TABLE OF CONTENTS

LIST OF TABLES

LIST OF ENCLOSURES

1 SCOPE OF WORK

1.1 Broad Scope

The Project comprises of construction of six number clover leaves as shown in the layout plan at Karkari More to make the existing junction signal free.

The work under this contract pertains (not limited) to construction of the following components:

1.1.1 Construction of Six Numbers Clover Leaves over Drain No.1

Proposed clover leaves are to be constructed on one side of the existing flyover. The work shall consist of providing pre-stressed concrete Box-girder and I-Girder spans for superstructure with RCC sub-structure resting on pile foundations (vertical and raker), abutments and approach slabs, expansion joints, bearings, crash barriers etc.

For approaches, remodelling of existing road is done with new embankment supported by RCC walls. For construction of new ramps, RE wall is adopted. The work shall include the provision of friction slab to support crash barrier over the wall.

Widening of the existing road and construction of new road is proposed partly on embankment and partly supported by retaining wall on pile foundation constructed along bank of the drain.

1.1.2 Remodelling / Widening of Existing Roads, Footpaths, Service Roads

The work shall consist of providing bituminous pavement, overlay on existing roads, footpath, drains etc. This includes the construction of median kerbs, footpath kerbs etc as per the final drawing. Re-grading road to match the existing and proposed structures, remodelling the footpath of the existing road to accommodate footpath and cycle track and remodelling existing drains and service roads is included in scope.

1.1.3 Widening of existing bridge (both sides) on Drain No. 1

Widening shall be done by dismantling existing railings and footpaths of existing bridges, chipping existing slab to lap reinforcement bars, construction of RCC slab to widen deck and reconstruct footpaths and railing. Extended slab shall be supported on RCC piers resting on pile foundation.

1.1.4 Construction of Pedestrian Subway and Split-Rotary for U-Turning

This work includes construction of a pedestrian 2subway after the existing bridge on drain no.–1 near post office. Split rotary for U-turning is proposed after the railway line towards Ghaziabad side. This includes widening of existing road by construction of retaining wall along drain, remodelling of existing median to construct split-rotary and closing existing gap in the median to make the T-junction signal free.

1.1.5 Finishing Works.

This includes the lane markings, zebra, directional arrows, fixing cats-eye road delineators, reflectors, painting kerb / crash barrier and providing signage, as per the approved drawing.

1.1.6 Development of Green Areas

This work shall include dismantling existing pavement wherever required, clearance of trees and shrubs, land grading, supplying and implanting grass, plants and shrubs including manure, watering, etc. for development of green areas.

1.1.7 Sequence of construction

In general the site is free of encumbrance and the work can be started at all the locations simultaneously. However the work shall be taken up in phases for allowing traffic diversion during construction.

Suggested phase wise construction sequence are given below. Layout Plan drawing may be referred for the nomenclature used below.

i) Construction of piles foundation & Substructure for clover leaves 3,4&6, widening of slip road, construction of approach ramps.
ii) Construction of Temporary roads to divert the traffic movement during this phase of construction.
iii) Construction of piles foundation & Substructure for clover leaves 1,2&5, widening of slip road, construction of approach ramps.
iv) Construction of Superstructure for clover leaves 3,4&6 and split rotary towards Ghaziabad side, new road construction and widening, start subway construction.
v) Construction of Superstructure for clover leaves 1,2&5 and new road construction and widening, finish subway construction.
vi) Widening of existing bridge on drain no.-1. All other miscellaneous works, road finish & furniture are carried out in the final phase.

Based on approved traffic diversion plan, contractor shall work out his own construction sequence and incorporate in his work program and submit for approval of department.

1.1.8 Temporary construction

1. Construction of temporary rotary / traffic islands / medians using concrete barricades and traffic signs, diversion roads to enable smooth traffic flow during construction. Traffic diversion plans shall be got approved from DDA and traffic police. The cross section of temporary roads to be adopted shall be got approved from DDA.

