully actuated by on street demands and extensions,
- ii) demand dependent (vehicle or pedestrian Phases), or
- iii) fixed time phases (vehicle or pedestrian Phases).

Each phase may provide control for one of the following:-

- i) vehicular movements,
- ii) pedestrian movements,
- iii) vehicular movements controlled by Green Arrow Signal,
- iv) dummy phase (a dummy phase is used where timings or detectors operation have to be associated with a particular traffic movement, which is not uniquely signaled, a dummy phase may be used to provide a suitable time periods or to condition stage changes even though no signal aspect is associated with the phase).

Timers shall be allocated to phases. The timers shall control the following timed periods of each phase but shall not be limited to only these:-

- i) minimum green time,
- ii) extension time,
- iii) maximum green time,

Timers shall control the appearance and disappearance of phases during the interstage period. Such timers shall generate the phase to phase intergreen periods and introduce any further delays to offset phases with respect to the stage end point.

Vehicle detectors shall be associated with phases and may:-

- i) demand a phase,
- ii) extend a phase,
- iii) demand and extend a phase,
- iv) introduce a hurry call facility,
- v) be associated with an all red condition,

All Red - The controller shall allow any stage to be specified as an All Red stage.

3.10 Statutory Timing Periods

There is no Starting Red/Amber sequence in use at this time in Mumbai therefore this facility shall not be used.

The duration of the Leaving Amber intervals shall be configurable in the range 3 to 6 seconds and normally set to 4 seconds.

A flashing red pedestrian clearance display shall be provided, to terminate the right of way for pedestrian phases. The bidder shall describe how pedestrian safety is assured through the timing arrangements.

Phase Minimum Green. Shall be provided to prohibit a phase losing right-of-way until a minimum safety period, known as the minimum green period has expired. It shall not be possible to terminate prematurely any minimum period. At the commencement of a phase green, the minimum green period of that phase shall start to time off immediately.

Minimum Green Expiry Period - A stage change may occur after the expiry of the last phase minimum green for a phase or phases which will lose right-of-way on a change to the next stage to be introduced, providing no extension request exist for the terminating phases. Phase minimums may still be running when the stage change occurs, providing the associated phases run in the new stage. The duration of the stage minimum green period will be determined by the expiry of the minimum periods of the phases which will lose right-of-way upon the change to the next stage.

Vehicle Phase Green Extensions - The passage of a vehicle over a detector loop as indicated by a detector unit which normally demands a phase may, during the green period of that phase, cause a green extension to be generated for that phase. The continued output from the detector or detectors associated with a phase shall hold that phase green signal; the cessation of the output from the loop detector shall normally terminate the green extension request after a fixed period - the extension time. If at the end of the extension time the stage is held by extensions associated with another phase, further extension request shall be permitted. (these are the minimum criteria which may be supplemented with further facilities).

It shall be possible to arrange that selected detector inputs do not extend a phase during a single selected stage.

It shall be possible for the relevant phase green signals to be terminated before extension inputs that have been accepted are actioned or legitimately overridden by Max or ATC influence.

A gap change shall occur to change stages when the following conditions are satisfied:-

- i) A demand for right-of-way for a conflicting phase exists,
- ii) The minimum green running periods of phases which will lose right-of-way have expired,
- iii) The vehicle green extension timers have expired on all phases which will lose right-of-way upon the change to the next stage.

The maximum green running period shall be provided for each vehicle actuated phase. When a phase obtains right-of-way, the maximum green running period shall commence to time off immediately if there is a demand for any conflicting phase, or, if there is no conflicting demand present, it shall commence to time off upon the receipt of a subsequent demand for any conflicting phase.

The effect of this facility shall be to limit the duration of a phase before the controller may allow right-of-way to terminate in order to introduce a conflicting phase. The maximum duration of a particular stage green shall be governed by the termination of the last associated phase if more than one phase is to be terminated by the stage change and if the maximum for these phases are different.

Alternative values of maximum running periods shall be available.

Under ATC or CLF control, the duration of the green period shall be determined by these control modes.

After the termination of the last phase maximum green for phases not served by the next stage to be introduced, a stage change shall occur to serve the conflicting demanded phases. This change may take place irrespective of whether the maximum or minimum green periods for the phases also served by the new stage have expired.

It shall be possible for a phase to receive right of way at any time in the stage or combination of phases after the beginning of the stage or combination of phases Minimum Green interval.

The stage shall not be permitted to terminate while any of these Minimum Green timers are active, thus ensuring that the phase(s) are not terminated without running the required Minimum Green time.

For pedestrian phases the pedestrian green time setting will provide the Minimum time on a phase by phase basis.

Phase Intergreens between conflicting phases shall be specified and shall influence the starting and ending of stages where stage control is appropriate. The intergreen period is the period between one phase losing right-of-way and another phase gaining right of way. It shall be possible to allocate individual intergreen timing values to all conflicting phase transitions. Intergreen values shall not be violated in the event of multiple stage changes.

Phase Change Delays/ Advances - the controller shall have the facility to delay the disappearance of any phase with respect to the end of a stage or combination of phases at any stage to stage transition. Such delays shall be defined fixed durations. The controller shall also have the facility to advance the appearance of any phase.

Following the leaving amber period, the phases losing right-of-way shall change to red. The controller shall include the facility such that during any stage to stage change a red condition can be generated simultaneously on all phases which change their right-of-way condition at the stage-to-stage change. The necessary timing for such an all red condition shall be generated from the valued of the intergreen timing parameters and any related phase delays allowing for mandatory amber periods.

Extended Red Periods - the timing of the stage to stage movements shall be capable of being increased by red extending detectors.

The controller shall provide a separate delay and timesetting for each pedestrian phase to allow delayed introduction of the pedestrian green display.

Limiting Values - minimum green and intergreen timings shall each be protected by a single minimum value stored in ROM, below which it shall be impossible to set. Unless otherwise specified limiting values for minimum green shall be 3 seconds and for intergreens 5 seconds.

3.11 Vehicle Detection

The vehicle detectors are not envisaged in this project.

3.12 Controller Functional Requirements Operational Facilities

Modes of operation - The controller shall provide the following modes of operation:-

- i) Hurry Call,
- ii) Manual,
- iii) ACT mode,
- iv) Cableless Linking;
- v) Vehicle Actuation,
- vi) Fixed Time,
- vii) Night Time Flashing,
- viii) Part Time.

The controller shall provide a configurable priority structure for the operating mode.

The controller shall enter Flash-Amber / Flash Red mode if a fault is detected at any time which may cause unsafe operation on site. These may result from conflict monitoring hardware failures or red lamps failing on an approach and in turn causing an entry to be made in the fault log. Any significant fault condition which places a Fault entry in the controller Fault/Error Log will cause the controller to enter the Flash Amber mode. At an appropriate time of day the monitoring computer may isolate the local control to enter flashing amber/flashing red signal sequences. This sequence is to provide flashing amber aspects to main road approaches whilst indicating flashing red aspects to side road approaches. This facility shall also be timetable programmable via controller timetable and shall remain in operation until reset by the time table facilities on the following morning.

Mode Priorities - The controller shall normally operate in the appropriate mode of control for any particular site at any particular time of the day.

Demands - The controller will accept demands for operating modes as follows:-

- i) An actuation at the designated controller input will demand the Hurry Call mode.

- ii) A demand at the manual panel will demand the Manual mode.
- iii) The controller timetable may command the controller to operate in either the cableless linking mode or vehicle actuation mode.

Timetable - The controller shall provide control of "Time of Day" functions. Standard Timetable Control Functions shall include:

- i) Signal aspect dimming.
- ii) Special Facility control output switching.
- iii) Selection of fallback mode.
- iv) Signal plan selection.

Timetable Scheduling - The controller clock time shall be used to activate the timetable requests by time of day and day of week. Timetable events shall be scheduled within a day by the hour, minute and second from the real-time clock so that the resolution can be to the nearest 1 second within any day.

The day of week will be specified by a daycode which shall provide economy in schedule entries. There shall be an appropriate number of such daycodes which allow selection of individual days, (Sunday through Saturday), and combinations thereof. The Bidder shall provide comprehensive details of what his equipment provides.

The time clock system provides the facilities necessary for the controller to be integrated into a cableless link system or to allow the controller to be operated in a fall back mode of operating in an Area Traffic Control Scheme. The time clock may additionally be used to achieve time controlled switch facilities such as alternative timings or stage structure or the control of secret signs.

Manual Switch - A Switch shall be provided to control lamp status and provide for manual sequencing of the signal displays. The switch shall be directly accessible from the controller requiring the opening of a panels or door. The bidder shall describe how the step on mode is provided and operated.

Cableless Linking - It shall be possible to set the controller to operate in the cableless linking mode as either the normal mode of operation, or as the fallback mode of operation when the controller is no longer able to operate in a higher priority mode. Demands for higher priority modes of operation shall cause the controller to operate in the higher priority mode.

Operation - In the cableless linking mode the controller shall operate in accordance with the plan data stored in the controller. The plan data shall be stored in site specific data EPROM or battery backed RAM.

The cableless linking mode shall provide fixed time operation as its most basic mode. Programmable release signals should be used to provide semi-VA operation. The release signals may be associated with stages or particular phases, and may be enabled or disabled by entries in the plan data. The function of each release signal is

defined by entries in the controller site specific data. Bidders shall describe what semi-VA operation is provided by their controller.

Plans - The controller should provide storage of a minimum of 11 cableless linking plans. The bidder shall provide full details of the plan data, its structure, influences and their effects.

Plan Selection - The active plan shall be selected by day of week, hour, minute and second of the day.

Plan changes must not cause unsafe signal displays, such as very short green times or incorrect stage sequences.

Reference Time - The monitoring computer shall generate a synchronization signal for its associated traffic signal controllers. The bidder shall specify the time clock synchronization times appropriate to the controller equipment and monitoring computer, clearly stating the signals used for synchronization and confirmation of synchronization.

3.13 Controller User Interface

Facilities either external to the cabinet or located behind a flap secured by a key shall permit the local controller lamps to be switched On or Off, to select Night Time operation, to assume Normal Operation (mode priorities) and to permit the selection and control of MANUAL mode.

Facilities within the Controller Cabinet - Access to the controller housing shall be by a controller key, that fits a secure, vandal proof compression lock at the top and bottom of the door.

Monitoring - The controller panel shall provide Red, Amber and Green LED's for each phase output to allow easy monitoring of the drive signals to the signal displays.

Status LEDs shall be provided to give indication of the state of the hardware and software. The status LED's include:-

- CPU is operating normally.
- Conflict detected.
- Communications synchronized.
- Power is OK.
- Lamp Alarm (i.e. a lamp fault exists).
- System Shutdown (due to an internal system fault)

An engineering interface shall also be provided, with a separate lockable access to the manual panel whereby an engineer can access the controllers fault log and obtain operational data. The interface shall also allow controller timings and operational features to be modified.

3.14 Controller Safety and Reliability

Fault Detection - The controller must employ a number of different fault checking processes, including both hardware and software checks using the processors. In general, the signal displays must be switched off within 500 milliseconds of the occurrence of a fault. There are exceptions to this as noted below.

The occurrence of conflict in signal displays will cause the signal displays to be switched to flash amber / flashing red within 150 milliseconds by the conflict monitor. Configuration faults which cause unsafe signal displays must cause the signal displays to be switched off within 100 milliseconds. Examples of this class of fault are:-

- i) An attempt to change a signal display from Green to Red without an intervening Leaving Amber display.
- ii) Premature termination of a pedestrian signal display from either pedestrian green or flashing red to the pedestrian red.
- iii) An attempt to terminate a phase Green display before expiry of the minimum green time for the phase.
- iv) Invalid site specific data in a data or condition table.

The controller must perform range checking on timesettings for both RAM and EPROM. Any timesetting data that is outside limits must be detected within 200ms, with immediate entry to flash amber-flashing red mode.

Software checks should be performed on the battery backed RAM and also checksum checks performed on non-volatile memory.

3.15 Design Life

All components must be rated for minimum 10 year life, excluding the standby battery which should have a typically life of 5 years.

A Mean Time Between Failures (MTBF), of greater than 3 years should be achieved.

3.16 Fault Log & Diagnostic Facilities

The controller must provide a Fault/Error Log in battery backed RAM. The Log will provide storage for Faults which cause the signals to be blacked out. Storage is also provided for Errors which are detected, such as Hurry Call Request Watchdog time-out etc. These would not cause the signal displays to be blacked out.

Fault Diagnostics - The controller Fault/Error Log will store relevant diagnostic data concerning each Fault or Error entered into the Log. Each Fault and Error is identified by a unique fault code which will allow each fault to be quickly assessed as to the likely cause. Diagnostics should be provided that identify:

- i) Green Conflicts.
- ii) Phase Monitor Faults.
- iii) Memory Corruption/Failure.
- iv) Plan and Timetable Data Faults.

- v) Real Time Clock Failure.
- vi) Hurry Call Request .
- vii) Special Facility faults.

The controller shall monitor detectors and pushbuttons in alarm checking intervals. The duration of each alarm checking interval shall be specified by tables in the site specific data. The tables will allow different alarm checking intervals for each of four time zones within a day. The tables will also allow two day types, normal and alternative, each with its own time zones and duration of time checking intervals for each time zone.

Any detectors which did not change state in an alarm checking interval shall be flagged as faulty. Any pushbuttons which remained continuously actuated for the entire alarm checking interval shall also be flagged as faulty. On detection of a faulty detector, a permanent demand and extension shall be placed in the controller for the phase associated with the detector. If the detector resumes operation, the permanent demand and extension shall be removed.

"Chattering" detectors, with periods of oscillation less than 100 milliseconds, will generate alarms. Such alarms will be stored in the controller.

3.17 Phase Drive Monitor

The output switching circuits must monitor the driven state for each phase aspect to check that the output state corresponds to the drive signals from the processor. If a discrepancy is found then the controller will switch off the signal lamps and records the fault in the Fault/Error log.

The controller must provide a comprehensive conflict detection mechanism for conflict monitoring.

3.18 Electrical Specification

Main Power Supply - The controller should be designed to operate with wide variations in nominal mains supply and be tolerant to variations in supply voltage and frequency.

An interruption in the mains power of less than 50ms will not cause any disruption to normal controller operation. The controller will shut down in an orderly fashion as a consequence of a power failure of more than 50ms. The controller shall automatically re-start when power is restarted.

The controller must be protected against overvoltage on the mains power supply of 800 Volts, 50 microsecond pulses, (5 ohm source impedance) randomly phased. The controller must survive these overvoltage transients and continued to operate correctly without damage, or without any tripping of breakers etc.

All terminals that provide an interface to equipment external to the controller shall be isolated by opto-couplers which will provide protection from transients of +/- 75V for 1 minute.

A main fuse and switch rated to a minimum of 20 Amps will be provided. The Main Switch will remove power from all circuits within and fed from the traffic controller.

3.19 Lamp Circuit Isolation/Protection

A Lamps Circuit Breaker will be provided to switch off the signal lamps and the WAIT indicators without affecting the operation of the controller logic. The lamps circuits (red/amber/green) for each phase will be protected by separate fuses.

Signal Lamp Switching shall be by solid state, triac load switches. The Triac load switches must be rated in excess of five million switching operations and to 40 amps. The rated lamp load must be at least 4 Amperes continuous for each aspect for each phase at voltages in the range 32V to 250V.

Signal Lamp Dimming shall be provided for all signal displays, including WAIT indicators.

The battery shall protect the real time clock and RAM against loss of power. Data will not be corrupted in either the clock or the RAM due to loss of mains power, or the removal of any circuits cards from the logic module.

The battery shall maintain the clock and RAM for a minimum of 12 months.

The status of the back-up battery shall be checked at controller start-up, and automatically once every month. If the battery condition is bad then the condition will be logged.

Real Time Source - The controller shall provide both a Real Time Clock with day of week, hour, minute, second and fraction counters.

3.20 Mechanical Specification

Controller Housing - The traffic signal controller must be an integrated system with all necessary control, communications, input/output and termination facilities located within the one base mounted cabinet. The cabinet base shall be constructed to raise the cabinet above the surrounding level by at least 300 mm to avoid damage during flooding.

Physical Design - The controller shall be housed in a cabinet fabricated from 2mm thick mild steel, zinc seal steel electro-galvanized to an appropriate international standard with a powder coated baked enamel finish. The cabinet shall be supplied with all fixtures and fittings to mount internal equipment and to fix it to the base plinth. All fittings and fixtures supplied with the cabinet shall be protected against corrosion.

Access to all internal equipment will be via a single front opening door hinged at three positions, top, middle and bottom. A document pocket (A4 size) shall be provided on the door to carry necessary documentation.

The cabinet may be convection ventilated with air entry through a channel at the base of the door, and air exit around the top cover. The base design shall provide frangible mountings to minimize accident damage.

Cabinet weatherproofing shall be to a minimum of IP65 standard or better.

The standard cabinet shall provide field wiring terminals in 4 phase increments to capacity of 24 phase outputs, or alternatively may be available to allow connection of larger phase drive capacity where appropriate.

The cabinet shall include a site identifier that will ensure that the cabinet once prepared for a particular intersection can only accept a logic unit also prepared for the same intersection.

Key operated compression locks shall be provided at the top and bottom of the door.

Manual control of the controller shall be possible by either a key flap revealing a manual control panel or alternatively by a 5 position key-switch "facility key". The lock shall be flush mounted to a side panel of the controller cabinet. The lock shall be protected against water and dirt ingress. The manual panel or key-switch shall provide the following switched functions as a minimum:

- i) AUTO (Normal operation, key can be removed in this position).
- ii) FLASH (Flash amber / red, controller continues to run, key may be removed in this position).
- iii) OFF (lamps off, controller continues to run. The key may be removed in this position).
- iv) MANUAL (select manual control).

Cable Termination and Earthing - Cable clamp bars, and cable trunking shall be provided for all internal cabinet wiring. Termination points shall be provided for all incoming and outgoing cables.

Mains voltage lamp output terminal units shall be separate from loop terminal and auxiliary input/output terminal units.

Lamp output terminal units shall be provided in each controller cabinet. Each shall have terminal positions for four 3-aspects phases, Red/Amber/Green for vehicles and Red/Wait/Green for pedestrians. Three screw terminal should be provided at each position for incoming cables.

Cable clamps shall be provided at the base of the controller to be fixed to a castellation bar.

Provision for termination of loop feeder cables from the field shall be provided.

Labelling of Equipment - All equipment within the controller must be suitably identified. Where required warnings shall be provided of hazardous voltages.

Mains Power Supply Termination - Provision shall be made within the controller cabinet for the mains cable termination to the live/neutral/earth termination points (16 sq. mm wire).

3.21 Traffic Signal Heads and General Street Furniture

3.21.1 Definitions: For the purpose of this specification, the following definitions shall apply;

- i) Signal Aspect; An optical system which produces light or a light pattern of specified size, colour and shape.
- ii) Signal Face: A combination of signal aspects which together provide a continuous display of control information to a traffic stream.
- iii) Signal Head: An assembly of signal aspects presenting one or more signal faces, mounted on a single pole.
- iv) Vehicle signals: Signal faces providing control information to vehicles.
- v) Pedestrian Signals: Signal faces providing control information to pedestrians.
- vi) Phantom: A reflection of sunlight and sky light from the internal optical surface of the signal aspects, normally the reflector.
- vii) Spectral Reflection: Reflection of sunlight and sky light from the outer surfaces of the optical system of the signal aspects, either the lens surface, or in the case of a pedestrian or arrow aspects, the mask which defines the symbol displayed.

3.21.2 Arrangement of Aspects:

(a) *Vehicle Signals*

Each signal face shall, unless otherwise specified, contain three aspects arranged vertically. The polycarbonate LED based signal lamp of the upper aspects shall be red, the middle one amber, and the lower one green. In addition, red, amber, green arrow or amber arrow aspects may be used.

All aspects on each vehicle signal face shall be of the same diameter. Aspect diameters shall be between 210 mm and 310 mm as required for each installation.

(b) *Pedestrian Signals*

Each signal face shall contain two aspects arranged vertically. The aspects shall be circular with a diameter of between 210 mm and 310mm. The upper aspect shall show a standing red man on a black background. The lower aspect shall show a walking green man on a black background.

3.21.3 Optical Performance:

The Bidder shall submit details of the standards that their aspects meets and shall submit copies of certified independent test reports showing that their aspects meet the

standard requirement, or any other independent standard which is approved by the employer.

The design of the optical system shall be such that when a signal aspect is installed with its visor, under all normal conditions experienced in the City of Mumbai it shall give a clear and unambiguous indication to motorists (and pedestrians) when viewed from all normal viewing angles up to a distance at least 100m from the aspect. Optic glass shall be made from unbreakable tempered glass. In particular:

- i) When the aspect is switched off it shall give a uniform, near black appearance with no visible phantom or spectral reflection.
- ii) For the pedestrian and coloured arrow aspects. When switched on, the contrast between the illuminated and non illuminated portions of the aspect shall be such that the intended indication is completely clear.

It is the responsibility of Bidders to satisfy the Employer that their signal aspects meet these general requirements. Unless previous approval and compliance to this specification has been obtained Bidders shall submit samples of their equipment for evaluation.

3.21.4 Construction of Signal Heads and Visors (Hoods):

The materials used and the form of construction used shall be such as to ensure that the signal head (including visors) has adequate mechanical strength and durability to withstand the conditions of installation, operation and maintenance. In particular it should be capable of withstanding winds of up to 145 km/h. The colour of the signal body and visors shall be black or dark green.

Materials, fixings and fastenings used shall either be inherently corrosion resistant, or shall be treated to prevent corrosion.

All materials used shall be capable of withstanding the action of direct sunlight and external ambient temperatures of between - 10 and +55 °C and relative humidity to 95 percent, non-condensing, without significant deterioration of mechanical strength, or change of colour.

The signal head should be of modular construction, designed to be safe, vandal resistant and easy to install and maintain. It should comply with the requirements of BS505 as amended by TRO102 and BS837, EN12368, BS1376, DIN6163 or other International Standard appropriate for use in India.

The unit should be modular permitting signal head configurations to be built from standard building blocks. The units should incorporate anti-vandal captive hinge pins with the aspect open, full access to the interior of the head should be possible allowing easy maintenance. Aspect lenses should be available in either 200 or 300mm sizes.

(ADO) as well as secure locking action to prevent vandalism or movement of the signal head from the locked position.

Fastenings used on signal heads and poles to gain internal access shall not require special tools and shall be wholly captive.

The signal heads should be provided with seals between all openings and these may be supplemented with knife edge types seals to prevent the ingress of water.

All signals aspects shall be fitted with visors. Visors shall be of sufficient size to adequately shade the aspects and to minimize phantom effects. The visors shall be manufactured from matt black or dark green material. Where specified, or made necessary by site conditions, deep or specially designed visors shall be provided which give a constrained directional view of the signal aspect.

The signal head should achieve a precise beam distribution which produces high intensities of light in the centre of the optic. The displayed symbols shall offer some form of protection against the adverse effects of sun phantom illumination of aspects. The Contractor shall state in his bid return how the equipment offered achieves this.

Lamps shall be of the incandescent type, of sufficient wattage to produce the required optical performance and have an operational life of 5000 hours. The lamp holder shall provide a positive and accurate fit to the reflector. Location and heat conduction by lamp pins alone is not considered adequate.

The equipment shall be made of Polypropylene with stainless steel/Polypropylene fixings.

Brackets shall be pre-drilled to suit and supplied in kit form including fixing kit for standard poles and should be treated for use in a high salt content atmosphere.

3.22 Signal Poles

All poles and posts shall comply with or exceed the requirements of BS505 or Similar International approved specification as appropriate for use in India with regard to fabrication and steel content and shall be galvanized steel Class B.

The post shall have a diameter of between 100 and 115mm and a strength and rigidity at least equivalent to that for a seamless steel tube of 100mm outside diameter and 4.4mm thickness and a tensile strength of 375MNm².

Signal poles shall be of a uniform diameter. An exception may be made to increase the diameter of the lower part of any post at a signal installation to accommodate, for example, electrical services and/or termination assemblies.

The height of the signal posts may increase by 150mm above the upper bracket fixing to permit better access to the post cap termination assembly.

All the signal poles shall be coated with polyurethane (PU) coating.

All plastic coatings shall be, even when scratched or torn, and shall be resistant to peeling.

It shall be so designed and constructed as to provide adequate support and stability for the signal head and shall be fitted with a weather-proof cap.

Where an entry is required to permit the entry of an electric supply cable, unless otherwise specified by the employer it shall be not less than 300mm high by 500mm wide and the top of the slot shall be between 75mm and 130mm below ground level. The top and bottom of the aperture shall be radiused with radii equal to half the slot width. Where an aperture is required to permit the entry of cables which are not supply cables, it shall be capable of accommodating four cables each of 32mm diameter and any apertures above ground level shall be fitted with a suitable gland or grommet maintaining as far as possible a smooth surface of the same colour as the post.

Unless otherwise specified the post shall be of sufficient length to allow a minimum 700mm below ground level when correctly erected.

The interior of the steel posts shall be protected by:-

- i) a finish complying with the requirements of BS729; or
- ii) an anti-corrosive paint which shall be effective over the temperature range 25 °C to 70 °C.

The exterior portion of the steel posts below ground level and extending to at least 450mm above ground level shall be protected:-

- iii) by spraying with molten zinc to BS5269, Part 1 or
- iv) as in (i)

The interior surface of steel posts shall be finished either in a protective plastic material as specified in clause 6 of BS 873 Part 1 1970 or alternatively be protected by spraying with molten aluminium. The colour of the surface shall be yellow.

Any surface cut after galvanizing painting or the application of the plastics finish shall be protected by one of the methods 1 to 3 above as appropriate.

All non-current carrying metal parts used to support the terminal assembly (housed at the top of the post), and the bonding for cable earth leads shall be non-corrodible and earthed in accordance with the current requirements of the IEE wiring regulations or similar International standards as appropriate for use in India. Any method of terminating armoured cables shall ensure electrical earth connection between the frame supporting the terminal assembly support frame shall resist vibration fatigue when supporting its full complement of cables and terminal blocks.

The post cap, covering the cable termination assembly, shall be constructed in such a way that it will not become loose due to vibration or adverse weather conditions. The post cap shall prevent rain from reaching the termination assembly. Pole cap securing the pole cap to the pole through the top of the pole cap shall not be acceptable.

Poles shall be shotblasted with a crossover adhesive and dipped in fluidized bed of PVC, to a thickness of 250/300 microns with a bitumen finish applied to the internal surfaces of

the pole, alternatively a fully galvanized pole in accordance with BS729 or to a similar International standard shall be provided. All poles shall be polyethylene sleeved for protection.

3.23 Fixing

Suitable means should be provided to firmly fasten brackets and signal heads to poles, and to allow adjustment where required. All nuts, bolts, fastening, hinges, brackets and other fittings shall be of non-corrodable material or suitably treated to prevent corrosion.

Vehicle signal heads shall normally be fixed with the centre of the amber aspect 3.5m above the carriage way level. Signal heads on high masts shall be fitted so that the lower part of the signal head assembly is at least 5.5m above the carriage way surface, or as directed by the Engineer.

Pedestrian signal heads shall be fixed with the centre of the Red Man aspect 2.3m above the carriage way level or as directed by the Engineer.

The poles shall be such as to provide adequate stability in wind gust velocities up to 145 km/h. The bidder shall be provided with copies of the relevant standard details covering this point

Termination of signal cables should normally be to a terminal strip mounted within the pole some 1.2 metres above ground level. Cables connected permanently in the signal heads shall also be brought through the inside of the pole into the termination box and terminated there. Access to the terminal strip shall be through a hatch cut in the pole and providing a good seal to prevent water ingress.

The Bidder may propose an alternative method of cable termination providing it gives adequate protection to both cables and terminals.

Mast arm poles shall be fitted with a cable termination box or lockable panel casting.

Pedestrian Push-Buttons - Pedestrian push-button and illuminated "wait" indicator shall be fitted in cast aluminium mounted on signal poles or separate short poles. Boxes shall be painted black.

The "wait" indication shall comprise an LED display or low voltage tungsten bulb. When illuminated, the indication shall be uniformly illuminated and the brightness shall be sufficient that it is clearly visible in conditions of bright incident sunlight.

Pedestrian push-button boxes shall be mounted with the push-button 1.2m from pavement level, and shall be earth bonded to the supporting pole.

The mounting shall be such that the box cannot slide on the pole if the fixings become loose.

The boxes shall contain suitable terminals for controlling cables, which shall be routed inside the pole.

4.0 INSTALLATION, SPARES AND TOOLS

4.1 Introduction

The Contractor shall install all traffic control equipment required at each junction according to the specification and drawings for that junction. The precise location of all street equipment will be confirmed on site by the Engineer. At each junction, the installation shall include the civil work and all electrical work necessary to provide a complete working system. It shall include the removal of the existing traffic control equipment, where necessary.

The Contractor shall comply with all statutory regulations and local by-laws relating to this work and shall obtain permission of the authority before commencing work.

Before any work is undertaken on site the Contractor shall submit details to the Engineer for approval. For civil engineering work this will include the provision of drawings showing the work and may involve a site visit to check. For equipment and cable installation, it shall include provision of installation and testing specifications for the equipment. For cabling it shall also include cabling diagrams showing routing and cable purpose together with an indication of number of spare cores.

4.2 Civil Installation Work

At each junction, the following civil works have been included in the works to will be undertaken by the main civil engineering contractor employed by the Employer:

- Installation of cross road ducts;
- Installation of traffic signal poles;
- Installation of handholes in the footpath at the ends of the cross road ducts;

The signals contractor shall base with the civil contractor to provide all other works required. He shall:-

- (i) Liaise with the civil engineering contractor doing the works above to ensure it's adequacy and suitability for the purpose;
- (ii) Check the ducts and handholes when installed to ensure usability;
- (iii) Arrange for the civil contractor to provide all excavation and trenching both on and off the highway, ducting, backfilling and making good required in addition to that provided above This shall include all requirements for the controller and any other equipment bases and ducting to them, vehicle detector installation and ducting, power supply ducting and data transmission ducting.

The Contractor shall ensure that all necessary measures are taken for the protection of electricity supply cable, pipes, drains and all other apparatus during the progress of the works and to provide any auxiliary works necessary for the prevention of damage and interruption to other services.

4.3. Electrical Works

4.3.1 Installation of Cable in Ducts:

The Contractor shall ensure that:-

- (i) All ducts are clear and clean before installing cable
- (ii) A correct tensioning device is used and that the maximum allowable tension is not exceeded
- (iii) During bending, the cable is not damaged or the minimum internal bending radius is not exceeded.
- (iv) All cables are supported along their length. Mechanical supports for vertical cable runs shall be provided.
- (v) Communications cable shall not be installed in the same duct as power cables. If installed in the same trench, the communication cable shall be at a minimum distance of 300mm from other cables.

4.3.2 Cable Termination

The method of securing cable conductors on a terminal block shall ensure that pressure from the terminal screw is not applied directly upon the conductor. All components of the terminal block shall be corrosion resistant.

Unused cores of cable shall be laid and strapped in a tidy manner, leaving sufficient length of conductor to be suitable terminated at a later date.

Sufficient spare cable shall be left at each termination to allow the cable to be re-terminated or joined in the event of damage.

4.4 Installation of Junction Equipment

4.4.1 Sub-Assembly:

As far as practicable, equipment shall be pre-assembled and checked before being taken to site.

4.4.2 Signal Heads:

For post mounted signals, the minimum height from ground level to the lowest point of a signal head assembly after installation shall be approximately 2.7m. Each head shall be positioned to provide sufficient clearance for passing vehicles.

The minimum height from road level to the lowest point of an overhead mounted signal or cantilever shall be 4.7m.

Usually, primary signal heads shall be aligned so that the geometric axes of the signal aspects are aimed at a point 1.5m. above ground level at the centre line of the carriageway (for traffic approaching the signal) at a distance of 50m. for post mounted signals and 100m. for overhead signals. The dimensions may be varied where special circumstances dictate.

Secondary signal heads shall be aligned so that the geometric axes of the signal aspects are aimed at a point 1.5m. above ground level 2m. to the rear and centre of the stop line for the approach lane to which they refer. If necessary, special visors shall be provided to prevent signals being visible to traffic for which they were not intended.

Pedestrian signals shall be directed towards the centerline of the pedestrian crossing.

After installation, the controller functions shall be tested, as far as possible, with the signal lamps switched off. Tests on the signal lamps shall be as short as possible and aspects shall not be displayed to traffic. Until they are commissioned, all new signal heads shall be covered so that they are not visible to traffic.

4.4.3 Regulatory Signs:

Signs associated with signal head assemblies shall be fixed to posts or mast arms, with non-corrodible fittings.

Signs shall be located either beneath a signal head or to one side of it. The signs associated with right or left turning vehicles shall be mounted only on the appropriate side.

The signs shall not cause obstruction and shall be clearly visible to approaching vehicles.

4.4.4 Controller Housing:

The controller housing shall be positioned so that it is not vulnerable to damage by vehicles and so that neither the housing or it's open doors obstruct the footpath.

On the completion of installation, the base of the housing shall be sealed with epoxy resin or in a manner approved by the Engineer.

4.4.5 Electricity Supply:

The Contractor is responsible for arranging with the electricity supply authority for the provision of a suitable power supply at each junction. The Contractor shall be responsible for the connection of the supply to his equipment and shall supply all ducting, cable and equipment required to comply with the supply authorities regulations and tests.

If required by the electricity supply authority, an electricity supply meter shall be installed within the controller housing or in a separate cabinet, as required. It shall be possible to read this meter without opening the main door of the housing.

The supply to equipment shall be protected by a suitably rated miniature circuit breaker and an earth leakage detector.

4.4.6 Electrical Tests:

All cables shall be tested before installation, after installation but before termination and after connection. The tests shall be carried out by the Contractor and may be witnessed by the Engineer.

4.5 Installation of Communication Cable

4.5.1 General Requirements

Communications cables shall be installed in lengths such that jointing of cables shall be made, as far as possible, within the controller housing. The use of underground jointing techniques is to be avoided. The method of jointing shall be submitted to the Engineer for approval. A minimum of 3m. of spare cable shall be left either side of an underground joint

The cable terminations shall be designed to allow easy access to the conductors. The method of termination shall allow the connection of additional conductors or cables without disruption of existing circuits.

All cables shall be tested before installation, after installation but before termination and after connection. The tests shall be carried out by the Contractor and may be witnessed by the Engineer.

The connections between the communications cable terminations and the data transmission equipment, both at the traffic signal controller and at the control centre, shall be via a "U" link panel or other means, which permits the isolation of each circuit for testing.

4.6 Spares

Bidders shall list and include in their bids all spares necessary for the contract period and first two years of operation. This should include consumable spares (excluding paper, floppy discs and consumables easily available locally) and sufficient equipment spares to cover any failures which may occur.

Bidders shall provide full justification for each of the spares they propose using MTBF and similar calculations. For consumable spares, they shall provide anticipated consumption information.

Spares shall be provided during the contract according to a program to be agreed with the Engineer. The Contractor shall ensure that the full amount of spares required for two years operation are available in working condition at the end of the Contract.

4.7 Special Tools

It may be assumed that the Employers maintenance technicians will be equipped with a general purpose tool kit suitable for use with general electrical and electronic equipment. Bidders shall include in their Bid submissions for all other tools and adjusters which may be necessary for the setting up and on-going maintenance of all equipment and systems provided under the Contract, including routine and first line maintenance.

In the event of the Bidder proposing equipment which uses programmable read only memory devices, the Bidder shall include programming and erasing equipment suitable for use with these devices if they cannot be programmed and/or erased 'in circuit'. Programming units shall include a means of changing selected locations of the memory before programming and for loading program code into the programmer via a serial data communication channel.

5.0 MAINTENANCE AND WARRANTY

5.1 General

This section describes the services required and the procedures to be adopted for the maintenance and repair of the Traffic Control System. Maintenance and warranty shall be considered combined for the purpose of this contract. The cost of the Maintenance service will be expected to reflect the fact that the equipment itself is covered by a 12 month warranty. It will be expected that the cost of the spare parts utilized in the maintenance charge.

The equipment to be maintained shall be all that provided and installed under the Contract. It shall include any provisional items or options supplied, the maintenance and amendment of the documentation supplied, and the test and monitoring equipment. System software shall be maintained to the extent that any faults found during operation shall be fixed.

The Contractor shall provide a full maintenance service on all days and at such times of day as specified in the attached Schedule 1. The maintenance service will start from the time of issue of a Completion Certificate for a part or portion of the equipment to be supplied and shall terminate 12 months after the issue of the Completion Certificate for the complete works.

Subject to the Approval of the Employer, the Contractor may subcontract a portion of the maintenance services, not exceeding 49% of their total value. Such appointment of a subcontractor shall not relieve the Contractor of any of his obligations.

All subcontractors shall be subject to all the provisions of this Contract.

The Contractor shall give the Engineer at least 60 days notice of his intention to employ or change a subcontractor, stating the reasons for such employment or change and seeking the Engineer's approval. Details of the new subcontractor and his specific qualifications and experience relevant to the proposed nature of the subcontract shall be included in the said notice.

5.2 Scope of works

The equipment to be maintained is all that installed and/or provided as part of the Contract, and is listed in detail in the Annexed Schedule 2. It will include equipment installed at the Central Control Building, all cables and data transmission circuits supplied from that building to the extent of supply, whether they are in use or not, and all traffic signal, traffic control and detecting equipment installed at each of the road junctions and other locations specified in Schedule 2 of this Contract. The maintenance service covers all equipment, software, interfaces and cables. It does not cover maintenance of any civil work undertaken as part of installation, except where this was not carried out to a satisfactory standard and it fails or requires repair significantly earlier than would normally be expected for this type of work. It does, however, include the provision of any civil works necessary to undertake and complete the maintenance services.

For traffic signals, routine maintenance shall include, but not be limited to, cleaning of all signal heads poles and cabinets, replacement of all red, amber and green aspect bulbs every 6 months and painting of poles and control cabinets annually or as required. The details of the equipment to be maintained, other necessary routine maintenance work, drawings, repair procedures and other information will be as contained in the Operation and Maintenance manuals prepared and supplied by the Contractor.

The Contractor shall be responsible for all routine maintenance, cleaning, fault rectification and repair or replacement of all items forming the System, including all spares and test equipment. The Contractor shall provide and maintain from his own resources all necessary labour, transport, warehousing, tools test equipment and a stock of all spare parts required for both routine maintenance and repairs, except for the stock of spare parts specified to be supplied under the Contract and any special tools or test equipment supplied by the Contractor under the terms of his Contract. The Contractor shall supply to the Engineer a complete itemized inventory, including serial numbers where applicable, of all spare parts, tools and test equipment used for this Contract, and shall keep them properly stored and available for inspection by the Engineer at any time.

Consumable items required for routine maintenance shall be at the expense of the Contractor. The cost of components and spare parts used for repair of accidentally damaged equipment, which cannot themselves be repaired and must be replaced, will be reimbursed against invoice by the Employer. The spare parts inventory and any special test equipment purchased by the Employer under the Contract may be used by the Contractor but shall remain the property of the Employer and shall be delivered to the Employer complete and in "as new" condition on termination of the Contract.

The Contractor shall attend all calls for service made by a duly authorized officer of the Employer. Such attendance shall be by suitably qualified and equipped staff. The Employer shall inform the Contractor of the names of such officers and their Contact telephone and facsimile numbers.

On receipt of a call for service, the Contractor's staff shall attend as specified in Schedule 1.

When a fault is rectified, the Contractor shall demonstrate to the Engineer that the equipment is operating correctly. The Contractor shall also present to the Engineer a fault report showing, as a minimum:

- The nature of the fault;
- Rectification action taken;
- Serial Numbers of faulty and replacement sub- assemblies;
- Whether faulty sub-assembly will be repaired or replaced;
- Date and time of notification of fault;
- Date and time of clearance of fault and return to service of faulty equipment.

The fault report shall be signed by the Senior member of the Contractor's staff attending the fault and countersigned by the Engineer. Copies of the report shall be retained by each party.

The Contractor shall also supply to the Employer the contact telephone and facsimile numbers where fault reports are to be directed. The Contractor's staff shall be on call at these numbers during the times specified in Schedule 1. Telephone answering machines shall not be used except outside the service times specified in Schedule 1. A Fault Report faxed to the number provided shall be considered received by the Contractor's staff at the time faxed, regardless of whether the fax machine is manned. Similarly, a telephone call to report a fault to the designated telephone number during the hours of service, when that number may not be manned, shall be deemed to have been reported at the time the call was made. Under these circumstances, the Employer's staff will continue to make reasonable efforts to contact the Contractor's staff.

The Contractor shall give to the Employer at least 14 days notice of any change to the telephone or facsimile numbers supplied.

In the situation where intermittent or repeated faults occur, the Contractor shall, if required to do so by the Engineer, carry out special investigations on the appropriate parts of the System. Where it can be shown that the cause of the fault is outside the reasonable control of the Contractor, the cost of the special investigation will be borne by the Employer.

The Contractor shall not modify any part of the system without the written consent of the Engineer.

5.3 Contractor's Personnel

The Contractor and his subcontractors shall provide and employ for the maintenance services:

- Only such technicians as are skilled and experienced in their respective trades and such foremen or leading hands who are competent to give proper supervision to the work which they are required to supervise;
- Such skilled, semi-skilled and unskilled labour as is necessary for the proper and timely execution of the work in hand.

The Employer reserves the right to refuse to admit to his premises or property any person employed by the Contractor or by a subcontractor, whose admission would be undesirable in the opinion of the Employer.

The Contractor shall provide the Employer with a list of names and addresses of all his personnel who may require admission to any premises of the Employer, specifying the duties on which they are engaged.

5.4 Working Space and Storage

The Contractor shall provide appropriate working accommodation, services, utilities and suitable safe storage for tools, equipment and spares.

5.5 Public bodies

The Contractor shall make all necessary arrangements and negotiations with all public bodies and other companies as required in the execution of his duties. The Employer will use his reasonable endeavors to assist the Contractor in these matters. Any charges, fees, licenses, penalties and the like, incurred by the Contractor or his staff shall be the responsibility of the Contractor.

5.6 Stoppages

The Contractor shall be relieved of any liability to perform any of his obligations under the requirements for provision of maintenance services for any cause, including industrial disputes, which the Contractor was not responsible and could not have prevented. The Contractor shall deliver to the Employer at the start and end of any such stoppage, a notice in writing relieving the Employer of any obligation to pay for maintenance services not carried out during such a period. Such notice shall include the name and means of contacting a subcontractor or other firm or organization with whom the Contractor has made arrangements for maintenance or emergency work during the period of the stoppage. The contractor shall assume responsibility for any such work carried out by his nominated subcontractor, firm or organization.

5.7 Standard of Maintenance

The Contractor shall perform the maintenance and repair services in an efficient and workmanlike manner to the satisfaction of the Engineer. The Contractor shall maintain the equipment, including spares and test equipment, to a level of performance and condition that is, as a minimum, not less than the level of performance and condition of the equipment at the commencement of the maintenance service, having due regard for fair wear and tear.

The Contractor shall use his best endeavors to ensure that a fault is rectified within a maximum of one hour, from the time of arrival of his staff at the site of the faulty equipment. Wherever possible, first line repair shall be achieved by replacement of a complete assembly or sub-assembly in order to minimize equipment down time. Faulty assemblies

or sub-assemblies shall then be repaired in the workshop, where possible, or replaced with new equipment. The Contractor shall inform the Engineer if, following the investigation of a fault, the time required to clear it is estimated to be in excess of the specified times. The Contractor shall continue to keep the Engineer informed of the progress and action being taken to rectify such faults.

In addition to the reports specified above, the Contractor shall keep comprehensive records of all work carried out. For on-site servicing these shall include, but not be limited to:

- Date and time of call out;
- Date and time of arrival on site;
- Details of fault reported;
- Details of fault found;
- Remedial action taken;
- Serial numbers of units involved;
- Date and time of fault clearance and return to service;
- Follow-up actions taken, if any.

The Contractor shall maintain such records for each system and subsystem and for each site. Similar records shall be maintained for units repaired in workshops. The records shall preferably be kept in a computer data base, allowing retrieval of the information and formatting of reports and generation of statistics in a flexible manner, e.g. equipment service history by serial number, installation service history by site, failures by nature of fault, etc. The method of record keeping and format of the records shall be agreed by the Engineer.

The Contractor shall carry out routine maintenance, following schedules to be submitted by the Contractor to the Engineer for his approval. The Contractor shall keep records, similar to those described above, for all routine maintenance activities.

The Contractor shall provide, at three monthly intervals, a written report on the fault performance of the system, which shall include a detailed record of all routine maintenance and faults attended, together with an analysis of faults, equipment and system design problems and, where possible, solutions and suggestions for improvements to the system or the maintenance procedures to improve overall system performance and reduce equipment down time.

The Contractor shall, after carrying out his duties on such occasion, leave the equipment and site in a clean and sound condition and shall clear all rubbish from the site.

The Contractor shall at all times carry out his works on site in such a manner that no interference is caused to traffic flow and no danger is caused to members of the public. If any effect on traffic is anticipated, the Contractor shall liaise with the Engineer and the Traffic Police and present a work plan and traffic diversion plan, if necessary, for approval by the Traffic Police sufficiently prior to the performance of the work to allow a reasonable period for the approval of the plans. The Contractor is advised that some works may only be allowed during the night, between midnight and 5 a.m., and shall make allowance to perform work without additional cost to the Employer. No work affecting traffic flow, other

than in an emergency situation, shall be carried out without the prior approval by the Traffic Police of the work plan and traffic diversion plan.

The Contractor shall supply, install and remove after completion of his works any necessary covers, warning signs, flashing lights and barriers as may be required for the safe conduct of the works. No excavation shall be unfenced and, if not filled or properly covered overnight, shall be surrounded by reflective barriers and flashing warning lights and, if encroaching on traffic lanes, shall have advance warning signs, appropriately positioned so as to be clearly visible to approaching traffic.

5.8 Accident Damage

Where accident damage has occurred to equipment for which he is responsible, the Contractor shall:

- Make the installation and the site safe;
- Collect damaged equipment and retain it whilst a decision is made, in conjunction with the Engineer concerning its disposal or repair;
- Restore the site to full working order within 24 hours of the site being restored and replacement equipment being available.

The Contractor shall maintain in his stock of spares a number of the items most likely to suffer accident damage, such as traffic light poles and signal heads. The level of holding of these stocks shall be by agreement with the Engineer.

The cost of clearance and reinstatement of accident damaged equipment shall be reimbursed by the Employer to the Contractor.

5.9 Care by the Employer

The Employer and his staff or appointed operator shall use the equipment correctly in accordance with the operation manuals, training and advice supplied by the Contractor and such reasonable guidance as the Contractor may issue from time to time.

5.10 Liability for Damage etc.

The Contractor shall be responsible for all damage to buildings and to other properties, including roads, whether belonging to the Employer or not, insofar as such damage arises out of or in the course of or by reason of the services whether or not arising from the negligence of the Contractor or his agents, including subcontractors, or their servants or workmen.

The Contractor shall be responsible for any injury to persons or any accident of any kind whatsoever that may occur in or arise out of the services or in consequence of its obligations, provided that such injury or accident is due to the negligence of the Contractor or his agents (including Subcontractors), their servants or workmen.

The Contractor must provide for the efficient protection of the public in order to prevent mishaps or accidents and all reasonable means are to be used to avoid inconveniences to frontages and motorists.

Notwithstanding any provisions contained herein to the contrary, The Contractor shall not be liable to the Employer under this Clause for:

1. Any claims made against the Employer, except as provided in this Contract.
2. Any damage or injury to the extent that it is caused by or arises from acts or omissions of the Employer or of others not being the Contractor or his agents (including subcontractors), their servants or workmen.
3. Any loss or damage in circumstances over which the Contractor has no Control.

5.11 Civil Works

The cost of any civil works made necessary by anything done or to be done by the Contractor in pursuance of his performance of the maintenance services, or by parts of the equipment which become defective or in order to make replacements or adjustments, other than due to accident damage, or unforeseeable circumstances, shall be borne by the Contractor.

The Contractor shall not be liable for the cost of repair or replacement of any equipment or property which may be damaged by or in consequence of circumstances outside his control or by failure of the equipment which has been properly maintained under the Contract, including but not limited to civil works, imperfect foundations, or subsidence or from any other similar cause of negligence on the part of others.

5.12 Insurance

The Contractor shall effect whatever insurances are necessary, or he may consider necessary, in respect of the provision of maintenance services. No insurance cover will be provided by the Employer in respect of the maintenance services to be carried out by the Contractor under this Contract.

In the event that the Contractor becomes liable for any claim arising out of his maintenance services carried out under this contract, the Contractor is required to ensure timely settlement of the claim, whether or not he has received any compensation under any relevant insurance policy.

5.13 Payment

The Contractor shall be paid the annual maintenance contract price in four quarterly installments, in arrears and upon submission of a detailed invoice. The invoice shall contain :

- a) A list of each faults attended with date and time of fault report, arrival time at site and time of repair of fault;
- b) Details of routine maintenance activities carried out during the previous 3 months;
- c) A list of all callouts for Emergency Services and the charges;

- d) Details and charges for any other work included in the contract, where additional payment is considered justified.

No additional payment will be made for maintenance services performed on items of equipment after take over and before take over of the full system after the Tests on Completion. The cost of such maintenance shall be deemed to be included in the cost of supply and installation.

On receipt of the Invoice, the Employer shall, within 2 weeks give notice to the Contractor of any items that he disputes and the reasons for such dispute. The Employer shall pay the Invoice less any disputed items within a further 2 weeks. Sums due for any disputed items shall be paid within 2 weeks of the settlement of the dispute.

The Employer may also make a deduction from the payment where he considers that the performance of the Contractor has not met the requirements of the contract. Such deduction shall only be made when the Employer has given due notice of non-performance and has given the contractor the opportunity to improve his service.

5.14 Period of Operation of Maintenance Contract

The Maintenance Contract shall commence at the commencement of the Defects Liability Period for the System.

The Maintenance Contract shall operate each day of the year, regardless of public holidays.

The Maintenance Contractor shall be on call for 24 hours a day to provide an Emergency Service and attend on site to 'make safe' equipment and systems subject to accidental damage or otherwise damaged such as to make them unsafe and likely to cause a hazard to the public or staff of the Employer.

The Maintenance Contractor shall be available for the receipt of fault reports for a 12 hour period each day from 7.00 to 19.00. Any fault reported during this period shall be deemed to have been reported at the time when the report was made. Any fault reported outside this period, except under the Emergency Service specified above, shall be deemed to have been reported at 7.00 following the actual time the report was made.

For faults affecting the efficient and safe operation of traffic signals, the contractor shall attend the fault on site within 2 hours of the fault report being made. For other faults, the contractor shall attend on site within 4 hours of the fault report being made, except where the fault report is made between 17.00 and 19.00 when he may attend within 16 hours of the fault report being made.

For faults reported under the Emergency Service, the Maintenance Contractor shall attend on site within 2 hours of the report being made.

5.15 Equipment to be Maintained

The Bidder shall list below all items of equipment and systems to be supplied under the Systems Contract, including optional items. The list will be updated before the Contract is signed and finalized before the Maintenance Contract comes into operation.

CLAUSE SP-11 MAINTENANCE OF WORK ORDER BOOK

A work order book shall be maintained on the site and it shall be the property of Employer and the Contractor or his authorised representative shall promptly sign orders given therein by the Engineer or his authorised representative and comply with them. The compliance shall be reported by Contractor to the Engineer in sufficient time so that it can be checked. The blank work order book with machine numbered pages in triplicate with perforated sheet for two copies to be detached shall be provided by the Engineer for this purposes. The Contractor shall be supplied the first and carbon copy.

The contractor shall depute his representative not below the rank of Project Manager to attend periodic review meetings notified by the Engineer. The Engineer shall record the business of meeting and is to provide copies of his record to those attending meeting and to the Employer.

CLAUSE SP-12 WORKING METHODS AND PROGRESS SCHEDULE

1. A quality assurance procedure covering all aspects of the work shall be adopted for this work to ensure the desired quality. Details of the procedure shall be decided by mutual consultation between the Engineer and the Contractor at the start of the Works.
2. The Contractor shall submit within the time stipulated by the Engineer in writing, the details of actual methods that would be adopted by the Contractor for the execution of any item as required by the Engineer at each of the locations, supported by necessary detailed drawings and sketches including those of the equipment and machinery that would be used, their locations, arrangements for conveying and handling materials etc. and obtain prior approval of Engineer well in advance of starting of such item of work.
3. The Engineer reserves the right to suggest modifications or make complete changes in the methods proposed by the Contractor, whether accepted previously or not, at any stage of work, to obtain the desired accuracy, quality, safety, and progress of work which shall be binding on the Contractor and no claim on account of such change in method of execution will be entertained by the Employer, so long as Specifications of the items remains unaltered.
4. The Contractor shall furnish sufficient plant, equipment and labour as may be necessary to maintain the progress schedule. The working and shift hours for operations to be done under the Employer supervision shall be such as may be approved by the Engineer. They shall not be varied without the prior approval of the Engineer. The Contractor shall provide necessary lighting arrangements etc., for night work, as directed by the Engineer without extra cost.

5. The Contractor shall submit the progress of work in prescribed forms and statements at periodical intervals in the form of progress charts, forms, statements and/or reports as may be approved by the Engineer.
6. The Contractor shall maintain proforma, charts, details regarding machinery, equipment, labour, materials, periodical returns thereof as may be specified by the Engineer.

CLAUSE SP-13 ADDITIONAL SPECIFICATIONS FOR MAINTENANCE OF RIGHT OF WAY

Throughout the period of the Contract the Contractor shall at all times maintain public vehicular access along the right-of-way and from the right-of-way to all public and private access and land, as exists immediately prior to his commencement of the Works.

The Contractor may on written request to the Engineer, (including a drawing, program and specification), be given approval to operate:

- (a) a road diversion suitable for the road traffic and suitable width, or
- (b) traffic on a one way system using manual co-ordinated direction control or automatic traffic lights having a secure source of power.

Applications for approval shall show every detail of the proposals including road construction (cross section including pavement and surfacing, and profile and drainage), road signing, communication between the ends of the controlled section lighting and proposed period of operation.

One way systems shall be provided with adequate sign posting and the Contractor shall limit delays to any traffic to the minimum and with the approval of the Engineer. The travelling public shall be notified by signs, of exceptional delay well in advance of the site of delay, as required by the Engineer.

Payment for temporary diversions, traffic provisions and maintenance of roadways shall be as provided in the Contract and as instructed by the Engineer.