2. Temporary shifting of existing drains and temporary shifting and supporting of utilities etc. to facilitate construction. The contractor shall identify all over-ground and underground services and utilities requiring shifting for carrying out the works well in advance as part of the topographic survey work for setting out of works. Relocation/shifting or temporary supporting of such utilities shall generally be done by the utility provider/owner. The contractor may temporarily support utilities/services not requiring permanent shifting in consultation with the utility provider and complying their requirements.

3. Fabrication and providing barricading as per drawings for safe working

1.1.9 Site Surveys, Layout and Setting Out

This includes all levelling work, layout and setting out of all works using Total Station survey, Auto-levels, etc. establishment and maintenance of reference pillars and bench marks for accurate setting-out of structures as per drawings. This shall also include any additional surveys as per site conditions for any modifications required during execution.

1.1.10 Maintenance during Defect Liability and Routine Maintenance Period

The contractor shall maintain the Project/Project Facilities and if required, modify, repair or otherwise make improvements to the Project/ Project Facilities as described earlier (broadly comprising six clover leaves, slip roads, service roads, subway, footpaths, cycle tracks, area drainage and green areas) to comply with Specifications and Standards, and other requirements set forth in this contract, Sound Engineering Practice, Applicable Laws and manufacturer's guidelines and instructions with respect to manufactured items used for the project. More specifically, the contractor shall be responsible for:

(i) maintaining liaison with emergency services, traffic police and any other law enforcing agencies so as to minimizing disruption to traffic in the event of incidents affecting the safety and use of the Project/ Project Facility by providing an effective response system,

(ii) undertaking routine maintenance including prompt repairs of potholes, cracks, concrete joints, footpaths, drains, traffic markings and signage,

(iii) undertaking maintenance works in accordance with Maintenance Manual and the Maintenance Programme,

(iv) preventing with the assistance of the concerned law enforcement agencies where necessary, any encroachments on the Project/Project Area and preserving the right of way of the Project.

1.1.10.1 Maintenance Manual

The contractor shall in consultation with the DDA evolve not later than 120 (one hundred twenty) days before the Scheduled Project Completion Date, a manual for the regular and preventive maintenance (the "Maintenance Manual"), and shall ensure and procure that at all times during the Maintenance Period, the Project Facilities are maintained in a manner that it complies with the Specifications and Standards. The contractor shall supply, at least two months before the scheduled Project Completion Date, 10 (ten) copies of the Maintenance Manual to the DDA.

1.1.10.2 Maintenance Programme

(a) Not later than forty five (45) days before the beginning of each year, the contractor shall provide to DDA, its proposed programme of preventive and other scheduled maintenance of the Project/Project Facilities necessary to maintain the Project at all times in conformity with the Specifications, Standards and Contract Agreement (the "Maintenance Programme"). Such Maintenance Programme shall include but not be limited to the following:

(i) intervals and procedures for the carrying out of inspection of all elements of the Project,

(ii) criteria to be adopted for deciding maintenance needs,

(iii) preventive maintenance schedule,

(iv) intervals at which the contractor shall carry out periodic maintenance, and

(v) intervals for major maintenance and the scope thereof.

(b) Maintenance shall include replacement of equipment, consumables, horticultural maintenance and repairs to equipment, pavements, bridges, structures and other civil works which are part of the Project.

(c) The contractor shall keep the Project Area/Facilities in a clean, tidy and orderly condition free of litter and debris.

(d) The contractor shall be responsible for the maintenance of the approach roads to clover leaves, service roads and split rotary and drainage within the Project Area in accordance with sound engineering practice.

(e) In the event the contractor does not maintain and/or repair the Project Facilities or part thereof upto and in accordance with the Specifications and Standards and/or in accordance with the Maintenance Programme or the Maintenance Manual or the Inspection Report, as the case may be, and shall have failed to commence remedial works within (30) thirty days of notice in this behalf from the DDA, DDA shall, without prejudice to its rights/remedies under this contract, including termination, be entitled to undertake to cause the repair and maintenance of the Project at the risk and cost of the contractor. The contractor shall, reimburse to DDA within seven days of demand the costs and expenses incurred for undertaking such repairs and maintenance.