CLAUSE SP-14 ADDITIONAL SPECIFICATIONS FOR USE OF EXPLOSIVES

The Contractor shall not use explosives. Where the use of explosives is so provided or ordered or authorised, the Contractor shall comply with the requirements of the following sub-clauses of this Clause beside the law of the land as applicable:

The Contractor shall at all times make full liaison with and inform well in advance and obtain such permission as is required from all Government Authorities, public bodies and private parties whatsoever concerned or affected or likely to be concerned or affected by blasting operations.

The Contractor shall pay all license fees and charges, which may be, required for storage of explosives or in respect of any other matters whatsoever.

CLAUSE SP-15 ENVIRONMENTAL MANAGEMENT PLAN

The Contractor shall implement the EMP measures, enhancement measures and measures as directed by PIA and PMC. The contractor shall submit a report on compliance with the environmental mitigation measures (Environmental Compliance Reports, ECRs) periodically to the PMC. The PMC will review and approve the ECRs submitted by the Contractor. After approval, the PMC will forward the ECR to PIA. The PIAs will then submit the ECRs to the JPD (Env), which after review and monitoring will be submitted to IMP through the Project Director, MUTP for confirmation of the implementation of the Environmental Mitigation Measures. The Project Director will accordingly submit the report to the World Bank.

Table 1 - Pre-Construction Stage EMP for NCR Project

<i>Environmental Issue</i>	<i>Mitigation Measures</i>	<i>Cross Reference to Documents</i>	<i>Time Frame</i>	<i>Responsibility</i>	
				<i>Implementation</i>	<i>Supervision</i>
Utility relocation	All utilities identified for relocation in the DPR to be shifted after prior approval of agencies. Utility relocation shall be carried out in the shortest possible time to reduce inconvenience to public. Prior approval of the concerned utility agencies to be obtained by Contractor.	M/ORT&H 110	Before start of construction of relevant section	Contractor/PMC	NWCMC
Impact on land use outside ROW	Construction related activities shall be preferably restricted within project road RoW.	M/ORT&H 201.2	During entire site clearance and construction phases	Contractor	NWCMC
Ecological impacts due to tree cutting	Trees falling within the alignment which are to be removed before commencement of construction shall be identified and approved by PIA. Prior permission from NWCMC/Tree authorities shall be obtained by the Contractor.	Preservation of Tree Act of Maharashtra, 1975	Before start of construction of relevant section	Contractor	NWCMC/ITNL
Local Traffic Arrangement	Temporary traffic arrangement during construction within RoW has been planned in the DPR. This plan shall be periodically reviewed with respect to site conditions. During site clearance activity, the demolition debris shall be preferably removed during non-peak hours and with deployment of more vehicles for the purpose.	M/ORT&H: 112	During site clearance and construction	Contractor/PMC	NWCMC/ITNL

Contractor

<i>Environmental Issue</i>	<i>Mitigation Measures</i>	<i>Cross Reference to Documents</i>	<i>Time Frame</i>	<i>Responsibility</i>	
				<i>Implementation</i>	<i>Supervision</i>
Traffic Control and Safety	The Contractor shall take all necessary measures for the safety of traffic during demolition and site clearing activities. He shall provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the PMC for the information and protection of traffic	M/ORT&H: 112.4 M/ORT&H: 112	During pre-construction and construction	Contractor/PMC	NWCMC
Safety of Pedestrians	Special consideration shall be given in the local traffic management to the safety of pedestrians. The temporary traffic arrangement within RoW as recommended in the DPR should be kept free of encroachments / commercial activities	M/ORT&H: 112.2	Before construction and during construction	Contractor/PMC	NWCMC

Note: PIA – Project Implementing Authority; NWCMC – Project Management Consultant; ITNL – Mumbai Metropolitan Region Development Authority, M/ORT&H – Ministry of Road Transportation and Highways (formerly Ministry of Surface Transport, MOST Specifications for Road and Bridge Works, 3rd Revision, 1997); RAP – Rehabilitation Action Plan; RIP – Rehabilitation Implementation Plan; R & R – Resettlement and Rehabilitation; CEMP – Community Environmental Management Plan; CEA – Consolidated Environmental Assessment, MCGM – Municipal Corporation of Greater Mumbai; ROW – Right of Way; ProW – Proposed Right of Way

Table-2 - Construction Stage EMP for NCR Project

<i>Environmental Issue</i>	<i>Mitigation Measures</i>	<i>Cross Reference to Documents</i>	<i>Time Frame</i>	<i>Responsibility</i>	
				<i>Implementation</i>	<i>Supervision</i>
Plying vehicles on unpaved roads	The unpaved roads, if used by the Contractor, shall be sprinkled with water at least once in a day to control the fugitive dust emissions.	M/ORT&H: 111:10	Construction Phase	Contractor	NWCMC
Material Spill	All vehicles delivering material to the site shall be covered to avoid material spillage	M/ORT&H: 111.9 M/ORT&H: 111.11 M/ORT&H: 111.12	Entire Construction Phase	Contractor	NWCMC
Using existing hot mix/Concrete/Asphalt Plants	It is understood from the implementing authorities, that the Contractor will utilize the existing Concrete, Asphalt and Hot Mix Plants. Contractor shall ensure that existing plants, which are sourced, are licensed and authorized for operation by concerned authorities and shall intimate the PMC/PIA prior to procuring materials from them. PMC shall procure relevant documents from the plant owners to ensure that they are adhering to relevant emission norms as laid out by MoEF/CPCB	M/ORT&H: 111.5	During Entire Construction Phase	Contractor/PMC	NWCMC
Watering to control dust at site	Construction site to be watered periodically to minimize fugitive dust generation	M/ORT&H: 111.8	During entire construction Phase	Contractor/PMC	NWCMC
Roads used for transport	Contractor shall ensure that the transport vehicles used to ferry materials and dispose debris does not create hazardous conditions for general traffic using city road.	M/ORT&H: 111.9	During entire construction Phase	Contractor/PMC	NWCMC
Barricading site	The construction site should be barricaded at all time in a day with adequate marking, flags, reflectors etc., for the safety of general traffic movement and pedestrians	M/ORT&H: 112	During Construction Phase	Contractor/PMC	NWCMC
Earthwork	All earthwork and construction material should be stored in such a manner to minimize generation of dust and spillage on roads.	M/ORT&H 201.4	During entire construction phase	Contractor/PMC	NWCMC
Idling of Contractor vehicles	Idling of delivery trucks or other equipment should not be permitted during periods of unloading or when they are not in active use. This practice must be ensured especially near sensitive receptors like places of worship.	M/ORT&H 201.2	During Construction Phase	Contractor	NWCMC

Note: PIA – Project Implementing Authority; PMC – Project Management Consultant; MMRDA – Mumbai Metropolitan Region Development Authority, M/ORT&H – Ministry of Road Transportation and Highways (formerly Ministry of Surface Transport, MOST Specifications for Road and Bridge Works, 3^d Revision, 1997); RAP – Rehabilitation Action Plan; RIP – Rehabilitation Implementation Plan; R & R – Resettlement and Rehabilitation; CEMP – Community Environmental Management Plan; MCGM – Municipal Corporation of Greater Mumbai; D G Sets- Diesel Generator Sets; ROW - Right of Way; ProW – Proposed Right of Way, O & M – Operation & Maintenance

Table - 3 - Environmental Monitoring Plan

Environmental Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Air Quality	Construction	SPM, PM ₁₀ , SO ₂ , NO _x	NAAQS of CPCB	-LBS Marg junction -Amar Mahal junction	Once every season – Summer, Winter, post-monsoon	24 hr/day for 2 consecutive working days per week for 2 weeks.	Contractor through pre-approved monitoring agency	PMC/PIA
		CO, HC	NAAQS of CPCB	-LBS Marg junction -Amar Mahal junction	Once every season – Summer, Winter, post-monsoon	8 hr/day for 2 consecutive working days per week for 2 weeks.	Contractor through pre-approved monitoring agency	PMC/PIA
Noise level	Construction	Leq, L10, L50, L90 dB(A)	CPCB noise standards	-LBS Marg junction -Amar Mahal junction And at sensitive and residential locations located near construction equipment.	At start of construction activity, followed by every season (Summer, winter and post monsoon) during construction period	Continuous 24 hour reading with a frequency of 10 minutes for 2 non-consecutive days per week for 2 weeks	Contractor through pre-approved monitoring agency	PMC/PIA

Contractor

Environmental Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Water Quality	Construction	pH, BOD, TSS, TDS, DO, Turbidity and O&G	Coastal water Quality-SWIII & relevant stds for Heavy Metals in ground water	-Mithi River -Ground Water Sample near Disposal site	Once every following season-Summer, Winter and post -Monsoon.	2 grab sample for Mithi River and one sample near disposal site	Contractor through pre-approved monitoring agency	PIA/PMC
Traffic Volume	Operation	Traffic volume, characteristic and speed.	As per relevant IRC specifications	-LBS Marg junction -Amar Mahal junction	3 day hourly counts	Annually for three years	MCGM	MCGM/MMRD A
Soil Quality	Construction	Heavy metals and Oil and grease	Contaminant threshold level given by USEPA	-At all stockyard locations set-up by contractor. Exact sampling spot at the yard as directed by PIA/PMC -Debris disposal site	At start and end of construction activity.	One time sample	Contractor through pre-approved monitoring agency	PIA/PMC

Contractor

Environmental Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Ecology	Pre-Construction	Monitoring of tree felling.	As laid out in project detail design. Trees to be adequately marked for felling.	At locations of Tree felling	During tree felling	--	Contractor through pre-approved monitoring agency	NWCMC/ITNL
	Operation	Survival rate of road side plantation and other compensatory plantation.	Survival rate to be at-least 70%. Below which re-plantation should be done.	At locations of compensatory plantation	Annual	For 3 years after operation starts	PIA / Contractor	ITNL

**CLAUSE SP-16 SPECIFICATION FOR PROVIDING ANTI CORROSIVE TREATMENT
TO M.S. OR HYSD REINFORCEMENT BARS WITH CEMENT
POLYMER COMPOSITE COATING**

Anticorrosive treatment to H.Y.S.D./M.S. Reinforcing bars by “Cement Polymer Composite Coating” (CPCC) Treatment – (Method developed by CECRI, Karaikudi, Tamilnadu).

Material - The material required for C.P.C.C. treatment shall be procured from the approved Licensee of CECRI and also got approved from Engineer-in-charge.

Material shall be tested for following test prior to use –

- (i) Density
- (ii) PH value
- (iii) Specific gravity
- (iv) Chloride content

I. METHOD OF APPLICATION OF COATING SYSTEM

The application of the cement polymer composite coating system comprises the following sequence.

1. Surface preparation :

The surface of the steel reinforcing bars to be coated shall be cleaned by abrasive (dry sand) blast cleaning to the near-white metal in accordance with SSPC-SP10/NACE No.2 - 1994. It includes the following procedures.

- (i) Prior to blast cleaning visible deposits of oil or grease shall be removed by suitable cleaning method.
- (ii) Clean dry compressed air shall be used for nozzle blasting.
- (iii) Dry uniformly graded silica sand shall be used for blast cleaning which should be free from contaminants.
- (iv) Suitable arrangement shall be made in the sane blasting unit to suit automation.
- (v) During the operation, the pressure at the nozzle shall be regulated as per the supplier's specification.
- (vi) Dust and residues shall be removed from prepared surface by brushing, blowing off with clean, dry air, vacuum cleaning or other methods.

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- (vii) Any visible rust that forms on the surface of the steel after blast cleaning shall be removed by reblasting the rusted areas before coating.
- (viii) The prepared surface shall meet the visual standards of comparisons as in SSPC-VIS 1 or SSPC-VIS 2.

2. Application of the coating :

- (i) The coating shall be applied to the cleaned surface as soon as after cleaning, and before oxidation of the surface discernible to the unaided eye occurs. However, the application of the coating shall not be delayed more than 4 hrs. after cleaning.
- (ii) A rapid setting primer shall be applied over the prepared surface of the reinforcing steel by dipping.
- (iii) After 30 minutes of application of the primer a cement polymer sealing coat shall be applied by dipping.
- (iv) The coated rods shall be handled after 6 hours.

3. The above process of surface preparation and coating shall be mechanised / automatic.

II. REQUIREMENTS OF THE COATED BARS

The coated reinforcement rods of cement polymer composite coating system shall meet the following requirements.

(i) **Thickness of the coating :**

After curing, the minimum average dry film thickness of the coated rods shall not be less than 150 + 25 microns. Measurement shall be made using commercially available coating thickness meter which should be specially suitable for curved surface.

(ii) **Continuities of the coating :**

The coated rod when visually examined should be fairly uniform in thickness and should be devoid of any defects such as cracks, peeling, bulging etc. No surface area should be left uncoated. No rust spot should be visible with the unaided eye.

(iii) **Adhesion of coating :**

The coating should not peel off or cracked or disbanded on the outside radius when the coated bars are bent to 180^o around a mandrel (as per test procedure A).

(iv) **Relative bond strength :**

The bond strength of the coated rebar and concrete should not be less than that specified in IS 456 - 1978 clause 44.1.2 (bond stress for deformed bars in tension). The test procedure is to be followed as per BIS 2770 - part I 1967.

(v) **Resistance to applied Voltage test :**

No film failure as evidenced by evolution of hydrogen gas at the cathode or appearance of corrosion product at the anode shall take place during 1hr. of testing. (As per test procedure B).

(vi) **Abrasion Resistance :**

The abrasion resistance of the coating by a Taber abrasor should not be more than 100 mgm / 1000 cycles using CS 10 wheel under 1 Kg load per wheel. (As per test procedure C).

(vii) **Tolerable limit for chloride :**

Tolerable limit for chloride in 0.04 N NaOH medium using anodic polarisation technique shall be 10,000 ppm. (As per test procedure D).

(viii) **Chemical resistance of coating :**

The coated rods are kept partially immersed in the following four individual environments for 45 days. Distilled water, 3M CaCl₂, 3M NaOH and saturated Ca (OH)₂ for 45 days, the coating should not blister, soften, or loose bond when visually examined at the end of the test period (As per test procedure E).

QUALITY CONTROL MEASURES TO BE TAKEN AT SITE

- 1) The application steps are to be supervised strictly as per the specifications.
- 2) Sand-blasting of the surface of reinforcement steel is to be done as per the surface preparation mentioned in application system.
- 3) Primer coat and Sealing coat are to be applied by brush, or by spraying or by dipping under supervision.
- 4) Coating thickness of the finished bar can be checked frequently by pen type alcometer.
- 5) The 2 V Impressed Current Test (ASTM A-775/775/5M-90) is to be taken randomly at site laboratory (every 15 days). It is the most critical test for finished product.
- 6) The coated bars bending test can be observed frequently at site.

**GUIDELINES FOR HANDLING, STACKING AND TRANSPORTING
OF COATED REINFORCING BARS**

The durability of the coated rebars is related to the coating quality. The more damage to the coating is more prone to corrosion. Good job site practices can minimise the coating damage. For this reason, standards from ASTM, JSCE, NACE (USA) have laid down specific procedures for stacking and transporting coated bars. Some important guide lines are referred here.

Stacking

- (i) It is preferable to store the coated bars on buffer material placed at suitable intervals instead of placing them directly on the ground.
- (ii) It is not desirable to store coated bars by piling them on top of one another. If they are to be stored by piling, buffer materials such as wood, rubber, jute sack etc., should be used to separate the layers. However, the number of layers allowed shall be limited to a maximum of five.
- (iii) The coated rods shall be stored in yard.
- (iv) If any damage had occurred during stacking it should be repaired immediately by the same coating formulation before any rusting occur.

Handling and Transportation :

- (i) The coated bars shall be securely bound together using a buffer material (padding) and it is desirable that the bent bars shall be supplied with some canvas cover.
- (ii) When loading and unloading of bundles of coated bars, it shall be preferable to lift them with a strong back, spreader bar multiple supports etc. To avoid extreme bending, nylon slings at 2 or 3 points shall be used.
- (iii) The bundles of bars shall not be dropped.
- (iv) If damage had occurred to the coating during transportation, it must be repaired before rusting occurs.

SPECIFICATIONS FOR PATCH REPAIRING OF COATING DAMAGES

- (a) Coating repair is required when peeling off and other damages exist. Prior to repairs, the damaged area shall be cleaned by removing loose or deleterious material. In case where rust is present it shall also be mechanically removed to repair.
- (b) After this primer coat shall be brush applied. After curing (16-30 minutes) sealing coat shall be applied and it is desirable to ensure a thickness of 150 microns.

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SPECIFICATION FOR CUTTING, BENDING AND WELDING OF COATED REBARS AT FIELD.

- (i) It is desirable that the coated rods shall be bent gradually.
- (ii) In the field, the cut and welded portions of the coated rebars shall be repaired by the same formulations
- (iii) The cut ends of the coated rebars shall be repaired by the same formulation.
- (iv) It is advisable that the binding wires shall also be coated by the same formulation.

SAFETY PRECAUTIONS AND GUIDELINES

(To be followed during the preparation and application of the cement polymer composite coating (A know how released by CECRI).

- (i) A solvent resistant hand gloves must be used during the handling of chemicals.
- (ii) Gum-shoes must be used during the preparation and application.
- (iii) Face masks should be worn during the preparation and application.
- (iv) Other safety measures should be adopted for the persons handling solvents, chemicals, finished products and during application.
- (v) Closed sand blasting unit shall be used to avoid dust spreading.
- (vi) Aprons should be made preferably from plastics and rubber must be used.
- (vii) The containers containing chemicals and finished products shall be properly sealed.
- (viii) Adequate safety measures should be adopted for field operations.
- (ix) In general, all the safety measures should be followed as per Industrial safety regulations.

CLAUSE SP – 17 SPECIFICATION FOR PQ CONCRETE FOR ROAD WORK

1. NWCMC will not supply cement to the Contractors. They shall have to purchase cement from open market manufactured by reputed cement companies (except companies having mini plant). The cement shall be 43 grade OPC conforming to IS 8112, Portland slag cement or mixture of 43 grade cement blended with GGBS, both conforming to IS: 8112 for physical parameters and IS: 455 for chemical parameters shall be tested at Approved Laboratory at Contractor's cost as mentioned in Table-1 from special conditions for the Ready Mix Plant Owners, preferably before its use. In case, the cement test results are not available before its use, the concreting work shall be permitted on the explicit understanding that they will remove and redo the work at their own cost in case the cement specimen fails to attain the specified compressive strength.
2. Only 43 grade OPC conforming to IS 8112, Portland slag cement or mixture of 43 grade cement blended with GGBS, both conforming to IS: 8112 for physical parameters and IS:455 for chemical parameters will be allowed to be used. Contractor shall provide one independent cement godown with capacity of minimum 100 cement bags. Cement from locked godown will be released only after compliance of clause 1 above.
- 3. Water:**
 - 3.1 The rates proposed in this tender for all concrete and allied works are inclusive of water cost. The Contractors shall have to make their own arrangements at their cost for bringing adequate water of potable quality for mixing concrete, curing purposes, etc., and for this no extra payment will be made.
 - 3.2 Water used for mixing and curing of concrete shall be clean and free from injurious substance like oil, salt acid, vegetable matter and other substances harmful to the concrete. It shall meet the requirement stipulated in I.S. 456. The water brought for concreting and curing etc. shall be got tested from Approved Laboratory to verify whether it is suitable for above purposes, whenever directed. This testing will be done at Contractor's cost.
 - 3.3 Contractors will have to apply for water connection and avail one metered water connection of suitable size at their cost from nearby Municipal Water main for drinking purposes. The Contractor has to pay the water bill directly to the H.E.'s Department, as per the bill raised by the H.E.'s Department.
4. Sand shall be of approved quality with fineness modulus between 2.4 to 3.5 as per approved mix design. The sand will have to be screened to remove the oversized particles and washed to reduce the silt contents below 8% by volume after one hour. The fine aggregates will be tested as directed by the Engineer.

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5. If coarse aggregates are found having white spots, the same shall be got tested from approved testing laboratory to eliminate possibility of potential aggregate alkali reactivity before accepting or using spotted aggregates.
6. The Contractor should make the necessary arrangement to stock the aggregates separately so that they do not get mixed up with each other and/or with the foreign materials and do not get segregated. The screening of the aggregates shall be done if found necessary as directed by the Engineer.
7. The Contractors shall have to bring M.S./Tor steel and structural steel required for this work. M.S./Tor Steel and structural steel shall conform to the relevant latest Indian Standard code of practice. The steel brought on site shall be got tested at approved laboratory at the Contractors cost before using on site.

TESTING

8. To determine the 'K' value, it is necessary to take a plate load test/CBR test within the scope of the work wherever necessary. The test will be taken by Engineer. However, Contractor shall arrange at his cost for excavation, loading and refilling. No payment will be made for this work. For conversion of K-Value to CBR value, the value of CBR/K value shall be adopted from IRC/58 of 1988, as detailed below:-

APPROXIMATE 'K' VALUE CORRESPONDING TO CBR VALUE FOR HOMOGENOUS SOIL SUBGRADES									
CBR Value (%)	2	3	4	5	7	10	20	50	100
K-Value (kg/Cm ³)	2.08	2.77	3.46	4.16	4.84	5.54	6.92	13.85	22

The recommendations of IRC:15-1981 shall be followed and K-Value of less than 5.5 kg/cm³ tested on the subgrade shall not be permitted. In case, a large number of tests are required either in view of low K-value obtained, or in view of heterogeneity/variability of sub grade, additional field soaked CBR test may be conducted using the above table for assessing the K-value. The final checking will, however, be based on plate bearing test. In case the 'K' value is less than 5.5 kg/cm³ (C.B.R. less than 10.0) then the C.B.R shall be improved with intermediate W.B.M. sub base as decided by the Engineer.

10. Contractors shall set up a laboratory at site before commencement of work at their cost for performing various tests and at least the following machines and equipment shall be provided therein.
 - (a) Compressive strength testing machine (for cube tests) of minimum 130 tonne capacity, Calibration Certificate of recent calibration made shall be produced before commencement of work. Calibration shall be done every 3 months. Testing

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machine should be maintained properly. In case of failure, the same shall be repaired or replaced within 2 days.

OR

Compressive strength testing machine (for cube tests) of minimum 130 tonne capacity, electrically operated conforming to IS-516 and duly calibrated every 3 months. Testing machine should be maintained properly. In case of failure, the same shall be repaired or replaced within 2 days.

- (b) Set of Sieves
- (c) Laboratory weighing balance of minimum 10 kg. Capacity, with set of standard weights from 1 gm to 5 kg.
- (d) Aggregate drying equipments M.S. Tray of 0.6 m x 0.45 m and Kerosene stove or electric hot plate.
- (e) Equipment for testing of silt content in sand.
- (f) Dial thermometer calibrated upto 200 degree Celsius (for checking asphalt/bitumen temperature).
- (g) Sieve shaker
- (h) Kadappa stone platform of size 2.5 m x 0.90 m approx.
- (i) Other machines as may be directed by Engineer

All the test records shall be meticulously maintained in the site office and made available as and when required.

Contractor must establish this laboratory within 15 days from the date of letter of acceptance of Contract. On failure to establish the laboratory in full a penalty of Rs.300/- per week of part hereof per equipment will be imposed till the Contractor procures the necessary equipment in good working condition.

- 10.1 Testing for the compressive strength shall be carried out for cement concrete works of M 40 and above for each day's work when laying carried out manually otherwise 3 sets per week when machinery is used. At least three sets consisting of 3 nos. of cubes per set samples collected at random (at regular interval) along with 3 flexural beams shall be cast every day. In case of Contractors installing electrically operated compressive testing machine, cubes from each set shall be tested for 7 days & 14 days at the site laboratory in presence of Engineer's Representative of the work and the Contractor shall submit remaining 3 CC cubes for testing compressive strength for 28 days. Also, the Contractor shall cast & submit for each day's work. 3 flexural beams for testing flexural strength at the approved Laboratory. In case the Contractors cannot install electrically operated compressive testing machine, then all the 9 cubes shall be submitted and tested at approved Testing Laboratory for 7,14 and 28 days compressive strength along with 3 flexural beams for flexural strength for each day's work.
- 10.2 Whenever the cubes and beams are required to be sent to the approved Laboratory, the same shall be transported to the approved Laboratory by the Contractors at their cost. The acceptance criteria for the test shall be as per I.S. 456. No payment for this will be made to Contractors.

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The Contractors shall arrange to send the cubes and flexural beams to municipal material testing laboratory at least two days before the date of testing of the cubes as well as beams failing which penalty of Rupees 500/- per day will be imposed and recovered from the Contractors bill. The charges for testing of cubes and beams shall be borne by the Contractors.

Quality Control in the field shall be exercised on the basis of compressive strength and workability. The maximum water cement ratio shall be 0.40.

- 10.3 In case of concrete of less than M 40, at least two sets of cubes shall be cast and testing for 7 days and 28 days strength in site lab on the compressive testing machine for day's work.
- 10.4 At each work, minimum 3 cores per week for 1000 cum of concrete laid with paver or 3 cores per day for any four days work for manually laid concrete at the locations selected randomly (at regular interval) out of total M 40 and above grade concrete working days, aggregating to the total of 12 cores shall be extracted for testing. The average value of test results of 3 cores shall be considered for deciding the concrete strength for the day's work from which the cores are extracted. The cores shall be extracted preferably from the slabs of the standard size, i.e. 45 m x 3.25 M (2 on either longitudinal side of the work).

The extraction of core shall be arranged in such a way that three cores are extracted in a day's work on M 35 and above C.C. at regular interval. The average test result of three cores shall decide the core strength of the day's work. If average strength fails, the entire quantity of M 35 and above concrete poured on that day will not be paid.

- 10.5 In case the cube test for 28 days period fails, for any particular day's work, additional 3 cores shall be taken from that day's work and will be tested at Contractor's cost. The core will be 100 mm. Dia. If it fails, no payment will be made.
- 11.1 The density of the compacted concrete shall be such that the total air voids are not more than 3%. The air voids shall be derived from the difference between the density of core and that of concrete cubes taken for the said day's work.. The average value of three cores of at least 100 mm diameter shall be considered.
- 11.2 All cores taken for density measurements shall also be checked for thickness. In case of doubt, additional cores may be ordered by the Engineer and taken at locations decided by him to check the depth or density of concrete slab without any compensation being paid for the same. Thickness of the slab at any point checked as mentioned above shall have minimum specified thickness as per drawing.

The cost of the cores and samples to be taken and their testing shall be borne by the Contractors. Cores of slab of M-35 and above C.C. shall be extracted and submitted within a week's period after completion of 28 days in the laboratory approved by the Chief Engineer (NWCMC). On the failure of compliance of this condition a penalty of Rs.500/- per day shall

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be imposed. However, in circumstances beyond Contractor's control, the matter of waiving penalty will be reviewed by the Chief Engineer (NWCMC).

- 11.3 In calculation of the density, allowance shall be made for any steel in cores. Cores shall be reinstated with epoxy mortar or as directed by the Engineer at the Contractor's costs. In case the cores are taken from the road already opened to traffic, the mix/material adopted for filling shall be such that it will develop the requisite strength in a minimum period. The holes created by cores shall be so filled that these do not shrink. The core holes shall be reinstated within 24 hours of taking cores, failing which a penalty of Rs.1000/- per day shall be charged.
- 11.4 Core density test shall be carried out in accordance with relevant I.S. Codes. For testing of cores for strength, refer para 11.5.
- 11.5 The results of crushing strength tests on these cores shall not be less than 0.8 times the characteristic cube crushing strength (i.e.400 kg/sq cm) where the height to diameter ratio of the core is two. Where height to diameter ratio is varying then the necessary corrections would be made in calculating the crushing strength of cores in the following manner.

The crushing strengths of cylinders with height to diameter ratio between 1 and 2 may be corrected to correspond to the standard cylinder of height to diameter ratio of 2 by multiplying with the correction factor obtained from the following equation:

$$f = 0.11 n + 0.78$$

where f = correction factor and

n = height to diameter ratio

The corrected test results shall be analyzed for conformity with the specification requirements for cube samples. Where the core tests are satisfactory they shall have precedence for assessing concrete quality over the results of moulded specimens. The diameter of cores shall not be less than 100 mm.

- 11.6 If the test results of cores of the concrete are not satisfying the strength requirements, then the payment for the slab/day's work shall not be made.

PRE-CONCRETE CONSTRUCTION PHASE:

- 12 If the contractors excavate certain portion of the road and fails to concrete the same within the stipulated time limit as per the programme they will be required to reinstate this excavated road portion with bituminous layers as specified and directed by the Engineer. No payment will be made for such restoration.
- 13 The Contractors will have to obtain NOC from the Traffic Police Department well in advance for closing down the road or part thereof for the execution of the work. The work will have to be carried out in stages depending upon the permission granted by the Traffic Police Department for closure of the road or part thereof. The Contractors should therefore take this into account while quoting.

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- 14 The Contractors should also note that they will have to modify, if required, the detailed programme submitted in the form of BAR Chart or PERT/CPM, considering the permission obtained from Traffic Police before actual starting of the work at site so as to complete the same in the stipulated Contract period.
- 15 Mix – design to give the target strength as required shall be prepared preferably in accordance with the relevant IRC/IS Specifications. The same shall be done by the contractors and checked by the Engineer. Whenever fresh lot of aggregate is used by the Contractor, the same shall be got checked. For this purpose, gradation analysis of coarse and fine aggregate shall be performed. The necessary correction shall be made in the mix design accordingly.
- 16 The mix – design shall preferably conform one of the method specified in I.S. 10262 or IRC 44. However, preferably the mix design should be done as per details given in IRC-44 of 1976. “Tentative guidelines for cement concrete mix design”.
- 17 The minimum 43 grade O.P.C. consumption for various concrete mix grades shall be as follows:-
- M10 - 160 kg/cu. m.
M15 – 240 kg/cu. m.
M35 – 350 kg/cu. m.
- Maximum O.P. cement concrete shall be 550 kg/cu. m. The cement to be used, shall be weighed (not on the standard bag basis) while mixing. No claim for excess cement used shall be entertained. If this minimum cement content is not sufficient to produce the strength of concrete specified in the drawing/design, it shall be increased as necessary without additional compensation under the contract, or else the fresh mix design shall be carried out till desired results are achieved.
18. The water bound macadam base should be adequately watered on the previous day and also two hours before starting lean concreting work so as to keep it in moist condition.
19. Double bulkheads for keeping the dowel bars in the proper alignment shall be provided as per drawing, and as directed by the Engineer. Tie bars should be aligned exactly perpendicular to finished concrete surface of the slab by means of suitable device to be approved by the Engineer.
20. Dowel bars shall be Mild Steel rounds in accordance with details/dimensions as indicated in the drawings and free from oil, dirt, loose rust or scale. They shall be straight, free from irregularities and the sliding ends sawn or cropped cleanly with no protrusions outside the normal diameters of the bar. The dowel bars shall be supported on double bulk- head or chairs in prefabricated joint assembly position as approved by the Engineer prior to the construction of the slabs.

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Unless shown otherwise on the drawing, dowel bars shall be positioned at the mid depth of the slab within the tolerance of +/-20 mm spaced equally along intended lines of the joints within tolerance of +/-25 mm. They shall be aligned parallel to the finished surface of the slab, to the centerline of the carriageway and to each other within the following tolerance.

For the bars supported on bulk – head prior to the laying of the slab.

- a. All the bars in a joint shall be within +/-4.5 mm per 300 mm length of the bar
 - b. 2/3rd of the bars shall be within +/-3 mm per 300 mm length of the bar.
 - c. No bar shall differ in alignment from adjoining bar by more than 3 mm per 300 mm length of the bar in either horizontal or vertical plane.
 - d. The Dowel bars shall be covered by a sheath of High Density Polythene pipes of approved quality for half the length plus 25 mm for expansion joints. The sheath shall be tough, durable and of an average thickness, not less than 1.25 mm. The end portion of the sheath shall be plugged with suitable properly tight cap fitting.
21. All excavations, trenches, obstructions, materials, etc., taken, kept or stacked on site in connection with the work should be sufficiently barricaded, as per the specifications mentioned in the item included for providing barricade, transverse and longitudinally and blinking lights should be provided at night as directed by the Engineer to prevent against any damage or danger to the traffic. The Contractors shall take all precautions to keep all the blinkers working throughout the night for the guidance of the traffic in the following manner. No extra payment will be made for blinkers. The Contractors should take this in account while quoting for the tender.
- i) All blinkers shall be red in colour
 - ii) At least two blinkers shall be provided across the direction of the traffic
 - iii) The Contractors will take any other measures as may be directed by the Engineer from time to time for the safety of the traffic as well as concreted slab etc. The drawing showing full details of the barricade will be available from the Department of the Engineer.

In the event of contractors not complying with the provisions of this clause, the Engineer may without notice to the Contractors put up the barricade as per the specifications or improve upon the same or improve the lighting or adopt such other measure as he may feel deem necessary and all the cost of such procedures as may be adopted by the Engineer shall be charged to the Contractors in addition to a penalty of Rs.10/- R.M. per day till compliance of these requirements. Barricading will be paid separately.

22. All the trenches will be refilled by metal sand filling as specified and directed by the Engineer.

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CONCRETE BATCHING, MIXING, LAYING & COMPACTION

23. The laying of M-15 concrete in pavement, will have to be carried out with proper form work only. It shall be ready mix concrete compacted with vibrators and shall have smooth surface. It should have proper cross profile as directed by the Engineer. The surface of M-15 CC shall be maintained smooth till overlaid by slab of M 40 and above C.C. The work will have to be carried out as directed by the Engineer.

Curing shall be done by covering with hessian cloth and sprinkling with water for 7 days or till the lean concrete is overlaid by M35 and above C.C. slab, whichever is earlier, but for a minimum period of 48 hours.

24. M-10, M-15, M-35 & above concrete shall be carried out with ready mix concrete only.
25. For the desired workability, the ready mix concrete of M 40 & above will have a slump not more than 50 +/- 10 mm.
- 26.1 M –40 and above concrete slab shall be laid in two layers and each layer shall be compacted by the needle vibrator, plate vibrator. Double beam surface vibrator (S M Type) 40 shall be used for compaction of 2nd layer in addition with needle and plate vibrator.
- 26.2 To achieve the proper consolidation of the concrete slab, the top layer of the concrete shall be compacted by needle vibrator, plate vibrator and double beam surface of the concrete, fresh concrete shall be compacted by needle vibrator, plate vibrator & double beam surface vibrator (S M type) 40. If any depressions are observed on the surface of the concrete, fresh concrete shall be spread on the top, surcharged and got compacted with batten. Double beam surface vibrator (S M type) 40 is again to be used for compaction as well as levelling. Minimum 3 skilled masons shall be deployed during M35 & above concreting work.
27. The water cement ratio shall be strictly adhered to, as per the approved mix design and should be adjusted according to temperature variation during the day of casting of the slab, if found necessary. Care shall be taken to prevent the over vibration and appearance of water / laitance on top surface of the slab. If any excess water is noticed on the surface of the slab, the same shall be removed by moving Hessian cloth on top surface and the concrete mix shall be immediately rectified as directed.
28. Plate vibrators shall be used for compaction of concrete mix in addition to needle and screed vibrator and as such contractors must have at least two numbers of each machine such as plate vibrator, double beam surface vibrator (S M type)40 and at least three needle vibrators in working condition and an extra one of each as stand by for each work, in working condition.
29. The distance as well as time lag between bottom concrete layers and top layers during concreting operation shall not exceed 2.5 meters, or 20 minutes whichever is less.
30. Whenever the needle vibrator is used, the mason must follow with a trowel and punch to the portions of concrete from where the needle vibrator is withdrawn to ensure that no hollow

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portion remains in the stiff mass of concrete. Plate vibrating shall also follow thereafter immediately.

31. Concrete pavement must be in proper cross profile as per camber prescribed by the Engineer.
- 32.1 After the final regulation of the surface of the slab, surface of concrete slab shall be brush – textured in a direction at right angles to the longitudinal axis of the carriageway.
- 32.2 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. The brush shall be made of 32 gauge tape wires grouped together in tufts spaced at 10 mm centres. The tufts shall contain an average of 14 wires and initially be 75 mm long. The brush shall have three rows of 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 to 60 mm. long.
- 32.3 The texture depth shall be determined by the sand patch test as described in clause 32.6.2. The test shall be taken at least once in a week or whenever the Engineer considers it necessary, at times after constructions. 10 individual measurements of the texture depth shall be taken at least 2 Mtr. apart anywhere along the diagonal line across a lane width between points 50 M apart. No measurements shall be taken within 30 mm of the longitudinal edges of the concrete slabs. The texture depth shall not be less than minimum required as per the table below, nor greater than a maximum average of 1.5 mm.

Time of Test	Minimum Texture Depth required
i) Not later than 6 weeks or before the road is opened to public traffic.	0.65 mm for an average of 10 measurements with no single measurements less than 0.60 mm.

- 32.4 After the application of the brushed texture, the surface of the slab shall have a uniform appearance.
- 32.5 Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over length as directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.
- 32.6.1 The following apparatus shall be used for testing the texture depth.
- 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, struck 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.

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- 32.6.2 Method – The surface to be measured, shall be dried, any extraneous mortar and loose material removed and the surface swept clear 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 sand is spread into a circular patch with the surface depressions filled with sand to the level of the peaks.
- 32.6.3 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.
33. It will be the responsibility of the contractor to give the required finish of riding surface by checking with the straight edge and wedge gauge and any deficiency observed shall be rectified as specified in the general specifications for Road Works.
34. Initial curing shall strictly be done by covering with Hessian cloth and sprinkling with water over the concerted portion as soon as the concrete starts setting. Sprinkling of water be started just after brooming the concrete surface to avoid evaporation of water from the mix. Care should be taken not to disturb, the brushed surface texture.
- Further curing of concrete shall be done as directed, for a minimum period or 14 days from the date of casting of c.c. slab.
- A penalty of Rs. 200/- per sq.m. per day will be levied for broken vatas. A penalty of Rs. 2500/- per day will be levied for improper curing.
35. Impermeable plastic sheet membrane shall properly cover the gaps between two channels and the gaps at the bottom shall be properly sealed in C.M. for which no extra payment will be made.
36. The contractors shall have to cast runner beams, man hole bay, water tables, water entrance bays etc. within 5 days from the date of casting slab, failing which a penalty of Rs. 500/- per day shall be levied on contractors.
37. The cement concrete slab pavement in m 35 and above is required to be carried out strictly as per the drawing. As regards thickness no claims on account of additional thickness other than the specified, if provided, will be entertained.
38. Casting of slab shall be closed at 7.30 p.m on sunset whichever is earlier every day unless it is allowed by Engineer with proper adequate lighting arrangements.
39. The flexible pavement shall be improved in asphalt mix or by other methods as directed by the Engineer, before allowing the traffic on adjoining completed c.c. slabs. In case it is not possible, a specific sanction of Chief Engineer, NWCMC should be obtained before allowing traffic on c.c. slabs.

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40. The joints shall be cut within 48 hours to a minimum depth of 90 mm or minimum 1/4th depth of c.c. bay slab, as directed, failing which these will be got done at contractor's cost and penalty will be levied as directed by Engineer including withholding the payment of adjoining panels of the uncut joints for 5 years. A suitable rebate for less depth i.e. in between 75 mm to 100 mm will be taken on prorata basis.
41. The machine cut joints should be filled in immediately with thermocole as directed by the Engineer till regular dressing of joints is done. Separate payment will be made for this work.
42. The machine cut joints and expansion joints must be cleaned first by using Raking tool and then air blown with compressor, so as to remove dust, sand particles and foreign matter from the joints before filling them with hot sealing compound as specified in IS 1834-1984, after applying primer conforming to IS 3384-1986.
The details of sealing compound and bituminous primer to be followed as per Annexure I.
43. No separate payment for restoring vattas before and after cutting of joints or damaged on any account shall be made. Such vattas shall be restored immediately by the contractors. After curing period is over, the vattas shall be removed thoroughly, without keeping behind any vatta impression and without damaging the surface texture of the slab.
44. The contractors shall observe compliance of following requirement in respect of works of sealing of joint.
- 45.1 The Contractors shall have to purchase the joint sealing compound from open market and from reputed manufacturers, a list of which is available in the office of respective Engineer. The sealing compound Polysulphide/Polyurethane shall conform to Grade 'A' of IS 1834-1984, i.e. Specifications for hot applied sealing compounds in Concrete'. The Sealing compound shall have to be got tested at the V J T I, I I T or S P College Laboratory or at the laboratories approved by the Engineer at contractor's cost before its use for every batch in addition to manufacturers' test results of sample.
- 45.2 The Delivery challans for joint sealing compound shall bear requisite details, such as Sr No., Batch No., Date, Weight and name of the Contractor to whom the sealing compound is being supplied etc. The manufacturer's Test Certificate to the effect that sealing compound conforms to relevant I.S. specifications shall invariably accompany every consignment of sealing compound, brought on the site.
- 45.3 Due care shall be taken to see that temperature is carefully controlled while heating the joint sealing compound. Due precautions shall be taken to avoid over-heating of joint sealing compound above 180°C as well as heating for long periods since sealing compound will lose its properties due to overheating. In case of default on this account, entire overheated material will be rejected. Therefore, quantity or sealing compound required for one operation of joint sealing work, shall be heated.
- 45.4 Joint sealing compound once heated but not utilized will not be permitted for use after reheating the same and such material will be discarded and will have to be removed from site.

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Indian Standards (IS & IRC) for work of sealing of joints and quality control:

IRC-15-1981	Standard Specifications & Code of Practice for Construction of Concrete Roads
IRC-57-1974	Recommended Practice for sealing of joints in Concrete pavements
IS-1834-1984	Specifications for hot applied Sealing Compounds in Concrete
IS-3384-1986	Specifications of Primer

- 45.5 The joints cut and cleaned shall be got certified from the Engineer before filling with sealing compound as per the specification for sealing of joints in rigid pavements. The spilled over sealing compound if any shall be removed immediately.
46. The regularity of the surface of the slab shall comply with the requirement of following clause.
- 46.1 Compliance with the requirements of this clause for surface regularity shall be measured using an approved 3 m long straight edge and wedge in such a way as to reveal any and all irregularities. The maximum permitted number of surface irregularity of 5 mm and 7 mm in a length of 300 m shall be 20 numbers and such irregularities shall be properly recorded in the register.
- 46.2 Longitudinal irregularity shall normally be measured along any line or lines parallel to the edge of the slab.
- 46.3 Transverse irregularity shall normally be measured along any line with the straight edge placed at right angles to the center line of the road.
47. If deemed necessary by the Engineer, any section of the slab which deviates from the specified levels and tolerance shall be demolished and reconstructed at the Contractor's expense.
48. There shall be a defect liability for 5 years period (60 months) for c.c. pavement. If during this period, concrete road fails due to (1) development of cracks (2) spalling of edges (3) Erosion of concrete surface etc., the action as decided by the Engineer shall be taken against the c/s. In case of development of structural/full depth cracks, 25% cost of the slab shall be withheld per cracked panel during the guarantee period of 5 years. The penalty amount shall not exceed cost of respective slab. However, for cracks in M.H. bays, entire cost of M.H. bays shall be withheld. If the Contractors replaces the cracked panels within the guarantee period, the said amount shall be refunded. If not, the withheld amount shall be treated as penalty and said amount shall be forfeited. It is obligatory on the part of contractors to take care of such cracks during the guarantee period. In case of replaced slab, a defect liability period of 5 years shall be enforced from the date of completion of such works. During the defect liability period, dressing of joints complete in all respect shall have to be done free of cost at least once in a year preferably in the month of April or

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May or as directed by the engineer under municipal supervision. If the Contractor fails to comply with the above conditions, the note of the same will be taken while evaluating the tenders for c.c. road works in future.

In case of disputed cracks, nature of cracks may be ascertained by extracting core on the crack in question by the Contractor at his cost. If the depth of the penetration of the crack observed on the core is more than $1/3^{\text{rd}}$ the depth of the slab, the crack will be considered as structural crack. Reinstatement of the core holes shall be as per condition No. 11.3.

- 48.1 It will be the responsibility of the contractor to arrange for a joint inspection before monsoon every year after completion of the work till the expiry of defect liability period and also at the fag end of the defect liability period. Further, if the c/s fails to do so, the observations made by the staff during site inspection shall be considered for the purpose of noting the defects.
49. Tenderers must submit details of the various concrete roads constructed by them with controlled concrete/R.M.C. in the past along with the cost of the work and the years in which they were constructed. The experience, performance and capability in the cement concrete road works will be taken into consideration while considering the award of work.
50. The tenderers shall submit a list of equipments, machinery possessed by them which are required for execution of the works.
51. The Contractor shall obtain and maintain an electric connection at their cost till expiry of Contract period at the site for lighting as well as for operating machinery within 15 days from the date of receipt of permission for erection of site office from the respective ward office failing which a penalty of Rs.300/- per day will be levied and recovered.
52. The Contractors shall obtain and maintain a telephone at site at their cost till expiry of the contract period within 15 days from the date of erection of site office, failing which a penalty of Rs.300/- per day will be levied and recovered.
53. The tenderers should note the change in description of the specifications of the water proofing paper provided as a separation membrane, between concrete pavement slab and the sub-base in the relevant item.
54. After completion of the work, the Contractors shall submit three sets of completion drawings showing therein the details of work executed including the details of SWD and their diameters, water mains laid, location of ducts, manholes and water entrances etc., as directed by the Chief Engineer, NWCMC. Such plans shall be mounted on canvas cloth. The completed work shall be handed over to all the concerned departments of NWCMC along with the respective ward offices with necessary plans after completion of the work.
55. The Contractor shall maintain records, jointly with the Engineer's representative, of the day to day activities of work in the detailed performa prescribed by the Engineer from time to time, for documenting the quantum of work, the results achieved monitoring and shall strictly follow the Quality Assurance procedures laid down for grant item.

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56. After completion of the work, the Contractors shall submit three sets of completion drawings showing therein the details of work executed including the details of SWD and their diameters, water mains laid, location of ducts, manholes and water entrances etc., as directed by the Chief Engineer, NWCMC. Such plans shall be mounted on canvas cloth.
57. The Contractor shall maintain records, jointly with the Engineer's representative, of the day to day activities of work in the detailed proforma prescribed by the Engineer from time to time, for documenting the quantum of work, the results achieved monitoring and shall strictly follow the Quality Assurance procedures laid down for granting approval of construction items stage by stage including the procedures to deal with the products not conforming to the specifications.
58. If any contractor fails to carry out work, the same will be got executed at his risk and cost, through other agencies.
59. The works shall be carried out at various places at a time simultaneously if necessary, so as to complete the work in stipulated time.
60. The frame and cover of manholes, inspection chambers etc. shall be as per the prescribed drawings and specifications .
61. Contractor shall procure and maintain one Pentium III computer and a printer in good working condition on work site at their cost till expiry of contract period within 15 days from the date of erection of site office, failing which a penalty of Rs.1000 per day will be levied and recovered. The work carried out everyday including consumption of R.M.C. thickness of layers etc. as directed by the Engineer shall be recorded in the computer and reported on hard copy to Engineer twice a week. If the computer/printer goes out of order, a penalty of Rs.1000/- per day will be imposed till the Contractor repairs the computer. Further, the hand written reports shall be submitted till the computer/printer gets repaired.
62. The Contractor shall procure RMC from the RMC plant approved by NWCMC only. Ready Mix concrete prepared and transported will be as per relevant IS 4926.
63. Ready mix concrete will be brought to the site from RMC plant only by transit mixers (agitators).
64. Every transit mixer will carry delivery challan, mentioning the minimum following details:-
- i) Name of Manufacturer and Depot
 - ii) Serial No. of challan
 - iii) Date
 - iv) Truck No.
 - v) Name of Contractor to whom the RMC is being supplied.
 - vi) Location of Contract work
 - vii) Grade of Concrete
 - viii) Specified workability
 - ix) Cement content and Grade of cement

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- x) Time of reloading
- xi) Quantity of concrete

65. A computerized print out showing details of ingredients of ready mix concrete including admixture viz., the actual weight of each ingredients, required weight of each ingredient as per mix design etc. shall invariably be obtained with each transit mixer carrying RMC on site. The computerized sheet shall be signed by the site in charge and contractor's representative and shall be presumed as a record on the site.
66. When the truck arrives on site, the drum should always be speeded to about 10 to 15 rev/min, for at least 5-10 minutes, to make sure that the concrete is thoroughly mixed and uniform, before discharge.
67. As regards testing of workability, following procedure be followed –
- After making sure that the concrete has been uniformly mixed, take a sample from the first 0.5 cu.m. of concrete discharge, and do a slump (or compacting factor) test on the sample. If the result complies with the specified requirements, then the load should be accepted. If the results are beyond limits, a further sample should be taken from the second 0.5 cu.m. of the discharge, and if this is satisfactory, the load should be accepted, if not, the concrete load shall be rejected, as the same is not as per the specification range. The specified slump is 50 mm while carrying out above tests, it may vary by 10 mm as per IS 4926-1976.
68. All taxes/duties etc. will be borne by the Contractors and not by the NWCMC
69. No extra payment will be made for the use of admixtures
70. The defect liability period of 5 years will be the responsibility of the main tenderer.
71. It will be the sole right of the Administration to allow or disallow the use of ready mixed concrete in the specific works based on the site situation, number of works, distance of plant from the site of work, etc.
72. If any contractor desires to use Portland slag cement or mixture of 43 grade cement blended with GGBS, both conforming to IS: 8112 for physical parameters and IS: 455 for chemical parameters, then he shall have to write to Chief Engineer (NWCMC) requesting for permission to use the same. Engineer will issue permission to use Portland slag cement or external mixing of G.G.B.S. material with 43 grade O.P.C. after inspecting the RMC plant to ensure whether separate silo is provided for GGBS material. Contractor using GGBS material to mix in 43 grade cement or Portland slag cement will be paid at appropriate rates specified in the special condition of contract instead of rates of concrete in BOQ.

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TABLE-1 : MINIMUM TEST FREQUENCIES FOR QUALITY CONTROL OF CONCRETE ROAD CONSTRUCTION

Item		Test Check Control Criterion		Frequency
<u>APPROVAL OF SOURCE OF SUPPLY MATERIAL</u>				
Cement		Physical and Chemical Test	IS-8112	Once for each source supply for approval of source and subsequent when warranted
43 grade Portland slag cement conforming to IS 455 using GGBS only	Cement mixture of 43 grade OPC and GGBS	Physical Test	IS-8112	Twice a month
		Chemical Test	IS-455	Once before its use
Coarse and Fine Aggregate		-do- (including soundness and alkali reactivity)	IS-383	--do--
Water		Chemical Test	IS-456	-- do --

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DURING CONSTRUCTION:**MATERIAL:**

Cement		Strength	IS-8112	For each lot of cement received
43 Grade Portland slag cement conforming to IS-455 using G.G.B.S. only	Cement mixture of 43 grade OPC and GGBS	Physical Test	IS-8112	Twice a month
		Chemical Test	IS-8112	Once before its use
Coarse and Fine Aggregate		Gradation received	IS-383	For each lot of aggregate
		Moisture Content	--do--	Regularly as required subject to a minimum of 2 test per day
		Flakiness Index	--do--	--do--
		Elongation Index	--do--	--do--
Concrete		Workability		For each transit mixer
		Concrete Strength		Cube Samples, as specified for each age of 7 days, 14 days and 28 days (for every day's work)

TABLE-2 – ADDITIONAL QUALITY CONTROL CRITERIOR AND TOLERANCES

Position	Criterion	Tolerance
Cement concrete pavement	Quality Concrete grade M-35 and above	Tolerance level for characteristic strength Assessment: 1 in 15
	Workability 50 mm, (slump) maximum	+/- 10 mm

NOTES:

- A) The provisional approval gives no right to run a RMC plant upon ground which is not the property of RMC plant owner.
- B) The RMC plant owner shall obtain all the prevailing necessary statutory permissions/licenses etc. from various Gov./semi Govt./NWCMC authorities under various Acts applicable to RMC plant.

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ANNEXURE –I
SPECIFICATIONS FOR SEALING OF JOINTS IN RIGID PAVEMENTS

The sealing of joints in rigid pavements shall be accomplished with the use of appropriate grade of sealing compound (IS : 1834-1984). The sealing compound shall be heated to required temperature before filling into the joint.

(A) Materials

- (i) Sealing compound poly-sulphide/Polyurethane conforming to IS : 1834-1984
- (ii) Primer conforming to IS : 3384-1986.

(B) Physical requirements of sealing compounds of Grades A & B

Table 1 of IS 1834 – 1984

Sr. No.	Characteristic	Requirement	Method of Test	Remarks
(i)	Pour Point, Max	180 ⁰ C	Appendix A	Grades A & B
(ii)	Flow Test , Percentage Max	5	Appendix B	Grades A & B
(iii)	Extensibility, Min.	6 mm	Appendix C	Grades A & B
(iv)	Penetration at 25 ⁰ C., 100g. 5s, 1/10.	15 Min	IS 1203-1978*	Grades A & B
(v)	Aviation fuel resistance	50 max	Appendix D	Grade B only
	a) Increase in penetration as measured in (iv) after 7 days immersion in aviation fuel (See IS : 1571-1982#, Max 15		& Is : 1203-1978*	
	b) Changes in mass after 7 days immersion in aviation fuel, percent Max.	1	Appendix E	Grade B only

* Methods for testing tar and bituminous materials:
Determination of penetration (first revision).

Specifications for aviation turbine fuels, kerosene type (fourth revision).

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(C) Procedure for filling the joints

- (i) The joint shall be cleaned with coir raker and coir brushes. The fine particles / dust shall be blown off by compressed air.
- (ii) After the joint surface has thoroughly dried, primer shall be applied cold at ambient temperature to the cleaned joint in thin film by a brush. Care shall be taken that all vertical faces are thoroughly coated.
- (iii) As soon as the primer attains 'touch dry' state, sealing compound heated to appropriate pour point temperature (about 160⁰C-180⁰C) shall be poured in two stages in such a manner that the material does not spill over the exposed concrete surface. Due precautions shall be taken to avoid overheating of joint sealing compound above 180⁰C as well as heating for long period as sealing compound is liable to be damaged due to overheating.
- (iv) When sealing work is in progress, wooden battens shall be placed on either sides of the joints or suitable arrangements shall be made to prevent erratic flow of the compound.
- (v) After the sealing compound is cooled to ambient temperature, the excess quantity of compound, if any shall be cut with a hot spatula to make it flush with the existing concrete surface. The finished surface shall be dusted with lime powder in order to prevent any damage likely to be caused on account of traffic movement.