(f) The contractor shall not close any part/ lane of the Project/Project Facility for undertaking maintenance or repair works except with the prior written approval of the DDA. Such approval shall be sought by the contractor through a written request to be made at least 7 (seven) days before the proposed closure of part / lane and shall be accompanied by particulars indicating the nature and extent of repair works and the arrangements made for safe movement of traffic, the length and section required to be closed and the period of closure. The contractor shall also furnish particulars indicating the minimum time required for completing such repair works.

1.1.10.3 Vehicle Breakdown and Accident

(a) In the case of vehicle breakdown and accidents, the contractor's responsibility on the Project shall be limited to informing the law enforcing agencies, the removal of debris or any other obstruction, which may endanger or interrupt the smooth traffic flow on the Project Area. The contractor shall ensure that any diversion or interruption of traffic is remedied without delay.

1.1.10.4 Monitoring and Supervision during Maintenance Period

(a) The contractor shall undertake periodic inspection of the Project in accordance with the Maintenance Manual, the Maintenance Programme, Specifications and Standards and shall submit reports of such inspection ("Maintenance Reports") to the DDA.

(b) The DDA shall undertake periodic (at least once every calendar quarter but once every fortnight during monsoon) inspection of the Project Facilities jointly with the contractor to determine the condition of the Project including its compliance or otherwise with the Maintenance Manual, the Maintenance Programme, Specifications and Standards and make out a report of such inspection (the 'Inspection Report') and forward it to the contractor. The Inspection Report shall set forth defects and deficiencies, if any, and may also require the contractor to undertake such tests as may be specified by the DDA engineer for the purpose of determining that the Project is at all times in conformity with the Specifications and Standards. The contractor shall within 30 (thirty) days of the receipt of the Inspection Report from the DDA engineer remedy the defects and deficiencies and undertake such tests, if any, set forth therein, without any delay and furnish compliance thereto and/or results thereof to the DDA engineer along with a report (Inspection Compliance Report) specifying in reasonable detail the measures, if any, that have been undertaken for rectifying the defects or deficiencies indicated in such results. Such inspection or submission of Inspection Compliance Report by the contractor shall not relieve or absolve the contractor of his obligations and liabilities hereunder in any manner whatsoever. Where the remedying of such defects or deficiencies and/or undertaking such tests is likely to take more than 30 (thirty) days in accordance with Sound Engineering/ Good Industry Practice, the contractor shall undertake the works in accordance with such practice and submit progress reports of such works every fortnight and finally the Inspection Compliance Report to DDA.

1.2 Item rate tender

The Item rate tender, based on design and drawings finalised by the department shall be inclusive of cost of labour, materials, tools and plants and specialised machinery for completing the various components of the project and all operations connected therewith, under all conditions of site, moisture, weather etc. The rates shall be inclusive of all taxes and duties such as VAT and excise duty on materials, income tax, supply and carriage of materials (By rail, road, river, air etc.), plants and machinery, octroi, toll, royalties, incidental charges, local taxes, patent rights etc. Thus the quoted offer shall be consolidated for all components/items of work. Royalties, sales tax, levies, local taxes, incidental charges etc. wherever applicable shall be paid by the contractor to the respective authorities and no claim whatsoever on this account shall be entertained by the Department.

The quantities of various main items of work involved have been detailed in "Schedule of Quantity" in Volume I of this tender. The nomenclature of the items given in Schedule of Quantity gives in general the scope of item assessed by the Department, but are not exhaustive i.e. do not include all the incidental work that may be required for complete execution of item. The quoted rates shall include the cost of all such incidental works. The quoted rates shall also include the consultancy charges which may be required to be paid by the contractor to specialised consultants for the design of temporary structures (i.e. staging,

shuttering etc.), bearings, expansion joints, RE Wall ramps, traffic diversion plans, etc. for the execution of the project. In case of defective construction or on account of any other reason attributable to the contractor, if the consultant appointed by the Department submits additional claims for proof checking or re-designing or review of any component, or for any input required from them by the department, the same will also be paid by the Contractor.