PART B AMENDMENTS/MODIFICATIONS/ADDITIONS TO EXISTING CLAUSES OF GENERAL TECHNICAL SPECIFICATIONS

SECTION 100 GENERAL

**CLAUSE 102 DEFINITIONS
(Addition)**

The following abbreviations shall be added in this Clause:

"MORT&H"	:	Ministry of Road Transport and Highways
"NHAI"	:	National Highways Authority of India
"MMRDA"	:	Mumbai Metropolitan Region Development Authority
"MSRDC"	:	Maharashtra State Road Development Corporation

CLAUSE 107 CONTRACT DRAWINGS

**Clause 107.1
(Modification)**

The first sentence of this Clause shall read as under:

"The Contract Drawings provided for bidding purpose shall be as contained in Volume-4 of the Bidding Documents and shall be used as reference only."

CLAUSE 108 SITE INFORMATION

**Clause 108.4
(Substitution)**

This clause shall read as follows:

"Identification of quarry sites and borrow areas shall be the responsibility of the Contractor. Materials procured from quarry sites and borrow areas identified by Contractor and to be used in Works must comply with the requirements of quality as stipulated in the Technical Specification for particular items of work."

CLAUSE 110 PUBLIC UTILITIES

(Substitution)

Replace whole of this clause with the following:

Clause 110.1

The contractor shall be responsible to coordinate with service provider / concerned authorities for shifting of utilities and removal of encroachments etc. and making the site unencumbered from the project construction area required for completion of work. This shall include initial and frequent follow-up meetings / actions / discussion with each involved service provider / concerned authorities. The contractor will not be entitled to any additional compensation for the delay in shifting of utilities. The expenses incurred for shifting of utilities as required by the respective departments shall be made by the contractor.

The information contained in the Bid Documents concerning the public utility services such as water, sewer, power transmission lines, telephone lines and oil/gas pipelines, OFC cables, etc. may not be exhaustive, and it shall be the responsibility of the Contractor to ascertain the utilities that are likely to be

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affected by the works through site investigations and collection of information from the concerned utility owners.

Clause 110.2 The contractor will make payments to the respective service provider/authorities for shifting of utilities, wherever required. The Contractor will obtain necessary approvals from such authorities and also in cases where payments are not required to be made for such shifting. Provisional sum has been indicated against each item for relocation of utilities.

Clause 110.3 Any utility likely to be affected by Contractor's work should be brought to the notice of the Engineer and such work shall be undertaken only after getting written clearance from the Engineer.

Clause 110.4 The Contractor may be required to carry out certain works for and on behalf of the various bodies and the Contractor shall also provide, with the prior approval of the Engineer, such assistance to the various bodies as may be authorized by the Engineer.

**Clause 111.13
(Addition) Dust Control During Construction**

The Contractor shall make adequate provision, including frequent spraying of water, to mitigate dust nuisance from on-site equipment during the construction of the works.

CLAUSE 112 ARRANGEMENT FOR TRAFFIC DURING CONSTRUCTION

**Clause 112.2
(Addition)** Where the Project road under construction crosses existing cross roads, or an established road, the road shall be kept open at all the times for which no extra payment shall be made. In case the Engineer specifically orders to construct and maintain diversion as described in the clause 112.3(see below), the same will be paid for if specifically provided for in the BOQ. Otherwise, it is deemed to be included in the rates quoted for items of project work. Temporary diversions for diverting the traffic from existing carriageway to new carriageway or vice-a-versa will have to be constructed by the contractor at his cost and this work is treated as incidental to the work execution.

**Clause 112.3
(Substitution)** In stretches where it is not possible to pass the traffic on part width of the carriageway, a temporary diversion shall be constructed as described below:

Sr. No	Type of Road	Carr- i- age- way width	Shou- lder width each side	Pavement Element (compacted)
1	Arterial	7.0m	2.5m	<ul style="list-style-type: none"> ▪ 200mm Granular Subbase ▪ 225mm Granular base

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				<ul style="list-style-type: none"> ▪ 50 mm Bituminous Macadam(BM) ▪ Premix carpet with seal coat/mix seal surfacing
2	Sub-arterial/ Local Road	5.5m	1.0m	<ul style="list-style-type: none"> ▪ 150mm Granular subbase ▪ 150mm W.B.M ▪ 50 mm BM ▪ Premix carpet with seal coat/mix seal surfacing
3	Access Road	3.25m	1.0m	<ul style="list-style-type: none"> ▪ 150mm Granular subbase ▪ 150mm W.B.M ▪ Premix carpet with seal coat

Drainage should be provided as directed by Engineer.

The alignment and longitudinal section of diversion including junctions and temporary cross drainage provision shall be as approved by the Engineer.

**Clause 112.4
(Modification/
Addition)**

Traffic Safety and Control

Last line of Para 5 shall be read as under:

“The sign shall be of approved designs and of reflectory type.”

Add the following paragraph at the end of the clause:

“Before commencement of any construction, the Contractor shall prepare and submit details of the arrangements he proposes to make for passing traffic during construction, design of barricades, signs, markings, lights, flags etc. and get the same approved by the Engineer.”

Any reference to clause 112 in any of the work item in the specifications will exclude section 112.4 of MoRTH specifications.

“Delete para 2 of Clause 112.4”

CLAUSE 121

FIELD LABORATORY

**Clause 121.2
(Modification /Add-
ition / Substitution)**

Description

Replace the words “shown in drawings” in the first sentence of first paragraph of this Clause with the words “per provisions indicated in this clause and at a location approved by the Engineer.”

Add the words “including uninterrupted power supply” to the second sentence of first paragraph.

Delete the first sentence of second paragraph and substitute the following:

“The floor space required for the field laboratory shall be not less than 300 sqm.”

Delete the fourth sentence of second paragraph shall be read as under.

“A good semi furnished office accommodation shall be provided to each of the Material Engineers of the Supervision Team as per the direction of the Engineer.”

Add the following at the end of this Clause:

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“There shall also be provided a concrete paved area, for storing samples adjacent to the laboratory, of about 300 sqm and another 200 sqm shall be suitably roofed with open sides giving protection against sun and rain.

Within 14 (fourteen) days of the commencement date, the Contractor shall prepare and submit a layout plan and details of the laboratory building and make/supplier of the equipment to the Engineer for his approval.

The field laboratory to be provided under the Contract shall be ready and finished and fully equipped condition not later than 2 months after the receipt of Notice to Commence Work, and the field laboratory with all equipment/instrument shall be to the entire satisfaction of the Engineer. During the period specified, the laboratory tests shall be performed in another laboratory proposed by the Contractor and approved by the Engineer.”

Clause 121.3 Laboratory Equipment

(Substitution)

This Clause shall read as under:

The following items of laboratory equipment as a minimum shall be provided in the field laboratory:

The equipment and instruments shall be new and shall be quality certified by Bureau of Indian Standards (BIS).

Sr. No	Sub No.	Item, Specifications	Nos. required
A: General			
(i)		Balance	
	(a)	7 kg to 10 kg capacity semi –self indicating Electronic Type –Accuracy 1 gm	2
	(b)	500 gm capacity semi-self indicating Electronic Type – Accuracy 0.01 gm	1
	(c)	Pan balance 10 kg capacity – Accuracy 0.5 gm	6
	(d)	Platform Scale – 300 kg capacity	1
(ii)		Ovens – Electrically operated, thermostatically controlled	
	(a)	From 100°C to 220°C – Sensitivity	2
(iii)		Sieves, as per IS 460-1962	
	(a)	IS Sieves 450 mm internal dia. of sieve sets as per BIS of required sieve sizes complete with lid and pan	2 set
	(b)	IS sieve 200 mm internal dia. (brass frame and steel or brass wire cloth mesh) consisting of sieve sets of required sieve sizes complete with lid and pan	2 set
(iv)		Sieve shaker capable of taking 200 mm and 450 mm dia. Sieves electrically operated with time switch assembly (As per BIS)	1
(v)		200 tonnes compression testing machine	1
(vi)		Stop watches 1/5 sec. Accuracy	2
(vii)		Glassware comprising of Beakers, Pipettes, dishes, measuring cylinders (100 to 1000 cc capacity) glass rods and funnels, glass thermometers range 0°C to 100°C and metallic thermometers range 300°C	6 each
(viii)		Hot plates 200 mm dia (1500 watt)	2

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Sr. No	Sub No.	Item, Specifications	Nos. required
(ix)		Enamel trays	
	(a)	600 mm x 450 mm x 50 mm	10
	(b)	450 mm x 300 mm x 40 mm	10
	(c)	300 mm x 250 mm x 40 mm	6
	(d)	Circular plates of 250 mm dia.	6
(x)		Water Testing Kit	1
(xi)		First aid Box	1
B: For Soils			
(i)		Water still	1
(ii)		Liquid limit device with Casagrande and ASTM grooving tools as per IS : 2720	1
(iii)		Sampling pipettes fitted with pressure and suction inlets, 10 ml Capacity	2 set
(iv)		Compaction apparatus(Proctor) as per IS:2720 (Part 8) complete with collar, base plate and hammer	1 set
(v)		Modified AASHTO compaction apparatus as per IS. 2720 (Part 7) 1974 or Heavy Compaction Apparatus as per IS complete with collar, base plate and hammer	1 set
(vi)		Sand pouring cylinder with conical funnel and tap and complete as per IS 2720 (Part 28) 1974 including modified equipment	6
(vii)		Sampling tins with lids 100 mm dia x 75 mm ht 1/2 kg capacity and miscellaneous items like moisture, tins with lid (50 grams) etc	12
(viii)		Lab CBR testing equipment for conducting CBR testing, load frame with 5 Ton capacity, electrically operated with speed control as per IS:2720 (Part 16), and consisting of following:	1 set
	(a)	CBR moulds 150-mm dia – 175-mm ht complete with collar, base plate etc.	12
	(b)	Tripod stands for holding dial gauge holder	12
	(c)	CBR plunger with settlement dial gauge holder	1
	(d)	Surcharge weight 147-mm dia 2.5 kg. wt with central hole	12
	(e)	Spacer disc 148-mm dia, 47.7-mm ht. With handle	12
	(f)	Perforated plate (Brass)	12
	(g)	Soaking tank for accommodating 6 CBR moulds	
	(h)	Proving rings of 1000 kg,2500 kg and 5000 kg capacity	1 each
	(i)	Dial gauges,25 mm travel- 0.01 mm/division	10
(ix)		Standard Penetration test equipment	1
(x)		Nuclear Moisture Density Meter or equivalent	2
(xi)		Speedy moisture meter complete with chemicals	6
(xii)		Unconfined compression test apparatus	1 set
C: For Bitumen and Bituminous Mixes			
(i)		Constant temperature bath for accommodating bitumen test specimen, electrically operated and thermostatically controlled	2
(ii)		Penetrometer automatic type, adjustable weight arrangement and needles as per IS. 1203 – 1958	2

 Contractor

Sr. No	Sub No.	Item, Specifications	Nos. required
(iii)		Solvent extraction or centrifuge type apparatus complete with extraction thimbles with solvent and filter paper	1
(iv)		Laboratory mixer including required accessories about .02 cum capacity electrically operated fitted with heating jacket	1
(v)		Marshall compaction apparatus automatically operated as per ASTM 1559-62 T and complete with electrically operated loading unit, compaction pedestal heating head assembly, dial micrometer and bracket for flow measurement, load transfer bar, specimen mould 100 mm dia. (4 in) with base plate, collars, specimen extractor, compaction hammer 4.53 kg (10 lb.) x457 mm (18 in) fall	1 set
(vi)		Distant Reading Digital Thermometer for Measuring Temperatures in Asphaltic Mixes	As required
(vii)		Riffle Box	1
(viii)		Automatic Asphalt Content Gauge [Nuclear or equivalent]	1
D: For Cement, Cement Concrete and Materials			
(i)		Water still	1
(ii)		Vicat needle apparatus for setting time with plungers, as per IS. 269-1967	1
(iii)		Moulds	
	(a)	150 mm x 300 mm ht cylinder with capping component	12
	(b)	150mmx150 mm x150mm cubical for compressive strength	60
	(c)	150mmx150 mm x700mm beam for flexural strength	30
(iv)		Concrete permeability apparatus	1
(v)		High frequency mortar cube vibrator for cement testing	1
(vi)		Concrete mixer power driven, 1 cu ft capacity	1
(vii)		Variable frequency and amplitude vibrating table size 1 metre x 1 metre, as per the relevant British Standard	1
(viii)		Flakiness & Elongation test apparatus	2
(ix)		Aggregate impact test apparatus as per IS 2386 (Part 4) 1963	2
(x)		Los Angeles abrasion apparatus as per IS. 2386 (Part 4) 1963	1
(xi)		Flow table as per IS 712-1973	1
(xii)	(a)	Equipment for slump test	4
	(b)	Compaction factor test equipment	1
(xiii)		Equipment for determination of specific gravity for fine and coarse aggregate as per IS 2386 (Part 3) 1963	2
(xiv)		Flexural attachment to compression testing machine	1
(xv)		Core cutting machine with 150 mm dia. Diamond cutting edge	2
(xvi)		Needle vibrator	1
(xvii)		Vibrating hammer as per BS specification	1
(xviii)		Air entrainment meter	1
(xix)		0.5 Cft, 1 Cft cylinder for checking bulk density of aggregate with tamping rod	1
(xx)		Soundness testing apparatus for cement	1
(xxi)		Flexural Beam testing machine with accessories	1

Contractor

Sr. No	Sub No.	Item, Specifications	Nos. required
E: For Control of Profile and Surface Evenness			
(i)		Digital Level complete with all accessories	1
(ii)		Auto level	4
(iii)		Aluminium staff	8
(iv)		Total Station with all accessories	2
(v)		3 metre straight edge and measuring wedge	2 sets
(vi)		Camber templates 2 lane	
	(a)	Crown type cross-section	2 set s
	(b)	Straight run cross-section	2 sets
(vii)		Steel tape	
	(a)	5 m long	as reqd
	(b)	10 m long	as reqd
	(c)	20 m long	as reqd
	(d)	30 m long	as reqd
	(e)	50 m long	As reqd

- Note :**
- The laboratory set-up must be complete including a set of reference standards, adequately staffed and operational to the satisfaction of the Engineer before commencement of the works.
 - Following survey instruments from item in E above shall be made available exclusively for the use of Engineer during the tenure of the contract.

i)	Auto level	–	2 nos.
ii)	Total station	–	1 set
iii)	Aluminum staff	–	4 nos.

Clause 121.5 Maintenance

(Substitution) This Clause shall read as under:

“The Contractor shall arrange to maintain the field laboratory including sample store yards in a satisfactory manner until the issue of Taking over Certificate for the complete work. Maintenance includes all activities described in Clause 120.4 and maintenance of equipment and running of the same including chemicals and consumables.”

Clause 121.7 Rate

(Substitution) The construction, supply, installation, maintenance, and operation including all expenses involved in connection thereto for the field laboratory shall be incidental to the work, and shall not be paid for separately.

CLAUSE 123 PROVIDING AND MAINTAINING COMMUNICATION SYSTEM

(Substitute) Replace this Clause by the following:

Clause 123.1 Scope

Contractor

The work covers the provision and maintenance of cellular phone system (Group Services) provided by Orange / BPL or equivalent and land phone with STD facility.

Clause 123.2**Supply**

The Contractor shall arrange to supply, install and commission mobile cellular phones with following facilities:

Access Levels	No restriction	Outgoing to Group, incoming Open	Outgoing to Group, incoming from Group	Land phone
Quantity	4 Nos.	4 Nos.	8 Nos.	1 no.
Penalty (for not maintaining the system)	Rs. 7000/- per no.	Rs. 5000/- per no.	Rs. 3000/- per no.	Rs. 10000/- per no.

The system shall consist of the following:

- a) Hand held Mobile Cellular phones of Nokia/Motorola/Siemens or equivalent approved makes suitable for use throughout the State of Maharashtra.

The Contractor shall provide the phones within 15 days from the date of receipt of Notice to Proceed with work. He shall submit a guarantee for replacement of any defective phones during the currency of the Contract.

Clause 123.3**Approval**

The Contractor shall procure the services of authorised service providers within the State of Maharashtra and shall be liable for the licences and approvals necessary for using the cellular phones.

Clause 123.4**Maintenance**

The contractor shall arrange to maintain the entire cellular phone system including the phone sets, and other accessories. Maintenance shall also include payment for local and STD calls and airtime charges as per actuals every month, rental, subscription fees and/or activation fees, security deposit etc. or any other airtime and operating cost. The period of maintenance shall be until the issue of taking over certificate for the complete work. He shall replace any instrument or component which goes out of order at his own cost and provide all necessary spares and attend to all repairs necessary for keeping the phones in satisfactory working condition. He shall also make arrangement for replacement/change of service provider if the performance of the latter is not found satisfactory. On issue of the taking over certificate, from the Employer. Mobile phones and accessories including unused airtime, will be the property of MSRDC.

Clause 123.5**Measurements for Payment**

Contractor

The payment for supply, commissioning and airtime for the Mobile Group Services and Land phone, shall be arranged by the contract from time to time.

If the Contractor fails to commission and hand over the system in good working condition in the stipulated time, an amount of Rs. 30,000 per month or part thereof shall be deducted from the Contractor's bills.

Provision of cellular phones, Land line as stated above, maintenance during currency of contract is considered incidental to execution of project and no separate payment will be made.

If the Contract Works are not completed within the stipulated period or within granted extended time of completion, the maintenance of the system in accordance with Clause 123.4 shall be carried out by the Contractor at his own cost and as such, no payment shall be made for the same. In case of any failure by the Contractor to do so, an amount of Rs. 25,000 per month or part thereof shall be deducted from the Contractor's bills.

Clause 123.6

Rates

Deleted

SECTION 200

SITE CLEARANCE

CLAUSE 201

CLEARING AND GRUBBING

**Clause 201.1
(Addition)**

Scope

Add the following at the end of this clause:

"After cutting of trees, the wood shall be the property of the Employer and shall be carted and stacked within a lead of 1 Km and as directed by the Employer."

CLAUSE 202

**DISMANTLING CULVERTS, BRIDGES AND OTHER STRUCTURES/
PAVEMENTS**

**Clause 202.5
(Modification)**

Disposal of Materials

This Clause shall read as under

All materials obtained from dismantling structures including houses /bungalows etc. shall be the property of contractor and shall be removed and disposed off as per directions of Engineer and as provided in Clause SP:25.

Clause 202.6

Measurements for Payment

Contractor

- (Addition)** Add the following items after item (vi):
“(vii) Footpaths and Median ----- Linear Metre”, for item code 1.5 g(ii).
- SECTION 300 EARTHWORK, EROSION CONTROL AND DRAINAGE**
- CLAUSE 301 EXCAVATION FOR ROADWAY AND DRAINS**
- Clause 301.1 Scope**
(Addition) Add the following as second paragraph under this clause:

“The work shall also include excavation for channel training at culverts/bridges, excavation of existing shoulders and medians for purposes of widening the pavement and excavation of existing embankment for reconstruction to specification.”
- Clause 301.3.3 Excavation - General**
- (Modification)** Delete the last two sentences of para 5 beginning and ending with
“ If trees were removed ---- by the Engineer” and
“The cost of planting----- to the work”.
- Clause 301.3.7 This Clause shall read as under**
- (Substitution)** The title of this Clause shall read as under:

"Excavation of road shoulders/verge/median for widening of pavement or for providing treated/paved shoulders:"

This Clause shall read as under:

"In works involving widening of existing pavements or providing paved shoulders, the existing shoulders/verge/median shall be removed to its full width and to level as shown on drawing without disturbing the existing pavement. The subgrade material within 0.2m from the lowest part of the pavement for widened portion or paved shoulders shall be loosened and re-compacted as per Clause 305 to a density not less than 97% of maximum dry density determined according to IS: 2720 (Part 8). Any unsuitable material encountered in this portion of subgrade shall be removed and replaced with suitable material and compacted in accordance with Clause 305."
- Clause 301.3.11 Disposal of Excavated Materials**
- (Modification)** Delete this sub-clause and replace with "All the excavated materials shall be the property of the Employer Suitable material obtained from the excavation of the roadway, shoulders, verge, drains, cross drainage works etc shall be used for
- i) Filling for roadway embankments
 - ii) Filling existing pits in the right of way as directed by the Engineer including levelling and spreading with all leads and lifts

- iii) For landscaping of the road as directed by the Engineer, including levelling and spreading, with all leads and lifts.
- iv) Surplus material such as rubble, stones etc not intended for use as above shall be used as a raw material for crusher.

Unsuitable and surplus material, which in the opinion of the Engineer cannot be used in the works, shall be removed from site by the Contractor and disposed off including all lead & lifts and as per provided in Clause SP:15. The contractor shall obtain the written prior permission from the land owners, where they propose to dispose off the unsuitable excavated material. No place will be made available by the employer for disposing off the material and no claim will be entertained on that account.

**Clause 301.6
(Modification)**

Para 3, Replace the word "Granular base material" by M-10 grade cement concrete.

Clause 301.8

Measurement for Payment

(Modification)

Delete (k)
Read item (v) of the last para as "disposal of surplus material with all leads and lifts".

Clause 301.9

Rates

**Clause 301.9.1
(Modification)**

Add the following after item (vi)

"(vii) The removal from site and disposal of all surplus or unsuitable materials obtained from excavation operations, which, in the opinion of the Engineer cannot be used in the works shall be included in the Contract rate"

**Clause 301.9.2
(Modification)**

Replace the clause by "The loosening & recompaction of loosened material at sub grade is incidental to the work & no separate payment shall be made for this item.

**Clause 301.9.4
(Modification)**

Replace the word "Granular base material" by M-10 grade cement concrete

CLAUSE 304

EXCAVATION FOR STRUCTURES

Clause 304.3.4

Preparation of Foundation

(Modification)

In para 2 and 3 of clause 304.3.4 substitute concrete M-15 in place of 1:3:6 nominal mix.

Clause 304.5

Rates

Clause 304.5.1

Replace Sr. No. (v) of this Clause by "back filling, clearing up the site and disposal of all sample materials with all leads and lifts".

CLAUSE 305

EMBANKMENT CONSTRUCTION

Clause 305.2.2.2

Borrow Materials

Contractor

(Modification)

Para 1 of this Clause shall read as under:

"No borrow area shall be made available by the Employer for this work. The arrangement for the source of supply of the material for embankment and subgrade as well as compliance to the different environmental requirements in respect of excavation and borrow areas as stipulated, from time to time, by the Ministry of Environmental and Forest, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor. No earth, except when the road is in cutting, shall be borrowed from the Right of Way."

Para 8 of this Clause given below Table 300-2 shall read as under:

"The contractor shall at least 21 working days before commencement of construction of embankment and the subgrade, 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 8) for each fill material proposed to be used in the construction of embankment and subgrade.
- (ii) The graphs showing values of dry density against moisture content from which each of the values in (i) above (maximum dry density and optimum moisture content) was determined.
- (iii) The dry density-moisture content-CBR relationships for each of the fill material proposed to be used in the subgrade.
- (iv) Material to be used in the subgrade shall have a 4 day soaked CBR value of 8% at the unit weight applicable as per Table 300-2.

The above information shall form the basis for compaction only upon its approval by the Engineer."

Clause 305.2.2.3**Additional new Sub-clause****(New)**

Material to be used in the subgrade shall have a 4 day soaked CBR value of 8% at the unit weight applicable as per Table 300-2

**Clause 305.9.1
(Modification)**

Insert "including removal of top soil after word materials appearing in first line of item (v)"

**Clause 305.9.6
(Modification)**

Delete "lifts and upto a lead of 1000 mtrs or otherwise specified" replace by words "leads and lifts"

SECTION 400**SUB-BASES, BASES (NON BITUMINOUS) AND SHOULDERS****CLAUSE 401****GRANULAR SUB-BASE****Clause 401.1
(Addition)****Scope**

Add the following at the end of this Clause.

"A site trial shall be performed in accordance with Clause 901.16".

Clause 401.2**Materials****Clause 401.2.1
(Modification)**

Para 1 of this Clause shall read as under.

The material to be used for the work shall be crushed stone only. It shall be free from any organic matter and other deleterious substances and shall be of such nature that it can be compacted readily under watering and rolling to form, firm, stable base.

**Clause 401.2.2
(Substitution)****Physical requirements –**

This clause shall read as under :

“The material proposed to be used in the subbase course shall have a 4-day soaked CBR value not less than 30 percent. Besides the CBR (not less than 30), the typical stipulations in regard to the physical characteristics of coarse fraction of sub-base materials shall be as under:

- LA value of the material shall not exceed 50 or AIV shall not be more than 30 percent.
- Ten percent fines value of 50 KN or more (soaked condition) when tasted as per BS : 812 (Part – III).
- Combined Flakiness and Elongation Indices (Total) not more than 30 percent.
- The water absorption value shall not exceed 5 percent, (as per IS:2386-part-3).
- Sodium sulphate (5 cycles) shall be less than 15% (as per IS:383).

Table 400.2

(Modification)

In all three sizes of grading replace last line i.e IS sieve 0.075 mm < 10 percent by weight by 0.150mm < 5 percent by weight.”

Clause:401.4**Construction Operations****Clause :401.4.2
(Modification)****Spreading and compacting**

Second sentence of para 5 of this clause shall read as under.

For a compacted single layer upto 150mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 KN or pad foot-drum / heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 7 kg/cm² or equivalent capacity roller capable of achieving the required compaction.

To be added at the end of Clause 401.4

(Modification)

“Sub base (for drainage layer only) shall continue over the full extent of the earthworks in cuttings (excluding rock) and embankments and the base of the sub-base shall at all times fall towards the drainage system.”

CLAUSE: 406**WET MIX MACADAM****Clause:****406.2.1.1****(Modification)****Physical Requirements**

Delete the second sentence beginning with "If crushed gravel..." and ending with ".....fractured faces." and add as under:

"The aggregates shall be produced by a multiple stage crushing and screening plant and, unless otherwise instructed by the Engineer, crushing shall be carried out in at least two stages."

Add the following at the end of this Clause:

"The aggregate shall have a four day soaked CBR value of 100 or more."

Clause: 406.3.4**(Modification)****Spreading of Mix**

Substitute para 2 of Clause 406.3.4 as under:

"The mix shall be spread by a paver finisher only.

The thickness of the loose layer shall be so regulated that the maximum thickness of the layer after compaction does not exceed 150mm unless otherwise approved by the Engineer after satisfactory site trials (Clause 406.1)."

CLAUSE 407**SHOULDERS, ISLANDS AND MEDIAN****Clause: 407.6****(Modification)****Measurements for Payment**

This clause shall read as under:

" Construction shall be measured as finished work in position as below:

- a) Shoulders (Earthen/Hard/Paved)
 - i) For excavation: in cum
 - ii) For earth work / granular fill: in cum
 - iii) For sub-base, base, surfacing courses: in units of respective items.
 - iv) For kerb: in cum

- b) Island and Medians
 - i) For earthwork: in cum.
 - ii) For kerb: in cubic metres.
 - iii) For sub-base, base and tile/slab finish: in units of respective items

CLAUSE 408**CEMENT CONCRETE KERB AND KERB WITH CHANNEL****Clause: 408.6****Measurement for Payment**

Contractor

(Modification)

Cement concrete kerb/ kerb with channel shall be measured in cubic metre for the complete item of work.

SECTION 500**BASE AND SURFACE COURSES (Bituminous)****CLAUSE:501****GENERAL REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS****Clause : 501.3
(Modification)****Mixing**

The first sentence of para I shall read as under:

“Pre-mixed bituminous materials, including Bituminous Macadam, Dense Bituminous Macadam, Semi-dense Bituminous Concrete and Bituminous Concrete, shall be prepared in a hot mix plant of batch type of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates.”