In order to understand the quantum and complexity of work involved, the General Arrangement drawing and other drawings of the work involved are enclosed in Volume III of this tender document. All these drawings give the general idea of the total work to complete the construction of Cloverleaves, ramps, slip roads including widening of existing bridges and allied works in accordance with the scope of work contained in this chapter read along with other chapters included in this tender document. The scope of work of contractor also includes following items for which no separate payments will be made.

The construction agency shall make arrangements for progress photographs / video filming of the work on a regular monthly or other frequently basis to submit progress reports as directed by Engineer-in-Charge for the documentation of the progress of work i.e. start to completion of the project.

Besides the documentation will include all drawings, machinery and labour deployed, work plan and method statements, service details, pre casting/ batching plant yard details, electrical lighting fixtures and construction schedule etc. In a nutshell complete documentation for the project is required.

Construction of 2 nos. of temporary cabins (Portable cabins) of one room unit (approx. size 12ftx12ft), at suitable locations as approved by engineer-in-charge, for the field staff of the department including the arrangement of light, fans, coolers, furniture, cub-board, false ceiling and drinking water, toilet facilities etc. for better site supervision without charging anything extra. The Portable cabin shall be removed after completion of the work and all furniture shall be handed over to DDA after the completion of work. The contractor shall also provide a new SUV type AC vehicle to the Engineer-in-charge for site supervision for the entire duration of the project. Running (i.e. fuel and driver’s cost) and maintenance cost of the vehicle for upto 3000Km./ month shall also be borne by the contractor for entire duration of the project.

Providing adequate arrangement for barricading (1.75m and 1m high) for the areas exposed to the road side and as directed by the Engineer-in-Charge to cover the entire construction site including all T & P and materials and storage areas on site.

This shall also include arrangement for traffic diversion such as traffic signals during construction at site for day and night, reflective signs, markings, traffic marshals, flags etc. as directed by the Engineer-in-charge. The barricading shall be provided continuously during the execution of the entire work till completion and shall not be removed at any stage without prior approval of the Engineer-in-charge. The barricading provided will not be payable but it is compulsory and should be provided as directed by Engineer-in-charge.

The barricading provided at site beyond the project schedule time agreed by DDA will not be payable but it is compulsory and should be provided as directed by Engineer-in-charge.

1.2.1 Defect liability

Defect liability also includes maintenance (1 year) and Maintenance period of 4 years there after .The contractor shall be liable for rectification of defects in any part of the work covered in this contract, for a defect liability period of 1 year after completion of the project. Nothing extra shall be paid on this account. The Engineer-in-Charge shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion as recorded by Engineer-in-Charge and ends after one year. Such notice shall not absolve the contractors from his responsibility to find out the defects independently. The Defects Liability period shall be extended for as long as Defects remain to be corrected. Every time a defect noted, the Contractor shall correct the notified Defect/Defects within the length of time specified by the Engineer-in-charge. Contractor shall review and submit maintenance reports on monthly basis to the Engineer-in-Charge.

Further a maintenance period of 4 years is required by the department which shall be payable as per DSR-2007 except the items of Bituminous work. The maintenance period shall start after the defect liability period. The Contractor shall do the routine maintenance of all cloverleaves and project works and their components including roads, pavement, footpaths, road sides and cross drains including surface drains and keep the entire road surface and all structures in Defect free condition during the entire maintenance period which begins at Completion of defects liability period.

The routine maintenance standards shall meet the following minimum requirements that are not exhaustive and the contractor shall remain liable for rectification of all defects.

- Potholes on the road surface to be repaired soon after these appear or brought to notice either during contractor's monthly inspection or by the Engineer-in-Charge.
- Road shoulders to be maintained in proper condition to make them free from excessive edge drop off, roughness, scouring or potholes.
- Cleaning of surface drains including cross drains to maintain free flow of Water.
- Replacement / repair of damaged kerb stones and footpath paving blocks.
- Joint inspection with Engineer-in-Charge of all structural components of all the clover leaves structures, RE wall ramps, retaining walls, split rotary, widened bridge, etc. and maintaining all inspection records as per IRC maintenance manual and submitting to the Engineer-in-Charge.
- Any other maintenance operation required for keeping the clover leaves and roads traffic worthy at all time during the maintenance period.
- Regular inspection of bearings, expansion joints, etc. including submission of inspection reports.
- Regular cleaning of drainage spouts.
- Regular inspection of lighting and fixtures and painting if required

The Engineer-in-Charge may issue notice to the Contractor to carry out maintenance of defects, if any, noticed in his inspection, or brought to his notice. The Contractor shall remove the defects within the period specified in the notice and submit to the Engineer-in-Charge a compliance report.