**Clause : 501.5.3
(Modification)**

Add at the beginning of the 4th para:

“The temperature of mix at the time of laying shall be in the range 120 - 145 degree Celsius.”

**Clause : 501.6
(Modification)****Compaction**

Add at the end of 6th para :

“Rolling shall be continued till the density achieved satisfies the requirements of Clause 903.4.2 and all roller marks are eliminated.”

Clause : 501.8**PREPARATION OF SURFACE****Clause : 501.8.3.4****Laying the Profile Corrective Course****Clause : 501.8.3.4.1
(Modification)**

This Clause shall read as under :

“The surface on which profile corrective course is to be laid shall be thoroughly swept clean of dust and any other extraneous material using mechanical broom and dust collected removed or blown off using compressed air except in places where mechanical means cannot reach”.

“After preparing the granular surface as in Clauses 501.8.3.1, 501.8.3.2 and 501.8.3.3 the profile corrective course with materials as per Clause 501.8.2.3, 501.8.2.4 shall be laid and compacted to the requirement of particular specification Clause. Where a bituminous profile corrective course is to be laid over primed granular surface, a tack coat conforming to Clause 503 shall be applied prior to laying profile corrective course”.

Clause : 501.8.3.4.2

This Clause shall read as under :

(Substitution)

“An existing bituminous surface shall be prepared as per Clauses 501.8.3.3 and 501.8.3.4.1. The bituminous profile corrective course shall be laid after applying tack coat conforming to Clause 503 and compacted to the requirement of specification Clause.”

CLAUSE : 502**PRIME COAT OVER GRANULAR BASE****Clause : 502.8
(Modification)****Rate**

Replace 0.6 by 1.0 in line 7.

CLAUSE : 503**Tack Coat****Clause : 503.8
(Modification)**

Replace “0.2” by “0.3” in line 5.

CLAUSE : 507**DENSE GRADED BITUMINOUS MACADAM****Clause : 507.2****Materials****Clause : 507.2.1**

This clause shall read as under :

(Substitution)

The Bitumen shall be paving bitumen of Penetration Grade 60/70 as per Indian Standard Specifications for Paving Bitumen – IS:73

**Clause: 507.2.2
(Modification)****Coarse Aggregates**

- i) Delete the words from 2nd line of 1st para “Crushed gravel or other hard material retained on the 2.36mm sieve”.
- ii) Delete the entire para 2 of Clause 507.2.2
- iii) From the table 500.8 delete at the bottom of the table asterisk “Aggregate may satisfy requirements of either of these two tests” and modify as under :
“Aggregate should satisfy both the tests value of Los Angeles Abrasion Values and Aggregate Impact Value”.

**Clause 507.3.3
(Modification)**

Insert the following paragraph between existing paragraph 3 and 4

Contractor should choose the appropriate Mix Design method to satisfy all the properties as & stipulated in the MoRTH specifications.

**Clause 507.9
(Modification)****Rate**

Add the words “except for the item of tack coat” after the words “ required operations as specified” in second line.

Add at the end “Replace 4.25 by 4.5 in line No. 5”

CLAUSE 509**BITUMINOUS CONCRETE**

- Clause 509.2.1
(Addition)** This clause shall be read as under :
- If ordered by the Engineer, Polymer modified bitumen based on SP-53 shall be used in the work.
- Clause 509.2.4
(Substitution)** This Clause shall read as follows :
- “Filler shall consist of cement minimum of 2% by weight of mix.
- Clause 509.2.5
(Modification)** **Aggregate Grading and binder content**
- Add the note below Table 500-18.
- “The grading of the aggregate mix as used in work shall be a smooth curve within the approximate parallel of the envelope in Table 500.18”
- Clause 521.2
(Modification)** The modifier in the required quantity shall be blended at the refinery only.
- Clause 521.7
(Deletion)** Deleted
- SECTION 600 CONCRETE PAVEMENT**
- CLAUSE 601 DRY LEAN CEMENT CONCRTE SUB BASE**
- Clause 601.2.3.2** In the 5th line of this clause, replace ‘25mm’ to ‘40mm’.
- Clause 601.2.3.4
(Replacement)** Replace Table 600-1 Aggregate gradation for Dry Lean Concrete by Table 600-4 Aggregate gradation for Dry Lean Concrete.
- CLAUSE 602 CEMENT CONCRETE PAVEMENT**
- Clause 602.2.2
(Replacement)** Ordinary Portland Cement, 43 Grade (IS 8112) shall only be used.
- Clause 602.2.3
(Modification)** To be added at the end of Clause 602.2.3
Admixtures containing calcium chloride shall not be used.
- Clause 602.2.4.1
(Modification)** Los Angeles abrasion test results should not be more than 25%.
- Clause 602.2.6** To be added at the end of Clause 602.2.6
All steel bars shall be epoxy coated (ref. Clause 1008.3).
- Clause 602.2.8
(Substitution)** **Joint Seals**
- a) Compression seals shall be pre-compressed neoprene impregnated expanding foam sealing strip having a current BBA certificate or rubber seals

made of polychloroprene elastomers complying with BS 2752 and conforming with the requirements of ASTM Standard D2628-81. Seals of butadiene-acrylonitrile or other synthetic rubbers may be used if certificates are produced to show that they confirm to the performance requirements of ASTM Standard D2628-81 for oven ageing, oil and ozone resistance, low temperature stiffening and recovery. Seals made of ethylene vinyl acetate in microcellular form and other synthetic materials may be used in longitudinal joints and in structures with the approval of the Engineer if test certificates are produced to show adequate resistance to fuels and heat ageing when tested in accordance with BS 4443: Part 4, Method 10 and Method 12 respectively. The compression set of any seal shall not be greater than 15% when the specimen is subjected to a 25% compression in accordance with BS:4443 Part 1, Method 6. When immersed in standard oils for 48 hours at 25°C in accordance with BS 903: Part A16, the volume change shall not be greater than 5%.

Compression Seals shall be shaped so that they will remain compressed at all times and shall have a minimum 20mm contact face with the sides of the sealing groove. If lubricant-adhesive is used, it shall be compatible with the seal and the concrete and shall be resistant to abrasion, oxidation, fuels and salt.

When compression seals are used, the widths of the seal shall be selected in relation to the width of the sealing groove, the bay lengths and manufacturer's recommendations so that the estimated maximum width of the joint opening shall be not more than 70% of the original width of the seal, the estimated maximum width being calculated on the basis of a movement of 4mm per 10 m run of slab. The maximum calculated width of sealing groove shall be such that the contact face of the seal with the side of the groove shall be not less than 20mm and that the top of the seal shall be a minimum of 3mm below the surface of the concrete.

- b) The Preformed Neoprene compression seal shall be Manufactured by an experienced neoprene extruder. Manufacturer must have minimum 10 years experience in designing, compounding and extrusion of Preformed Neoprene compression seals for pavements as per the relevant ASTM/ BS codes. The manufacturer shall have the capacity to produce dies and test production to all the ASTM D-2628-81/BS specifications, in-house, without the assistance of a source outside the extruder's company. In-house testing facility is critical to ensure that batches being produced are tested during production. Owner/owner's representative may like to witness the in-house test facility of manufacturer to ensure that each lot is tested during production before shipment is made to the site.
- c) Testing Facility

The manufacturer shall have the capacity to test production to all the ASTM D-2628-81/BS specifications in-house without the assistance of a source outside the extrusion workshop.

The samples will be tested in the presence of owner/owner's representative in the laboratory within India. If no such test facility is available in India, it will be the responsibility of manufacturer to upgrade any existing facility or create a new facility in India for such testing at his cost.

The seals shall be marked with the name or trademark of the manufacturer, lot no. and catalogue number at intervals of less than 4 ft. Also, on top surface of the seal, a mark shall be placed at every 30 cm interval to enable marking length measurements in the seal after installation.

d) Sampling

A lot, during manufacture, shall consist of no more than one days production or 20,000 linear meter, whichever is less. Samples shall be taken at random from each lot to be shipped. A minimum of six linear feet shall constitute one sample for testing purposes.

Owner/owner's representative will randomly select one test sample per 4 lots, or part thereof, delivered together. If less than 4 lots are delivered in single delivery, one sample per delivery will be selected for testing in India.

e) Testing

The material as delivered to the job site shall be accompanied by the manufacturer's certification stating it meets all requirements of ASTM D-2628-81. Testing shall be completed on each lot by the manufacturer. Specimen preparation and testing shall follow the method explained in ASTM D-2628-81. A copy of this method may be obtained from the manufacturer of the seal.

The owner/owner's representative will verify the certification by sampling and testing the material in their presence in India after delivery at the job site.

f) Lubricant - Adhesive

The lubricant-adhesive used to install the Preformed Neoprene joint sealer shall be a one-component polychloroprene compound containing only soluble phenolic resins blended together with antioxidants and acid acceptors in a suitable mixture of organic solvents. The lubricant-adhesive shall meet ASTM D-2835-96 and shall have the following properties:

Solids Contents : 22 - 28%, by weight.

Viscosity shall be that the lubricant will perform suitably with the installation equipment.

The lubricant shall remain fluid from 5^o to 120^o F.

The lubricant should be kept from freezing and used within the shelf life as specified by the manufacturer.

Each of lubricant-adhesive shall be delivered in containers plainly marked with the manufacturer's name and trademark, lot number and date of manufacture and shall be accompanied by the manufacturer's certification as to conformance to this specification.

g) Storage/Shipment

The Preformed Neoprene seal should be delivered either in cardboard boxes or on wooden cable reels. The proper storage of the cardboard boxes requires the boxes be protected from moisture to keep the cardboard from deteriorating. The large wooden cable reels should be covered by a tarpaulin to keep the seal clean and damage free. The lubricant-adhesive shall be kept from freezing.

h) Joint Preparation

To form the joint, a two-stage operation shall be performed. The first saw-cut shall be a minimum of 33% of the depth of the concrete. This cut shall be made at the proper time to eliminate all random cracking. The second saw-cut shall create the proper shape factor for the Preformed Neoprene seal. This saw-cut will be made with a water-cooled diamond blade saw capable of holding a tolerance of $\pm 1/16$ ". The saw-cut shall be inspected for proper width, depth and the face of the joint must be at 90 degrees to the surface of the pavement. If spalling occurs due to the sawing operation, it shall be repaired prior to seal installation.

Once the secondary saw-cut is made, the joint shall be immediately pressure washed with clean water and blown out with compressed air.

i) Installation

The joint is now ready for installation of the Preformed Neoprene seal. The Installation machine should be capable of installing the seal at the specified depth without cutting, nicking or twisting the seal. The installation machine also must be capable of installing the seal with 4% or less stretch. It must have large powered compression wheels that deliver the Preformed Neoprene seal to the joint with minimal stretch, installing it to the proper depth (adjustable) while applying the lubricant-adhesive directly to the sides of the seal. Hand installation is not acceptable.

The lubricant-adhesive is used mainly to facilitate the installation of the Preformed Neoprene seal. The lubricant-adhesive must contain a minimum of 24% solids, be uniform, contain no lumps, have the correct viscosity and have a drying time between eight and twenty minutes. The containers of lubricant-adhesive should be labeled with the manufacturer's name, catalog number, lot number and manufacture date. Also, an MSDS must accompany all shipments for the safety of the user. The lubricant-adhesive will begin to thicken at 32°F. When sealing

operations occur where the air temperature is below 32°F. The lubricant adhesive must be stored in a heated warehouse until immediately prior to use.

The proper installation sequence for Preformed Neoprene seal is to install the longitudinal seal first. After allowing the glue to dry (approximately 20 minutes), the longitudinal seal is cut with a sharp blade at the intersection of the transverse joint. The transverse joint seal is then installed through the cut in the longitudinal seal to form a tight intersection. The transverse seal should be installed in one continuous place. The transverse seal will exert outward force on the end cut of the longitudinal seal to form a tight intersection.

j) Inspection

Stretching the seal during installation is the major cause of premature failure of the Preformed Neoprene seal. Inspecting for stretch should be done very early in the sealing process. The inspection involves loosely laying a piece of Preformed Neoprene seal for the entire width of the pavement and cutting it at the exact width of the pavement. The seal is then installed in the joint. Any excess amount of the seal remaining at the end of the joint is due to stretch. The length of this excess is measured and a stretch percentage is calculated by dividing the excess length by the original length. Stretch greater than 4% is unacceptable. The seal shall not be twisted or have any deformity that interferes with the seal making complete contact with the joint face.

Clause 602.3.3 Concrete Strength

Clause 602.3.3.1 The last sentence of this Para shall read as under:

(Modification) "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 0.45."

Add the following at the end of this Clause:

"The concrete for the rigid pavement shall be of minimum M40 Grade with a 28-day compressive characteristic strength of not less than 40 MPa and a flexural strength of not less than 4.8 MPa with a corresponding tolerance factor of 1.96."

Clause 602.3.4 Workability

Clause 602.3.4.1 Delete the last sentence of the para and replace with:

(Modification) "The control of workability in the field shall be exercised by Slump Test (IS: 1199) and shall be further confirmed/controlled by Compaction Factor Equipment and the compaction factor shall be in the range of 0.8 to 0.92."

Clause 602.5 Separation Membrane

(Modification)

To be added at end of this Clause

“There shall be no standing water on or under the separation membrane when concrete is placed upon it.”

Clause 602.9.3.3 Paving Equipment

(Addition) Add the following sentences in this Clause

Paver shall be equipped with dowel bar inserter.

Clause 602.9.6.5 Add new clause after clause 602.9.6.4

(Addition)

- i) The final regulation of the surface slab shall be provided by a longitudinal oscillating float travelling across the slab. Before the texture is applied, the longitudinal oscillating float shall complete the traverse of the slab in both directions within the length of the float and shall have a total longitudinal stroke of 200 mm to 300mm.
- ii) The longitudinal float shall either be a separate machine closely following a slipform paver or alternatively it shall be attached to a slipform paver in such a manner that it functions effectively and does not adversely affect the performance of the paver or the surface of the slab.
- iii) The longitudinal oscillating float shall have a minimum length of 3m and a minimum constant width of 250mm with a maximum weight of 10kg/m. The edges of the float shall be curved or chamfered.
- iv) A minimum length of 500 mm of longitudinal oscillating float shall be within the length of the machine tracks or wheels.
- v) Joint grooves shall be constructed in compliance with Clause 602.6 Where grooves are wet-formed the concrete shall be compacted around the former by a separate vibrating plate compactor with twin plates. The groove former shall be compacted to the correct level by a vibrating pan, which may be included with the transverse joint finishing beam. Final finishing shall be carried out in accordance with sub-Clause (i) of this clause. Any excess concrete on top of the groove former shall be removed before the surface is textured.
- vi) Where a concrete slab is constructed in more than one width or where the edge need to be matched for one level to another section of surface slab, and the surface levels at the edges are not achieved, the slab shall be supported by separate side forms placed before or after the paver to ensure that edge levels meet the required tolerances.

Clause 602.15.2 Pavement Thickness

(Modification)

- (a) Table 600.3 Payment Adjustment for Deficiency in Thickness shall be replaced as follows

Contractor

Deficiency in average thickness of Day's work	Percentage of contract unit price payable
Upto 5mm	100
6 - 10 mm	87

(b) In para 4, replace 25mm by 10mm

(c) First sentence of last para of this Clause shall read as under

In the stretch where deficiency of average thickness is more than 10 mm, the section is identified with the help of cores.

SECTION 800 TRAFFIC SIGNS, MARKINGS AND OTHER ROAD APPURTENANCES

CLAUSE 802 OVERHEAD SIGNS

CLAUSE 802.9.1 (Modification) Delete second sentence of para. 1 of this clause.

Clause 803 ROAD MARKINGS

Clause 803.4.1 (ii) (Modification) In the second line replace word 'Suitable' by 'fully/semi automatic'.

Clause 803.7.2 (Substitution) In respect of markings like directional arrows and lettering etc. the measurement shall be in Sq.m of actual area. (Excluding gaps if any)

Clause 803.6 Application

Add the following Sub-Clause at the end of this Clause:

Clause 803.6.6 Tolerances

i) General

Road traffic markings shall be constructed to accuracy within the tolerances given below:

- The width of lines and other markings shall not deviate from the specified width by more than 5%.
- The position of lines, letters, figures, arrows and other markings shall not deviate from the true position specified by more than 20 mm.
- The alignment of any edge of a longitudinal line shall not deviate from the true alignment by more than 10 mm in 15 m.
- The length of segments of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

In broken lines, the length of segments and the gap between segments shall be as indicated on the Drawings. If these lengths are altered by the Engineer, the ratio of the lengths of the painted sections shall remain the same.

Line and curves, whether broken or unbroken, shall not consist of chords but shall follow the correct radius.

ii) Faulty Workmanship or Materials

If any materials not complying with the requirements is delivered at the Site or used in the Works, or if any sub-standard work is carried out, such material or work shall be removed, replaced or repaired as required by the Engineer, at the Contractor's own cost. Rejected traffic markings and paint that has been splashed or has dripped onto the surfacing, kerbs, structures or other such surfaces shall be removed by the Contractor at his own cost, in such a way that the markings of split paint will not show up again later."

Clause 803.8 In second line after 'material' add 'including sealing primer coat'.

CLAUSE 809 CONCRETE CRASH BARRIER

Clause 809.2.2 Replace "M-20 by M-40".

SECTION 900 QUALITY CONTROL FOR ROAD WORKS

CLAUSE 901 GENERAL

Add a new Sub-Clause 901.16 – Site Trial at the end of this Clause as given hereunder.

Clause 901.1 This clause shall read as under:

(Substitution)

"All materials to be used, all methods adopted and all works 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 all required tests and Quality Control work as per Specifications and/or as per Clause 121 and/or as directed by the Engineer. The list of laboratory equipment and the facilities to be provided shall be as per Clause 121 and shall be got approved from the Engineer in advance."

Clause 901.5 This Clause shall read as under:

(Substitution)

"The Contractor shall provide necessary cooperation and assistance in obtaining the samples for tests and carrying out the field tests as required by the 'Engineer' from time to time. This may include provision of laboratory, equipment, transport, consumables, personnel, including labour, attendants, assistance in packing and dispatching and any other assistance considered necessary in connection with the tests."

Add the following sub-clause 901.16

Clause 901.16 Site Trial

Contractor

(Additional)

The Contractor shall carry out full-scale site trials on all earthwork and pavement items proposed for the Works using the equipment and methods proposed by the Contractor for constructing the Works. The trials shall be carried out with the agreement and in the presence of the Engineer or his authorised representative.

The trials shall be carried out to enable the Contractor to demonstrate the suitability of his mixing and/or compaction equipment to provide the specified material and compact the same to the specified density and to confirm that the other specified requirements of the completed earthworks and pavement courses can be achieved.

Each trial area shall be at least 1000 (approx. 15m x 75m length) square metres and shall be laid to the specified depth for the material. It may form part of the works if so ordered by the Engineer provided it complies with the specification. Any trial areas, which do not comply with the Specification, shall be removed.

The Contractor shall allow in his programme for conducting site trials and for carrying out the appropriate tests on them. The trials on earthworks and each pavement layer shall be undertaken at least 14 days ahead of the Contractor proposing to commence full scale work on earthworks and the pavement layers.

The following data shall be ordered at each site trial:

- The composition and grading of the material, including the bitumen content and properties, if appropriate;
- If appropriate, the moisture content at the time of laying;
- If appropriate, the temperature at the time of laying and rolling;
- The type and size of compaction equipment and the number of passes;
- The maximum density or target density as appropriate and the density achieved in the trial;
- The maximum compacted thickness of layer;
- The surface levels and the surface irregularities
- Calibration of machinery for best and efficient results;
- Any other relevant information

Not less than ten sets of tests for each type of test shall be made on each 500 square meters of trial area, and provided nine out of ten sets of results meet the specified requirements for the material/work in Clause 903, the site trial shall be deemed successful. The above data recorded in the trial shall become the agreed basis on which the particular material shall be provided and processed to achieve the specified requirements.

If, during execution of the Works, the construction control type of tests indicate that the requirements for a material are not consistently being achieved, then work on that layer shall stop until the cause is investigated. Such investigation may include further laboratory and site trials on the material to determine a revised set of data, as above which, when agreed by Engineer, shall be the basis on which all subsequent material will be provided and processed to achieve the specified requirements.

Approval by the Engineer to a set of data recorded, as above in a site trial shall not relieve the Contractor of responsibility to comply with the requirements of Technical Specifications.

CLAUSE 903 QUALITY CONTROL TESTS DURING CONSTRUCTION**Clause 903.4 Tests on Bituminous Constructions**

Clause 903.4.1 Add at the end of this Clause:

(Addition) "The density test shall be carried out by 150 mm diameter core cutter machine on Dense Bituminous Macadam and Bituminous Concrete as per the frequency specified".

In Table 900-4, substitute "Tests for quality of binder as specified in relevant IS Code" under Test column for "Quality of binder".

In Table 900-4, serial No.6(xviii) for Dense Bituminous Macadam/Bituminous Macadam and for Bituminous Concrete, add the following at the end in the *Frequency* column:

"10% of the density tests shall be done on edges."

In Table 900-4, Serial No. 6 for Dense Bituminous Macadam/ Semi Dense Bituminous Concrete/Bituminous Concrete, modify the 'Frequency (Minimum)' values for Item NR. (vi), (vii) and (xv) as under:

S. No.	Type of Construction	Test	Frequency (Minimum)
6	Dense Bituminous Macadam/Semi Dense Bituminous Concrete/Bituminous Concrete	(vii) Sand Equivalent Test	Three tests on aggregates for each 400 t of mix subject to two tests per plant per day.
		(ix) Polished Stone Value (PSV)	Initially one set of three representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregates.
		(xviii) Density of Compacted Layer	One test per 250 m ² area subject to the condition that 10% of density tests shall be done near the edges.

Add the following note at the end of Table 900-4:

Note:

1. The laboratory and field tests shall be performed on materials and works at the frequency values indicated against each. The Supervision Personnel shall ensure that there are no deviations in this regard.
2. Daily, Weekly and Monthly Reports on the testing done, results obtained thereof must be prepared indicating the location of sampling and testing, deviations from the acceptance norms for materials and works and actions taken in respect of removal of defective works must be prepared by the

Contractor

Contractor and authenticated by the Supervision Personnel that these tests were done in their presence and that the testing has been carried out as per the prescribed methodology. The Supervision Personnel should also prepare a summary of all tests carried out the results obtained thereof. The Engineer-in-Charge of the Project should take full responsibility of authenticity of such reports and summary sheets.

Clause 903.4 Tests on Bituminous Constructions

Add the following Sub-Clause 904.4.3:

Clause 903.4.3 Characteristics to be tested on completed Bituminous Layers

(Addition) The characteristics to be tested on completed bituminous layers are:

- Relative compaction
- Layer thickness

For testing the above characteristics, the following sampling criteria shall apply:

(a) Random Sampling

When testing any lot, or an isolated section, which is obviously defective or exhibits abnormal variation of the characteristics under consideration, all samples shall be taken in a random pattern.

(b) Lot Size

The lot size shall normally be a section laid and compacted in one process and for which essentially the same materials had been used. Where production is on a continuous basis, a lot shall normally mean one-day production and shall not exceed two full days production. However, the Engineer for investigating compliance with the specifications may order a lot of any smaller size, if:

- The factors affecting the characteristics under investigation exhibit abnormal variation within the normal lot size;
- The area is obviously defective or of poorer quality than that of the rest;
- The rate of production is very high.

Clause 903.5.2.1 1. One sample set to be collected for each 150 cu.m of pavement

(Modification)

Concrete or part thereof shall consist of.

3 Nos. of cylinder / cubes	:	28 days Split Tension Test
3 Nos. of cubes	:	7 days testing
3 Nos. of beams	:	7 days testing
3 Nos. of cubes	:	28 days testing
3 Nos. of beams	:	28 days testing
3 Nos. of cubes	:	90 days testing/for other purposes
3 Nos. of beams	:	90 days testing/for other purposes

Contractor

2. Additional samples shall be collected if so instructed by the Engineer without extra cost.
3. Except above modification clause 903.5.2.1 will remain unchanged

**Clause 903.5.2.2
(Additional)**

Add the following sentence at end of this Clause.
The samples taken for density measurement shall cover the full depth of layer being tested.

**CLAUSE 903.5.2.4
(Modification)**

Summary of control tests :-
In table 900-6 –5(iii)
Add following
“compaction factor test IS :1199”

SECTION 1000 MATERIALS FOR STRUCTURES

CLAUSE 1007 COARSE AGGREGATES

(Addition)

Add the following at the end of the Clause:

"Primary and secondary stone crusher should be employed for getting proper size and grading of coarse aggregates."

1. The maximum value of elongation index and flakiness index for plain, reinforced and prestressed concrete should not exceed 15% each, taken separately, and not exceed 25% taken together. The flakiness and elongation index should be measured using methods as per IS:2386.
2. The alkali aggregate reactivity should be measured and reported for getting approval for the source aggregates at the beginning of the work using methods given in IS:2386. The tests may be repeated if the source changes, or if the type of rock being exploited for mining aggregates changes.
3. The water absorption limit of aggregates should not be more than 3% instead of 5% as per IS:383.

CLAUSE 1008 SAND / FINE AGGREGATES

The alkali aggregate reactivity should be measured and reported for getting approval for the source.

The table 1000.2 giving zoning limits of percentage passing various sieve sizes all both to natural sand and crushed stone / gravel sand. However for crushed stone sand the notes under table no. 4 of IS:383 –1970 shall be valid.

CLAUSE 1009 STEEL FOR PRE-STRESSING

**CLAUSE 1009.2
(Addition)**

Add (e) to the codes to which acceptable prestressing steel shall conform:

- (e) Stress relieved low relaxation seven ply strand for prestressed concrete - IS: 14268

CLAUSE 1010 WATER

(Modification) In para (C) the permissible limit for Chlorides (Cl) shall be read as "250 mg/lit for structures having length more than or equal to 30 m."

In case of structures of lengths 30m and below, the permissible limits of chlorides may be increased up to 500mg/ltr.

CLAUSE 1012 CONCRETE ADMIXTURES**CLAUSE 1012.3 (Addition)**

Add this Clause after Clause 1012.2

After selecting a few acceptable brands from MORT&H approved list of manufacturers & types of admixture based on the manufacturer's data / technical literature, independent acceptance tests should be carried out for the same using the approved combinations of cement / sand / aggregates intended for use in the Project. After establishing the basic acceptability using strength criteria (compressive & tensile strengths) a number of trial mixes be designed using different proportions of admixtures / cement / water etc. to establish the data bank on the behavior of the admixtures for the project site conditions. A spectroscopic signature of accepted product should be obtained and preserved for comparison for acceptance of the production lots.

Retrials should be conducted with change in source / type of cement.

WORKMANSHIP

The dosage should be finalised on the basis of field trial and special mechanical devices should be used for dispensing the admixture in the batching / mixing plant. No addition of admixture after initial dosage is permitted (including addition in transit mixers).

Manufacturer's experts should be available for consultation / troubleshooting of problems associated with their product. The conditions of storage, shelf life etc. as specified by the manufacturer should be strictly observed. The manufacturer's Quality Assurance Plan during process of production should be obtained and filed for reference / record.

CLAUSE 1013 REINFORCED CONCRETE PIPES

(Replacement) In place of existing para, substitute the following:

Reinforced concrete pipes for highway structures shall be of the class specified by the designer for the particular application. In absence of such specification, the class shall be NP 4 type conforming to the requirements of IS : 458.

CLAUSE 1014 STORAGE OF MATERIALS**Clause 1014.3 Aggregates**

(Addition) The following shall be added to this Clause:

"Aggregates shall be stored or stockpiled in such a manner that segregation of fine and coarse sizes will be avoided and also that the various sizes will not become intermixed before proportioning. They shall be stored, stockpiled and handled in such a manner that will prevent contamination by foreign materials."

SECTION 1100

PILE FOUNDATIONS

**CLAUSE 1101
(Addition)**

GENERAL

- Piling work shall be cast-in-situ bored piles of diameter as shown on the drawing. Boring / drilling, socketing of piles shall be done by using hydraulically operated rotary drilling machines only.
- M.S. Liner shall be provided to all piles of thickness as shown on drawing and painted with coal tar epoxy paint on outer face i.e. face in contact with earth.

**CLAUSE 1118
(Addition)**

MEASUREMENTS FOR PAYMENT

Boring for piling, concreting of piles, reinforcement in piles and M.S.Liner to be measured and will be paid separately as per relevant items of Bill Of Quantities.

**CLAUSE 1119
(Addition)**

RATE

Cost of pile concrete includes cost of initial and routine test on pile and no separate payment will be paid for these tests.

SECTION 1500

FORMWORK

CLAUSE 1503

DESIGN OF FORMWORK

Clause 1503.2

Add the following at the end of this Clause :

"For distribution of load and load transfer to the ground through staging, an appropriately designed base plate must be provided which shall rest on firm sub-stratum."

**CLAUSE 1505
(Substitute
clause)**

FORMED SURFACE AND FINISH

Substitute the following clause in place of the existing clause:

Formed & Unformed Surface Finishes

The surface finishes for formed and unformed surfaces are classified and defined as below. Surface irregularities permitted for the various classes of finishes are termed either 'abrupt' or 'gradual'. Fins or offsets caused by displaced or misplaced form sheeting, lining or form sections, by loose knots in form lumber or by otherwise defective form lumber are considered abrupt irregularities. All other cases are described as gradual irregularities. Gradual irregularities will be measured with a template consisting of a straight edge for plan surfaces or its equivalent for curved surfaces. The length of template for testing gradual irregularities on formed surfaces shall be 1.5 m in length, the permissible gradual irregularities being measured over this length of the template.

Finish F1, F2 and F3 shall describe formed surfaces.
Finish U1, U2 and U3 shall describe unformed surfaces.

Class F1 Finish

This class of finish shall apply to all formed surfaces for which class F2 or F3 is not specified. It shall generally be formed by sawn timber formwork/timber frame or steel frame mounted with plywood or steel sheet. It shall be so constructed that there shall be no loss of material from the concrete during placement and compaction. After hardening, the concrete shall be in the required positions and shall have the shape and dimensions called for in the drawings. Any abrupt irregularities shall not exceed 10mm. All fins and drifts in excess of the above limits shall be made good by chipping and grinding if required by the Engineer-in-Charge. Small blemishes caused by entrapped air or water may be expected but the surface shall be free from voids, honeycombing or other large blemishes. Class F1 finish shall be generally specified for all surfaces buried in ground or not visible during service or for surfaces that are to receive further rendering treatment such as plastering etc. Unless otherwise specified in the item of Bill of Quantity the surface finish shall be understood to be Class F1.

Class F2 Finish

Class F2 finish shall be obtained by the use of properly designed forms, either close jointed wrought timber forms or with forms having plywood or steel sheet lining. The abrupt irregularities shall not exceed 5mm and gradual irregularities shall be less than 8mm. Small blemishes caused by entrapped air or water may be permitted but the surface shall be generally free from honeycombing, voids and large blemishes. Surface irregularities in excess of those stipulated shall be removed by chipping or rubbing with abrasive stone.

Class F3 Finish

Class F3 finish shall be formed by specially designed close jointed rigid forms having lining of high quality form plywood. The surface irregularities shall be limited to nil for abrupt irregularities and 3 mm for gradual irregularities. Class F3 finish may be obtained from class F2 finish by carefully removing all abrupt irregularities including fins and projections by rubbing/grinding. If steel forms are used they shall have steel sheet backing faced with plywood.

In addition, finish F3 shall include filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include clean up of loose and adhering debris. For a sack rubbed finish, the surface shall be prepared within two days after of removal of the forms. The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part cement to one and one half parts by volume of fine (I.S. No. 16 mesh) sand. Only sufficient mixing water to give the mortar a workable consistency shall be used. The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids. The mortar in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean with clean burlap such that all air holes etc. are filled and the entire surface presents a uniform appearance without air holes, irregularities etc.

Class U1 Finish

This is the screeded finish used on surfaces over which other finishes such as wearing coats etc. are to be placed. It is also the first step in the formation of U2 and U3 finishes. The finishing operation consists of levelling and screeding the concrete to produce an even and uniform surface so that the gradual irregularities are not

greater than 5 mm. Surplus concrete should be removed immediately after consolidation by striking it off with a sawing motion of a straight edge or template across a wooden or metal strip that has been set as guide. Unless the drawings specify a horizontal surface or show the slope required, the tops of narrow surfaces, such as stair treads, walls, curbs and parapets shall be sloped approximately 10 mm per 300 mm width. Surfaces to be covered with concrete topping, terrazzo, and similar surfaces shall be smooth screeded and levelled to produce even surfaces, irregularities not exceeding 5mm.

Class U2 Finish

This is a floated finish used on all outdoor unformed surfaces not prominently exposed to view such as tops of piers etc. The floating may be done by hand or power driven equipment. It should not however be started until some stiffening has taken place in the surface concrete and the moisture film or 'shine' has disappeared. The floating should work the concrete no more than is necessary to produce a surface that is free from screed marks. All joints and edges should be finished with edging tools. It shall include the repair of gradual irregularities exceeding 5 mm. All abrupt irregularities shall also be repaired unless a roughened texture is specified.

Class U3 Finish

This is a trovelled finish used on all surfaces exposed to view at close quarters such as tops of parapets and kerbs etc. Steel trovelling should not be started until after the moisture film and 'shine' have completely disappeared from the floated surface and the concrete has hardened enough to prevent an excess of fine material and water from being worked to the surface. Excessive trovelling, especially if started too soon, tends to produce crazing and lack of durability. Too long a delay will result in a surface too hard for proper finishing. Steel trovelling should be performed with a firm pressure that will flatten and smooth the sandy surface left by floating. Trovelling should produce a dense, uniform surface free of blemishes, ripples and trovel marks. It shall include the repair of all abrupt irregularities and the repair of gradual irregularities exceeding 5 mm. It shall also include finishing the joints and the edges of concrete with edging tools.

CLAUSE 1509 RE-USE OF FORMWORK (Substitution)

This Clause shall read as under:

"After forms are stripped, all materials shall be examined for any damage and damaged pieces, if any, shall be removed either as rejected or for rectification if possible. The materials found fit to be reused shall be thoroughly cleaned. Holes bored through sheathing for form ties shall be plugged by driving in common corks or foamed plastics. Patching plaster may also be used to fill small holes. After cleaning and before re-fixing, each formwork shall be got approved from the Engineer.

Form work and staging shall be so used as to ensure quality of the exposed surface. If in the opinion of the Engineer, any particular panel/member has become unsatisfactory for use at any stage, the same will be rejected and removed from site."

Clause 1514 SPECIAL ARCHITECTURAL FINISHES (Additional Clause) Materials

Contractor

Where special architectural finishes have been specified which require special patterns, grooves, ridges, surface finishes etc., and which are to be obtained by casting concrete against forms, need specially designed forms and special finishing using suitable materials. These forms can be made from materials specified in IRC-87, relevant IS codes with special workmanship/controls. Use of any other material is to be permitted only after specific written approval from the Engineer.

Design and Workmanship, Removal, Protection and Reuse

The design and workmanship of these formwork has to be got approved from the Engineer. The method of removing formwork without damaging the 'form-finished' surface, use of de-bonding agents, the protection and repair of forms and forms-surfaces, and limit on re-use etc. are to be as per specification/drawings in absence of which the proposed details are to be got approved from the Engineer. All such methods will have to be suitably improved based on the result of mock-up or field use. The final procedure and details shall be improved till the specified/desired architectural finish is obtained.

Mock-up

After design and before incorporation in the main work, the effectiveness and success in achieving the desired finish has to be demonstrated/confirmed by casting the mock-up. The approved 'mock-up' surface shall be retained till the end of the project and then the 'mock-up' should be dismantled/removed from the work site and disposed off as directed by the Engineer.

Measurement and Payment

The measurement and payment for these items will be as specified in BOQ.

Clause 1515 (Additional Clause) TOLERANCES

All works shall be carried out true to the lines, levels and grades shown on the drawings and within the tolerances specified below. The forms shall be so designed and erected that the following tolerances are not exceeded unless more stringent and specific specifications have been required by the design and specified in the drawings/instructions. The contractor shall establish, erect and maintain in an undisturbed condition until final completion and acceptance of the project, control points and bench marks necessary and adequate to establish these tolerances.

	<i>Element</i>	<i>Limits</i>
-	For all elements, departure from established alignment	10 mm
-	Departure from established grades	10 mm
-	Variation from plumb or specified batter in lines and surfaces of piers, walls and abutments	10mm in 3 m. if exposed 20mm in 3 m. if backfilled
-	Variation from level or indicated grade in slabs, beams, horizontal and railing offsets	10mm in 3 m. if exposed 20mm in 3 m. if backfilled.
-	Variation in cross sectional dimensions of columns, piers, slabs, walls, beams and similar	-5mm, + 10mm

Contractor

	parts	
-	Variation in slab thickness	-5mm, + 10mm
-	<u>Footings:</u>	
	Plan dimensions	-15mm, + 30mm
	Misplacement or eccentricity	2% of footing width in the direction of displacement and not exceeding 30mm.
	Reduction in thickness	5% of specified thickness unless specified to be more stringent.
-	Variations in size and locations of slab or wall openings	10mm
-	The Alignment Tolerances shall be as under:	
	Tolerance in direction where 'd' is the dimension of members	
	Member with a depth of upto 200 mm	$\pm d/40$
	More than 200 mm	5 mm

SECTION 1700 STRUCTURAL CONCRETE

CLAUSE 1704 PROPORTIONING OF CONCRETE

(Addition)

Add the following at the end of this clause:

“In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the manufacturer’s weight per bag, 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.

It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined as frequently as possible; frequency for a given job being determined by the Engineer according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. The determination of moisture content in the aggregates shall be done as per IS: 2386 (Part III). Suitable adjustments shall also be made in the weight of aggregates to allow for the variation in weight of aggregates due to variation in their moisture content.”

Contractor

Clause 1704.4 Additional requirements

(Modification) In para (a) substitute “0.06%” for “0.1%”, “0.06%” for “0.2%”; and “0.1%” for “0.3%” for the three items respectively.

CLAUSE 1705 ADMIXTURES

(Substitution) This Clause shall read as under:

“Duly tested admixtures/additives conforming to IS: 6925 and IS: 9103 (without replacement of cement) may be used subject to satisfactory proven use, with the approval of the Engineer. Admixtures generating Hydrogen or Nitrogen and containing chlorides, nitrates, sulphides, sulphates and any other material liable to affect the steel or concrete shall not be permitted.

The general requirements, physical and chemical requirements shall be as per Clause 1012.

Admixtures shall be procured only from manufacturers approved by MORT&H”.

SECTION 1800 PRESTRESSING**Clause 1802.2 SHEATHING**

(Substitution) For all PSC members, Corrugated High Density Poly Ethylene – HDPE sheathing in compliance with the provisions in Clause No. 3.6.2 of IRC : 18 – 2000 shall be used.

Sheathing diameter will be as specified in the drawings.

Clause: :1802.2.3 (Addition)

Cables shall be threaded after concreting. In such cases a temporary tendon shall be inserted in the sheathing, or the sheathing shall be stiffened by other suitable method during concreting. The sheathing supports shall be provided in such an interval so as to prevent floatation of empty cable duct during concreting.

CLAUSE:1803 TESTING OF PRESTRESSING STEEL AND ANCHORAGES (Addition)

Add following Paragraph to the section.

Testing of cable sheathing ducts shall be carried out as per different tests specified in Appendix I-A of IRC : 18 – 2000. In addition to these tests, additional acceptance tests for HDPE sheathing shall be carried out as per provisions in Appendix I- B.

TESTING OF CABLE -ANCHORAGE ASSEMBLY

Testing of anchorage - cable assemblies shall be carried out in accordance with procedures in FIP document “Recommendation for the acceptance of Post Tensioning Systems” - June 1993.

All the tests shall be carried out in any approved laboratory. Contractor is required to produce testing certificate.

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The frequency of such tests should be as follows :

The manufacturers certificate together with the data of previously conducted and most recent test results of "Acceptance Testing" is acceptable subject to further testing as given below.

Acceptance Testing for the works

a) Static load test for tender-anchorage assembly

A series of three tests using the proposed combination of anchorage systems and the prestressing strand / wire / bars. All the tests should meet the following requirements.

- Residual deformations of anchorage components after the test should confirm the reliability of the anchorage.
- The increase in the displacements between the anchorage components as well as between the prestressing steel and anchorage components should not be disproportionate to the increase in tendon force.
- The above relative displacements during the $0.8F_{pk}$ load stage should stabilise within the first thirty minutes of the load duration of 1 hour.
- The mode of failure of tendon should be by the fracture of the prestressing steel. Failure of the tendon should not be induced by the failure of anchorage components.
- The measured anchorage efficiency should be :

$$nA = \frac{F_{Tu}}{F_{pm}} \geq 0.95$$
 (Refer CEB/FIP Guidelines for details).
- The total elongation ϵ_U in free length of the tendon under the load F_{tu} should be $\epsilon_U \leq 2\%$.

b) Dynamic load test with tendons / in charge assembly

This test is to be carried out for every new combination of type of anchorage and tendons. Satisfactory test results carried out in independent laboratories in previous 5 years with the same combinations are available and further provided that there is no known knowledge of distress or other reasons such as change in the materials / method of manufacture / source of actual manufacture etc., can be accepted at the discretion of the Engineer. Otherwise a series of Three successful tests should be carried out for acceptance of the systems. This test is considered as essential for both unbonded and bonded cables as per FIP document.

Requirements :

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Each test result should meet the following requirements

- Fatigue failure of anchorage components should not occur
- The minimum fatigue strength of a post-tensioning system should be $\sigma_{pmin} = 80 \text{ MPa}$

The fatigue strength is defined as the stress range σ_p which is endured for 2 million cycles without failure of more than 5% of the initial cross-section of the tested tendon at beginning of the test.

c) Load Transfer Test

A series of these successful tests should be carried out for acceptance of the system

Requirements :

- Crack width upon first attainment of upper force $0.8 F_{pk}$ (load point 4) should be [0.10 mm.]
- Crack width upon last attainment of lower force $0.12 F_{pk}$ (load point n-1) should be [0.10 mm.]
- Crack width upon final attainment of upper force $0.8 F_{pk}$ (load point n) should be [0.25 mm.]
- Readings of longitudinal and transverse strains should have stabilised during cyclic loading. The strains can be assumed to have stabilised if the increase of strain in the last two load cycles is less than 5%.
- Readings of crack widths should have stabilised during cyclic loading. The crack widths can be assumed to have stabilised if the crack width does not increase by more than 0.02 mm in the last two load cycles.
- The measured failure load F_u must meet each of the following requirements :

$$F_u \geq F_{pk} \frac{f_{cm,e}}{f_{ck,o}} \text{ and } F_u \geq 1.1 F_{pk} \text{ (Refer CEB / FIP Guidelines for details).}$$

CLAUSE : 1804

WORKMANSHIP

Clause :1804.5

Protection of Prestressing Steel

(Addition)

Insert following para after 1st Para

Mixture of water-soluble oil such as Dromas – B and Water is to be flushed through

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empty metallic ducts before threading of cables, and after threading of cable at frequency of at least once in a month. The layer of oil formed on sheathing / prestressing steel shall be fully flushed out by using clean water before final grouting by cement grout.

Clause :1804.10

Sheathing Duct Drawings

(New)

In case of unavailability of sheathing joints, such joints shall be made cement slurry tight by the use of corrugated threaded sleeve couplers which can be tightly screwed on to the outer side of sheathing ducts. A heat shrink coupler could be used if suitable. In addition to these details, the details specified in Appendix – 2 of IRC : 18-2000 shall be used.

CLAUSE 2000

BEARINGS

**CLAUSE 2002
(Addition)**

General

Type of bearings to be used shall be as shown on approved drawing. Bearings shall be procured from the manufacturers approved by MORT&H. It shall be as per IRC : 83 (Latest) and MORT&H Specification.

Based on the load data, detailed design and drawings shall be prepared by the Contractor in compliance with various provisions in IRC : 83 (Latest) and got approved from Engineer

All the bearings shall be manufactured and tested as per IRC:83 (Latest) provisions.

CLAUSE 2509

MEASUREMENTS FOR PAYMENT

(Modification)

Replace Para 4 by “ The filter media and pitching Shall be measured together in Sq. m. area of pitching”.

Clause 2510

RATE

(Modification)

Replace line 1 and 2 of para 3 by “The contract unit rate for one Sq. m of Stone pitching Shall include cost of filter media including cost of preparing”.

SECTION 2600

EXPANSION JOINTS

**CLAUSE:2602
(Addition)**

GENERAL

Type of Expansion Joint to be used shall be as shown on approved drawing. Expansion Joints shall be procured by the manufacturers approved by MORT&H.

The MORT&H has issued modified interim specifications for expansion joints vide letter dated 31/03/1997 and revised vide letter dated 17/07/1997. These specifications are also included vide following modifications.

**TABLE R - 1
SUITABILITY CRITERIA FOR**

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ADOPTION OF DIFFERENT TYPES OF EXPANSION JOINTS

Sr. No.	Type of Expansion	Suitability for adoption joint	Expected Service Life	Special Consideration
1.	Buried Joint	Simply supported spans Upto 10 metres.	10 years	Only for decks with bituminous / asphaltic wearing coat. Steel plate may need replacement, if found corroded or distorted at the time of relaying / renewal of wearing coat.
2.	Filler Joint	Fixed end of simply supported spans with insignificant movement or simply supported spans not exceeding 10 metres.	10 years	The sealant and joint filler would need replacement if found damaged.
3.	Asphaltic Plug Joint	Simply supported spans or right or skew (Upto 20 degree), moderately curved or wide deck with maximum horizontal movement not exceeding 25 mm. Ambient temperature should be in the range of 5 degree to 50 degree Celsius.	10 years	Only for decks with bituminous / asphaltic wearing coat. Not suitable for bridge with longitudinal gradient more than 2 % and cross camber / super-elevation exceeding 3%. Not suitable for curved spans and spans resting on yielding supports.
4.	Compression Seal Joint* (Chloroprene Seal & Cell Foam Seal)	Simply supported for continuous spans right or skew (Upto 30 degree), moderately curved with maximum horizontal movement not exceeding 40 mm.	10 years	Chloroprene / Closed Form Seal may need replacement during service.
5.	Elastomeric Slab Seal Joint*	Simply supported or continuous spans, Right or skew (less than 20 degree), moderately curved with maximum horizontal movement Upto 50 mm.	10 years	Liable to excessive wear and tear under high traffic intensity. Not suitable for bridges located in heavy rainfall area and spans resting on yielding support.
6.	Single strip seal joint *	Moderate to large simply supported, cantilever /	25 years	Elastomeric seal may need replacement during service.

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Sr. No.	Type of Expansion	Suitability for adoption joint	Expected Service Life	Special Consideration
		continuous construction having right, skew or curved deck with maximum horizontal movement Upto 70 mm		
7.	Modular Strip / Box Seal Joint	Large to very large continuous / canti-lever construction with right, skew or curved deck having maximum horizontal movement in excess of 70 mm.	25 years	Elastomeric seal may need replacement during service.
8.	Special Joints for special conditions	For bridges having wide decks / span length of more than 120 m or / and involving complex movements / rotations in different directions / planes, provision of special type of modular expansion joints such as Swivel joints joints may be made	25 years	Elastomeric seal may need replacement during service. Provision of these joints may be made with prior approval of the Ministry.
* - These are proprietary items for which 10 years warranty shall be insisted upon from the suppliers.				

Deletion

Delete Paragraphs (c), (d) and (e) from the original draft of specifications under clause 2602.

**CLAUSE :2604
(Modification)**

STEEL PLATE SLIDING EXPANSION JOINTS

Clause 2604 of MORT&H Specification for Road & Bridge Works (Third Revision) may be deemed modified as under :

**Clause :2604.1
(Substitution)**

I. BURIED JOINT

- a) This joint shall consist of continuously laid bituminous / asphaltic surfacing over the joint gap bridged by a steel plate resting freely over the top surface of the deck concrete.
- b) The width of the joint gap shall be kept as 20 mm.
- c) The steel plate shall conform to weldable structural steel as per IS:2062.

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The plate shall be 12 mm thick and 200 mm wide. The plate shall be made of minimum number of pieces (not exceeding two pieces per traffic lane width) welded together to form the required length.

- d) 8 mm dia, 100 mm long nails, spaced at 300 mm centres along the centre line of the plate shall be welded to the bottom surface of the steel plate to protrude vertically into the joint gap in order to prevent dislodging of the plate.
- e) The plate and the nails shall be protected against corrosion by galvanising thickness of 100 micron. These shall be completely free of oil, rust, loose paint or other similar material before application of anticorrosive coating.
- f) The concrete surface shall be free from any loose material and cleared of any grease, oil, paint etc. and the surface shall be sand blasted, clean of all laitence and level true, prior to placement of the steel plate.
- g) The plate shall be placed symmetrical to the centre line of the joint and it shall be ensured that the plate does not get displaced from its position while laying the wearing course.

Clause:2604.2
(New)

II. ASPHALTIC PLUG JOINT

Clause:2604.2.1

Asphaltic plug joint shall consist of a polymer modified bitumen binder, carefully selected single size aggregate, closure / bridging metallic plate and head resistant foam caulking / backer rod.

Clause:2604.2.2

General Requirements

- a) The joints shall extend to the full depth of the wearing course down to structural concrete. Where needed, a recess may be cut into the deck slab concrete to accommodate the minimum required depth of the joints.
- b) The joint shall be provided in the entire width of the structure including kerb and / or footpath. A recess in the kerb and / or footpath shall be made to allow the joint to pass beneath them. The expansion gap in the adjoining kerb and / or footpaths shall be sealed with a suitable sealant such as polysulphide sealant.
- c) Expansion joint shall cater for a horizontal movement of 25 mm & vertical movement of 2 mm. This shall be certified by the manufacturer / supplier of the joint.
- d) The minimum width (in traffic direction) of the joint shall be 500 mm and maximum width shall be 750 mm.
- e) Minimum depth of joint shall be 75 mm and maximum depth shall not

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exceed 100 mm.

- f) The joint shall be capable of performing satisfactorily, within the temperature (ambient) range of – 5 to + 50 degree C.

Clause:2604.2.3

Material

- a) Binder :

The polymer modified bitumen binder shall have the capacity to fill the gaps and voids between single size aggregate and to impart flexibility to accommodate various design movements. It shall be patented blend of bitumen, synthetic polymer, fillers and surface active agent and shall satisfy following requirement :

Softening point	:	100 deg. C minimum
Core penetration at 25 deg C, (0.1 mm (BS2499)	:	100 mm maximum
Flow resistance at 70 deg. C 5 hours (BS 2499)	:	3 mm maximum
Extension Test (blocks prepared to ASTM D 1190 and tested to limits BS 2499)	:	5 cycle of extension to 50 per cent at a rate of 3.2 mm / h at 25 deg.
Safe heating temperature	:	210 deg. C

- b) Aggregates :

The aggregate shall be single size aggregate chosen from basalt granite, grit stone or gabro group. The nominal size of aggregate shall be 12.5 mm for depths of joints Upto 75 mm and 20 mm for joints of more depths of joint. The aggregate shall not be flaky and the Flakiness Index shall not be more than 25 percent. The aggregate shall satisfy following grading requirements:

IS Sieve Designation	Nominal size of aggregate	
	20 mm	12.5 mm
	percent by weight passing the sieve	
26.5 mm	100	--
19.0 mm	85-100	100
13.2 mm	0-35	85-100
09.5 mm	0-7	0-35
06.3 mm	--	0-7

02.3	0-2	0-2
600 micron	---	---
75 micron	0-1	0-1

The aggregate should have good (i) Polished Stone Value (PSV), (ii) Aggregate Abrasion Value (AAV), Aggregate Impact Value (AIV) and (iii) Aggregate Crush Value (ACV). In addition surface characteristics should promote proper adhesion. The following are the required values :

PSV > 60
AAV < 05
AIV < 18
ACV = 10 – 25

c) Closure Plate :

The closure plate shall be weldable structural steel conforming to IS 2602. The minimum thickness of steel plate shall be 6 mm and the width shall not be less than 200 mm. Closure plate shall be provided with as large length as possible and welded together to form the required length. The number of pieces shall not be more than two per traffic lane width. It shall be provided with equidistant holes at a maximum spacing of 300 mm centres for anchorage to the caulking / backer rod along the longitudinal centre line of the plate. The plate shall be protected against corrosion by galvanising or any other approved anti-corrosive coating paint with a minimum thickness of 100 micron.

d) Foam caulking / Backer rod

A closed-cell polyolefine or open cell polyurethane foam cylindrical caulking or backer rod having diameter equal to 150 percent of the joint opening shall be provided. It shall be heat resistant and possess good flexibility and recovery characteristics with density of 25 to 30 Kg / Cum.

Clause:2604.2.4

Installation

- a) The Expansion joint shall be installed by the manufacturer / supplier.
- b) The block out for the joint shall be marked and constructed to the dimensions as indicated in the drawing or recommended by the manufacturer / supplier.
- c) The recess for the block out shall be thoroughly cleaned of any loose or foreign material wire brushing and air blowing and dried with hot

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- compressed air.
- d) The recess in the deck slab, if required, shall be repaired with epoxy mortar and cleaned and dried again.
 - e) The foam caulking / backing rod shall be placed about 25 mm down in the point opening.
 - f) The aggregate shall be washed, cleaned and heated to a temperature between 120 – 180 deg. C prior to placement.
 - g) The binder shall be preheated to temperature of 170 – 190⁰C before application.
 - h) While sealing the joint opening with preheated binder, care shall be taken that the binder does not spill on to the joint surface of the deck.
 - i) The joint shall not be installed when the ambient temperature goes below + 5 deg. C or above + 35 deg. C or while it is raining / snowing. (Planning for installation must take in to account the weather condition).
 - j) When clement weather resumes, the joint installation may be continued after the upper layer and or / exposed surface of the partially completed joint has been re-prepared by heating and / or coating with binder as necessary.

Clause:2604.2.5**Handling and Storage**

All the aggregates and binder shall be pre-bagged and clearly marked. All the material shall be stored on concrete platform at 150 mm above the ground in covered enclosures to avoid contamination.

Clause:2604.2.6**Test and Standard of Acceptance**

The material shall be tested in accordance with these specifications and shall meet prescribed criteria. The manufacturer / supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

**Clause:2604.3
(New)****III. COMPRESSION SEAL JOINT****Clause:2604.3.1**

Compression seal joint shall consist of steel armoured nosing at two edges of the joint gap suitably anchored to the deck concrete and a performed chloroprene elastomer or closed cell foam joint sealer compressed and fixed in to the joint gap with special adhesive binder.

Clause:2604.3.2**Material**

- a) Steel nosing

The steel nosing shall be of angle section ISA 100 x 100 conforming to weldable structural steel as per IS:2062. The thickness of legs shall not be less than 12 mm. The top face of the angle shall be provided with Bleeder holes of 12 mm diameter spaced at a maximum 100 mm centres so as to

ensure that there are no voids in the concrete beneath the angle.

b) Anchorage

The anchorage steel shall conform to IS:2061 or equivalent.

The steel nosing shall be anchored to the deck by reinforcing bars, headed studs or bolts or anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or anchor loops this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12 mm. Total cross sectional area of bars, studs or bolts on each side of the joint shall not be less than 1600 mm sq. per Metre length of the joint and the centre to centre spacing shall not exceed 250 mm. The ultimate resistance of anchorages shall not be less than 500 KN/m in any direction.

c) Corrosion Protection

All steel section shall be protected against corrosion by hot dip galvanising or any other approved anticorrosive coating with a minimum thickness of 100 micron.

d) Joint Seal

i) The sealing element shall be performed continuous chloroprene or closed cell foam seal with high tear strength, insensitive to soil, gasoline and ozone. It shall have high resistance to gain and ensure water tightness. The seal should be vulcanised in a single operation for the full length of the joint required for carriageway, kerbs and footpaths, if any. The seal shall cater for a horizontal movement Upto 40 mm and vertical movement of 3 mm.

ii) The physical properties of chloroprene / closed cell foam sealing element shall conform to the following :

Chloroprene Seal

Shall be performed extruded multi web cellular section of chloroprene of such a shape as to promote self removal of foreign material during normal service operation. Chloroprene of joint seal shall conform to clause 915.1 of IRC : 83 (Part-II) and satisfy the properties stipulated in Table – 2. Strip Seal Element Specifications of these specifications except in respect of the working movement range of the sealing element which shall be as specified in clause 2.4.1 above.

Closed Cell Foam Seal

Shall be of performed non extruded on cellular section made from

low density closed cell, cross linked ethylene vinyl acetate, polyethylene copolymer that is physically brown using nitrogen. The material shall poses properties as indicated in the Table.

Table – 1

	Property	Specified Value
viii)	Density	41.7-51.3 Kg / Cu.m
ix)	Compression Set on 25 mm	50 percent compression samples (ASTM D3575) for 22 hours at 23 degree Celsius, 2 hour recovery; 13 percent set.
x)	Working temperature	-70 to + 70 deg. C
xi)	Water absorption (total immersion for 3 months) (ASTM D3575)	0.9766 Kg / Sqm.
xii)	Tensile strength	0.8 Mpa
xiii)	Elongation at break (ASTM D3575)	195 ± 20 percent

e) Lubricant cum Adhesive

The type and application of material used in bonding the performed joint seal to the steel nosing and concrete shall be as recommended by the manufacturer / supplier of the seal system.

Clause:2604.3.3 Handling and Storage

- a) The expansion joint materials shall be handled with care and stored under cover.
- b) All joint material and assemblies shall be supported to maintain true shape and alignment during transportation and storage.

Clause:2604.3.4 Installation

- a) The expansion joint shall be installed by the manufacturer / supplier or their authorised representative, who will ensure compliance of installation procedure and instructions.
- b) The dimension of the joint recess and the width of the gap shall conform to the approved drawing.
- c) Anchoring steel shall be welded to the main reinforcement in the deck maintaining the level and alignment of the joint.
- d) Concreting of pocket / recess shall be done with great care using proper mix

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conforming to same grade as that of the deck concrete but not less than M30 grade in any case. The water cement ratio shall not be more than 0.40. If needed, suitable admixtures may be used to achieve the workability. The width of pocket shall not be less than 300 mm on either side of the joint. Care shall also be taken to ensure efficient bonding between already cast / existing deck concrete and the concrete in the joint recess.

- e) At the time of installation, joint shall be clean and dry and free from spalls and irregularities which might impair a proper joint seal.
- f) Concrete or metal surfaces shall be clean, free of rust, laitance, oils, dirt, dust or other deleterious materials.
- g) The lubricant cum Adhesive shall be applied to both faces of the joint and joint seal prior to installation in accordance with the manufacture's instructions.
- h) The joint seal shall be compressed to the specified thickness for the rated joint opening and ambient temperature at the time of installation which shall be between + 5 to + 35^o C.
- i) The joint seal shall be installed without damage to the seal. Loose fitting or open joints shall not be permitted.

Clause:2604.3.5

Acceptance Criteria

- a) All steel elements shall be furnished with corrosion protection system.
- b) For the joint seal the acceptance test shall conform to the requirements stipulated in Para 2.4. The manufacturer / supplier of this type of joint shall produce a test certificate to this effect conducted in a recognised laboratory in India or abroad.
- c) Prior to acceptance 25 percent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25 mm above the highest point of deck. The width of ponding shall be atleast 50 mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25 mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

Clause:2604.3.6

Tests and Standards of Acceptance

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacturer / supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

**CLAUSE:2607
(Replacement)**

Clause:2607.1

IV. STRIP SEAL EXPANSION JOINT

Components

Strip seal expansion joint shall comprise the following items :

Contractor

a) Edge Beam

This shall be either extruded or hot rolled steel section or cold rolled cellular steel section with suitable profile to mechanically lock the sealing element in place throughout the normal movement cycle. Further the configuration shall be such that the section has a minimum thickness of 6 mm all along the cross section. The minimum height of the edge beam section shall be 75 mm.

b) Anchorage

Edge beams shall be anchored to the deck by reinforcing bars, headed studs or bolts or anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or loops, this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12 mm. Total cross sectional area of bar studs or bolts on each side of the joint shall not be less than 1600 mm² per Metre length of the joint and the centre to centre spacing shall not exceed 250 mm. The ultimate resistance of anchorages shall not be less than 500 KN/m in any direction.

Clause:2607.2**Material**

- a) The steel for edge beams shall conform to any of the steel grade corresponding to RST 37-2 or 37-3 (DIN), ASTM A36 or A588, CAN/CSA Standard G 40.21 Grade 300 W or equivalent.
- b) Anchorage steel shall conform to IS : 2062 or equivalent.
- c) All steel sections shall be protected against corrosion by hot dip galvanising or any other approved anticorrosive coating with a minimum thickness of 100 micron.
- d) Chloroprene of strip seal element shall conform to Clause 915.1 of IRC : 83 (Part-II). The properties of chloroprene shall be as specified in Table – 1.

Clause:2607.3**Fabrication (Pre-installation)**

- a) The strip seal joint system and all its component parts including anchorages

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shall be supplied by the manufacturer / system supplier.

- b) The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformation (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is to be installed, the gap dimension shall be preset.

TABLE – R 2 – STRIP SEAL ELEMENT SPECIFICATION

Sealing element is made of chloroprene and must be extruded section. The working movement range of the sealing element shall be at 70 mm.

PROPERTY	SPECIFIED VALUE
Hardness *	63 ± 5 Shore A
DIN 53505	55 ± 5 Shore a
ASTM D 2240 (Modified)	
Tensile Strength *	Min 11 MP
DIN 53504	Min 13.8 Mpa
ASTM D 412	
Elongation at fracture *	Min 350 per cent
DIN 53504	Min 250 per cent
Tear Propagation Strength	
Longitudinal	Min 10 N/mm
Transverse	Min 10 N/mm
Shock Elasticity	Min 25 per cent
Abrasion	Min 220 Cum.
Residual Compressive Strain	
(22 h / 70 deg C/30 per cent strain)	Max 28 per cent
Ageing in hot air (14 days / 70 deg. C)	
Change in hardness	Max ± 7 Shore A
Change in tensile strength	Max – 20 per cent
Change in elongation at fracture	Max – 20 per cent
Ageing in ozone	
(24 h/50 pphm/25 deg	No cracks
C/20 per cent elongation	
Swelling behavior in Oil (168h/25 dec. C)	
ASTM Oil No. 1	
Volume Change	Max + 5 per cent
Change in hardness	Max – 10 Shore A
ASTM Oil No. 3	
Volume Change	Max + 25 per cent
Change in hardness	Max – 20 Shore A
Cold Hardening Point	Max – 35 deg. C

* Only one set of specifications viz. ASTM or DIN shall be followed depending on the source of supply.

- c) Each strip seal expansion joint system shall be fabricated as a single stage construction or excessive length prohibits monolithic

fabrication. It shall fit the full width of the structure as indicated on the approved drawing. The system shall be pre-set by the manufacturer prior to transportation. Prestressing shall be done in accordance with the joint opening indicated on the drawing.

- d) The finally assembled joint shall then be clamped and transported to the work site.

Clause:2607.4**Handling and Storage**

- a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.
- b) The manufacturer / supplier shall supply either directly to the Engineer or to the Bridge Contractor all the materials of strip seal joints including sealants and all other accessories for the effective installation of the jointing.
- c) Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding.

Clause:2607.5**Installation**

- a) The joint shall be installed by the manufacturer / supplier or their authorised representative who will ensure compliance to the manufacturer's instructions for installation.
- b) Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surfaces of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.
- c) The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be rigid and firm.
- d) Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.
- e) The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be leveled and finally aligned and the anchorage steel on one side of the joint welded to the exposed reinforcement bars of the structure. Upon

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completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.

- f) High quality concrete shall then be filled into the recess. The packing concrete must feature low shrinkage and have the same strength as that of the superstructure, but in any case not less than M-35 grade. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.
- g) The neoprene seal shall be field installed in continuous length spanning the entire roadway width. To ensure proper fit of the seal and enhance the ease of installation, dirt, spatter or standing water shall be removed from the steel cavity using a brush, scrapper or compressed air. The seal shall be installed without any damage to the seal by suitable hand method or machine tools.
- h) As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from the site traffic. Expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.
- i) The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing / wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

Clause:2607.6

Acceptance Criteria

- a) All steel elements shall be finished with corrosion protection system.
- b) For neoprene seal, the acceptance test shall conform to the requirements stipulated in Table – 1. The manufacturer / supplier shall produce a test certificate accordingly, conducted in a recognised laboratory, in India or abroad.
- c) The manufacturer shall produce test certificates indicating that anchorage system had been tested in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic loading.
- d) Prior to acceptance 25 percent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a

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minimum period of 4 hours for a depth of 25 mm above the highest point of deck. The width of ponding shall be at least 50 mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25 mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

- e) As strip seal type of joint is specialised in nature, generally of the proprietary type, the manufacturer shall be required to produce evidence of satisfactory performance of this type of joint.

Clause:2607.7

Tests and Standards of Acceptance

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacturer / supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

**CLAUSE 2609
(Addition)**

MEASUREMENTS FOR PAYMENT

Replace this Clause by "The expansion joint shall be measured in running metres except for the filler joints specified in clause 2605 which are to be measured in Sq. m. For filler joints the rate per Sq. m. shall include the cost of sealant".

Clause:2611

V. MODULAR STRIP / BOX SEAL JOINT

Clause:2611.1

A modular expansion joint consist of two or more modules / cells to cater to a horizontal movement in excess of 70 mm. It shall allow movements in all 3 directions and rotation about all 3 axes as per design requirements. It shall also ensure that during all movement cycles of the joint, opening and closing (gaps) of all modules are equal.

Clause:2611.2

Component

- a) The structural system consisting of two edge beams, one or more central / separation beams or lamellas and cross support bars supporting individual or multiple central beams to transfer the loads to the bridge deck through the anchorage system.
- b) Resilient or shock absorption support system for central beams as well as support bars no dampen dynamic loading thus reducing the forces transmitted to the substructure and anchorages as also to accommodate vertical and transverse movements apart from longitudinal movement.
- c) Sliding or control system which allows closing and opening of the joint and also ensures that all modules open and close equally.
- d) Mechanically locked sealing system of chloroprene which provides

watertight, noiseless and easy replacement system.

Clause:2611.3

Materials

a) Edge and Central Beams

These shall be either extruded or hot rolled steel sections or cold rolled cellular steel sections including continuously shop welded sections for central beams with suitable profile to mechanically lock the sealing element in place throughout the normal movement cycle. Further, the configuration shall be such that the section has a minimum thickness of 6 mm all along the cross section. the minimum height of the edge beam section shall be 75 mm. The steel for edge beams shall conform to any of the steel grade corresponding to RST 37-2 or 37-3 (DIN), ASTM A36 or A558, CAN/CSA Standard G 40.21 Grade 300 W or equivalent. The material for support bars may be same as that of edge / central beams or as per manufacturer's recommendations.

b) Chloroprene Seal

This shall be performed extruded single strip of cellular section of chloroprene of such a shape as to promote self removal of foreign material during normal joint operation. The seal shall possess high tear strength and be insensitive to oil, gasoline and ozone. It shall have high resistance to ageing and ensure water tightness.

Chloroprene seal shall conform to clause 915.1 of IRC : 83 (Part-II). The properties of chloroprene shall conform to Table-2 of these specifications.

c) Anchorage

The anchorage steel shall conform to IS : 2062 or equivalent.

Edge beam shall be anchored to the deck by anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or loops, this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12 mm. Total cross sectional area of bars, studs or bolts on each side of the joint shall not be less than 1600 mm Sq. per Metre length of the joint and the centre to centre spacing shall not exceed 250 mm. The ultimate resistance of anchorages shall not be less than 500 KN/m in any direction.

- d) **Support and Control System**
The overall system and components of the resilient / shock absorption system and sliding / control system shall conform to the specifications recommended by the manufacturer. The centre to centre spacing of transverse support bars shall not exceed 1.75 m.
- e) **Corrosion Protection**
All Steel sections shall be protected against corrosion by hot dip galvanizing or any other approved anti corrosive coating with a minimum thickness of 100 micron.

Clause:2611.4**Fabrication (Pre-installation)**

- a) The modular expansion joint system and all its component parts including anchorages shall be supplied by the manufacturer.
- b) The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformation (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is to be installed, the gap dimension shall be preset.
- c) Each modular expansion joint system shall be fabricated as a single entity free from any joint in the longitudinal direction unless stage construction or excessive length prohibits monolithic fabrication. It shall fit the full width of the structure as indicated on the approved drawing. The system shall be pre-set by the manufacturer prior to transportation. Pre-setting shall be done in accordance with the joint opening indicated on the drawing.
- d) The finally assembled joint shall then be clamped and transported to the work site.

Clause:2611.5**Handling and Storage**

- a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.
- b) The manufacturer / supplier shall supply either directly to the Engineer or to the Bridge Contractor entire assembly of Modular Strip / Box Seal joints including sealants and all other accessories for the effective installation of the jointing.
- c) Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding.

Clause:2611.6**Installation**

 Contractor

- a) The joint shall be installed by the manufacturer / supplier only.
- b) Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surface of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.
- c) The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be rigid and firm.
- d) Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.
- e) The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be leveled and finally aligned and the anchorage steel on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.
- f) Controlled concrete having strength not less than that in superstructure subject to the minimum of M-35 shall be filled into the recess. The packing concrete must feature low shrinkage. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.
- g) The chloroprene seal shall be field installed in continuous lengths spanning the entire roadway width. To ensure proper fit of the seal and increase the ease of installation, dirt, spatter or standing water shall be removed from the steel cavity using a brush, scrapper or compressed air. The seal shall be installed without damage to the seal by suitable hand method or machine tools.
- h) As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from the site traffic. Expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.

- i) The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing / wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

Clause:2611.7**Acceptance Criteria**

- a) All steel elements shall be finished with corrosion protection system.
- b) For Chloroprene seal, the acceptance test shall conform to the requirements stipulated in para 3.2. The manufacturer / supplier shall produce a test certificate accordingly, conducted in a recognised laboratory, in India or abroad.
- c) Fatigue strength of internal beams and support connections shall be investigated to withstand 2 million cycles of vertical load of 85 KN and a horizontal load of 10 KN without showing signs of distress. The supplier shall have to produce a test certificate in this regard conducted by a recognised laboratory from India or abroad.
- d) The manufacturer shall produce test certificates indicating that anchorage system had been tested in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic loading.
- e) Prior to acceptance 25 percent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25 mm above the highest point of deck. The width of ponding shall be at least 50 mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25 mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.
- f) As Modular strip / box seal type of joint is specialised in nature, generally of the proprietary type, the manufacturer shall be required to produce evidence of satisfactory performance of his product.

Clause:2611.8**Tests and Standards of Acceptance**

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacturer / supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

Contractor

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

SECTION 2700 WEARING COAT AND APPURTENANCES

CLAUSE 2702 WEARING COAT

Clause: 2702.1 Bituminous Wearing Coat

Clause: 2702.1.1 (Modification) Add at the end of item i) :

“The prime coat of mastic asphalt shall be 30% straight run, 30/40 penetration grade bitumen and 50% light solvent (Benzol) to be laid over the deck slab. The insulation layer of 10 mm thick mastic asphalt with 75% lime stone dust filler and 25% of 30/40 penetration grade bitumen shall be laid at 375⁰ F with broom over the prime coat.”

CLAUSE 2706 (Substitution) WEEP HOLE

This clause shall read as under :

“Weep holes shall be provided in solid concrete/ reinforced concrete/brick masonry abutments, wing walls, return walls as shown in the drawing or as directed by the Engineer to drive moisture from the back filling. Weep holes shall be provided with 100 mm dia. A.C. pipe and shall extend through the full width of concrete with slope of about 1 vertical: 20 horizontal towards the draining face.

The spacing of weep holes shall generally be 1 m in either direction or as shown in the drawing with the lowest at about 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer.”

CLAUSE 2708 (Modification) MEASUREMENTS FOR PAYMENT

Delete item “v” of this Clause

CLAUSE 2709 (Modification) RATE

Delete last para of this Clause.

SECTION 2900 PIPE CULVERTS

CLAUSE 2906 JOINTING

(Modification) Delete the first and second sentences of para 1 of this Clause and substitute:
“The pipes shall be jointed by collars shall be of RCC 150 to 200 mm wide and having the same strength as the pipes to be jointed.”

SECTION 3000
(Substitution)

MAINTENANCE OF ROAD

1. The contractor will be responsible for maintenance of the road (existing as well as all permanent works) from the day the worksite is handed over till the possession of completed work is taken over. No separate payment will be released for maintenance work and cost thereto is treated as incidental to the contract work.
2. The contractor will have to keep the road traffic worthy and in reasonably good condition throughout the construction period so as not to cause any inconvenience to the traffic.
3. During the construction period, contractor will have to attend to the following maintenance works from time to time to the satisfaction of the Engineer.
 - i) Restoration of rain cuts and dressing of side shoulders
 - ii) Maintaining public vehicular access along the ROW and from ROW to all public and private accesses at all times and in good condition by carrying out repairs and maintenance as directed by the Engineer.
 - iii) Maintenance of road side and cross drains to ensure that drainage is not affected.
 - iv) Filling pot holes and patch repairs in bituminous surface with a bituminous pre-mix after trimming the pot hole / depression to proper shape and depth with necessary tack coat and proper compaction with road roller.
4. During construction period it would be necessary to divert the traffic from new carriageway to existing carriageway and vice-a-versa to facilitate undertaking of permanent works on existing carriageway. Construction of such diversions by cutting across central median and maintaining the same will be the contractors responsibility and shall be at his cost. No separate payment will be made for construction and maintenance of such diversions.

SECTION 3100

REINFORCED EARTH

Clause 3101
(Substitution)

- a) Scope of works
This work shall consist of Reinforced Earth Structures with suitable reinforcing elements, precast RCC panel, metallic strip or wire mesh reinforcement and back fill materials in accordance with the Indian / international specifications and in reasonably close conformity with the lines, grades design and dimensions shown on the approved drawings.

The work shall generally be done in conformity to these specifications. The detailed design and drawing of the work shall be done in accordance with these specifications and guide lines contained in the IRC Highway Research Board, Special report No. 16, Patentee's Specifications shall be

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applicable wherever relevant only. The guide lines in BS 8006 (latest version) shall be referred whenever corresponding Indian Literature is not formulated. The design shall however adopt limit state method with various partial safety factors and factors of safety as per Design Criteria appended to the specification.

The material shall be procured from supplier of reinforced earth technology approved by engineer. The design and drawing shall be got approved from the Engineer or its Consultant before execution of work.

The supplier of reinforced earth technology should have an experience of providing similar kind of work for road/flyover projects.

The backfill material shall be in close accordance with specifications and in close conformity with the lines, grades, design and dimensions shown on approved drawings.

The design shall be based on proper soil investigation report of the foundation soil and the backfill soil. Foundation improvement required if any shall also be taken into account.

- b) All Reinforced Earth Structure shall carry guarantee to be furnished by manufacturer of reinforcement and shall cover all elements of reinforced work and final product in the form of Retaining Wall.

The guarantee period for the structure shall be ten (10) years from the date of completion of work irrespective of defect liability period specified elsewhere in the tender document; the principal contractor shall countersign the guarantee given by sub-contractor employed by him. The contractor/s shall furnish the guarantee bond as directed by the Engineer.

Wherever a patented process is used, the Contractor shall make his own arrangements to secure the supplies and services needed and pay for the licensee fees thereof directly. Owner shall be indemnified from any claims arising out of such patented product or methods of construction adopted at site.

**Clause 3102
(Substitution)**

Reinforcing Element

The reinforcing element shall be of aluminium alloy, ship-copper strip, carbon steel strip, mat of metal or metallic wire mesh procured from supplier of reinforced earth technology approved by the Engineer.

Metallic Reinforcement:

Shapes and dimensions of these elements shall be as shown on the approved drawings. Tie strips or voids or high adherence reinforcing strips / rods shall be hot rolled. Their physical and mechanical properties shall conform to IS 2062 or equivalent European norm like EN 10025. Reinforcing and tie strips / rods shall be hot dip galvanised to conform to the requirements IS 4759 or equivalent international standard. The galvanising shall be minimum 140 microns. For corrosion allowance, minimum all round 0.75 mm sacrificial thickness shall be provided.

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Reinforcing and tie strips shall be of required dimensions. Holes for bolts or threading shall be in the locations shown and size as per approved drawing. They shall be carefully inspected to ensure that they are true to size and free from defects that may impair strength or durability.

Fasteners :

Bolts and nuts shall be hexagonal cap high strength screw conforming to IS or equivalent European norm E 25100 CLASS 10.9. They shall be hot dip galvanised to 140 micron in conformity with relevant IS or international standard.

Metallic wire Mesh (Zinc + PVC) coated :

The (Zinc + PVC) Coated metallic Wire Mesh Reinforced shall be made up of Mechanically Woven Double Twisted Hexagonal shaped (Zinc + PVC) Coated Wire Mesh of type 10x12 or 8x10, Wire dia 2.7 (I.D.) / 3.7(O.D.). All the sides shall be Mechanically Edged/Selvedged with a wire of higher dia.3.4 (I.D.)/4.4 (O.D.). Material shall generally conform to ASTM A 975 / EN 10223 -3. Zinc Coating and Tensile strength of wire as per relevant British standards. PVC Coating as per ASTM A 975. Tolerances of Mesh Opening as per EN 10223 -3. These requirements shall also generally conform to MOST /I.S specifications.

**Clause: 3103
(Addition)**

Earth fill

Earth fill materials used in the Reinforced Earthwork shall be reasonably free from organic or otherwise deleterious materials.

Physio-chemical requirements (In case metallic reinforcing elements only)

Materials with a resistivity of 5000 ohm-cm or more, are readily acceptable, based on a standard test as directed by the Engineer-in-charge.

Materials with a resistivity less than 1000 ohm-cm are inadequate and shall not be used.

Materials with a resistivity between 5000 and 1000 ohm-cm are acceptable provided that in water extracted from soil-water mix, the content of chlorides does not exceed 200 ppm., the content of sulphates does not exceed 1000 ppm. and the pH value is in the range of 5 to 10.

Water of a minimum resistivity exceeding 700 Wcm shall be used for compaction.

Filter Material :

Filter material placed between RCC panel facia and earth fill 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

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or other deleterious matter. Unless the contract specifies any particular grading for the filter material or requires these to be designed on inverted filter criteria for filtration and permeability to the approval of the Engineer, the filter material shall be provided with following grading :

Sieve Size	Percent passing by weight
53 mm	100
45 mm	97-100
26.5 mm	-
22.4 mm	58-100
11.2 mm	20-60
5.6 mm	4-32
2.8 mm	0-10
1.4 mm	0-5

Drainage Pipe :

Perforated pipes for the drains may be of material, type, size and grade of the pipe to be used shall be, as specified in the approved drawing. In no case, however, shall the internal diameter of the pipe be less than 150 mm. Holes for perforated pipe 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 D_{85} size of the material surrounding the pipe, subject to being minimum 3 mm and maximum 6 mm, D_{85} stands for the size of the sieve that allows 85 percent of the material to pass through it. The drain pipe shall be rapped with geotextile from inside.

Clause:3104 (Substitution)

Facia of precast RCC Panel

- a) Only, Precast Reinforced concrete segmental panels shall be used for facia elements, both with metallic strip or metallic wire mesh reinforcement. Such element shall conform to the details and dimensions shown on the approved drawing. Minimum size of precast panel shall be 0.8 Sqm. area and thickness of 150 mm.
- b) Precast Reinforced concrete panel elements shall conform to the details and dimensions shown on the drawings. Concrete shall be of minimum M-40 grade shown on the drawings and shall conform to the requirements specified in section 1700 "Structural Concrete" of MORT&H.
- c) Reinforcement in the precast panels shall be placed as shown on the panel drawing and shall conform to the requirements specified.
- d) Protective coating of one zinc rich epoxy primer and two coats of coal tar epoxy paint to be applied on earth face of panels
- e) Air entraining retarding or accelerating agents or any other additive containing chloride, shall not be used without the previous approval of the Engineer.

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- f) Filler of vertical joints between panels shall be flexible open cell polyurethane foam strips or non woven fabric strips (the latter used as joint cover instead of filler), as approved by Engineer. Suitable arrangement for resting of panel over other capable of sustaining applied stress and allowing long term flexibility (like Elastometer with vulcanised EPDM) shall be used.
- g) Acceptability of the precast panel shall be determined on the basis of compression test, as per MOST specifications and visual inspection. A minimum of one sample of 9 cubes shall be taken for each lot of 5 Cu.m. of concrete or part thereof produced per day. 3 of these cubes shall be cured in the same manner as elements and tested to determine when the elements can be placed in the structure. Elements shall be acceptable for placement in the structure if the strength at 7 days, or before, exceed 75% of the 28 day requirement.

Elements shall be subjected to rejection in case of failure to meet any of the requirement specified above, in addition, defects that indicate imperfect moulding, or defects indicating honeycombed or open texture concrete, shall be sufficient cause of rejection.

**Clause :3106
(Substitution)**

Measurements for Payment

Measurements for this item shall be on Linear Meter basis (LM) for the heights specified in Vol. II. The heights shall be measured vertically from bottom of the first bed panel to top of the Capping Beam.

**Clause:3107
(Substitution)**

Rates

The rate shall include the cost for providing, casting and erecting of precast reinforced panels, laying of appropriate reinforcing elements of required width, applying protective coat to earth face of panel, providing drainage with perforated pipe rapped with geotextile, jointing material between facia panel, RE wall design and gurantee, reinforcement in RCC panel, cost of labour, plant hire, material, storage, necessary scaffolding and handing expenses for completing the works with all lead and lifts.