1.2.2 Uncorrected Defects

If the Contractor has not corrected a Defect pertaining to the Defect Liability Period, to the satisfaction of the Engineer-in-Charge, within the time specified in the Engineer-in-Charge's notice, the Engineer-in-Charge will assess the cost of having the Defect corrected, and the Contractor will pay this amount, on correction of the Defect.

Table 1-1 - Suggestive periodicity of Routine maintenance Activities

S.No.	Name of Item	Frequency of Operations in the year
1	Clearing of road side gutters, splasher and drainage spouts including down take pipe	Twice and before onset of monsoon season
2	Pothole filling (WMM, DBM and BC)	As & when required
3	Painting with synthetic enamel paint of crash barrier, kerb stones etc.	Twice
4	Fixing disturbed caution board/information /Speed limit board, etc.	As & when required
5	Refixing displaced footpath paving blocks, kerb stones, railing and crash barriers.	As & when required
6	Inspection of superstructure and sub-structure components of all six clover leaves and widened existing bridge and submitting inspection report as per IRC Standards.	Once or after occurrence of major seismic event.
7	Cutting of branches of plants and shrubs, etc.	As & when required
8	Clearance of cross drainage works	Twice and before onset of monsoon
9	Bearings, expansion joints	Twice
10	Anti-carbonation paint on concrete structures	Once
11	Maintenance of Lighting and other electrical works	Once
12	Dressing of Berms and protection of slopes	Quarterly

1.2.3 General

The quoted rates for the above work shall broadly include but not limited to the following main items:

i. The contractor shall provide and maintain at site throughout the period of work the following at his own cost and without extra charge, the cost being deemed to be included in the quoted rates.

ii. Preliminary works like setting out (using total station survey) and maintenance of permanent benchmarks reference points, central line of the clover leaves, roads and existing bridges & carriageways etc. It shall also include making adjustment in the layout if required as per site conditions and as directed by the Engineer-in-Charge. The contractor should submit survey plan giving levels and locations of proposed structures of slip roads, cloverleaves and other project roads for complete width. The other details like existing services etc may also be indicated to check any infringement. The survey plan/lay out shall be got approved from the Engineer-in-Charge before starting actual work. Existing levels of the area under the scope of work shall also be recorded.

iii. Clearing of site (to the satisfaction of the Engineer-in-Charge) after completion of entire work and handing over the same to the Department.

iv. All the exposed concrete surfaces shall have shutter or form liner finish using FRP liner as approved (except piles and lean concrete) and nothing shall be paid extra for the same. All the shutters, staging, machinery and other T& P etc. mobilised by contractor for execution of work shall remain property and liability of the contractor and shall be removed by him from site after completion of work.

v. Maintenance of all works during construction till handing over to the Department.

vi. Protection and maintenance of existing services.

vii. Provision for all safety measures for traffic, pedestrian, workmen, machinery etc. as considered necessary by the Engineer-in-charge.

viii. Identification of services like sewer lines, water supply lines, electric and telephone cables etc. well in advance of actual execution.

ix. It may be noted that all the safety requirements as per clause 7.7 of chapter 7 of Volume-1, shall have to be provided at all times during the construction period.

x. The methodology for important items of work like piling, pier and pre-stressed I-girder and Box-girder for superstructure construction, raker pile construction, retaining walls, covered portion of the underpass, underpass by cut & cover method, Reinforced Earth wall, embankment works, road works etc. shall be submitted by contractor for the approval of engineer in charge.

xi. All ancillary and incidental facilities required for execution of the work e.g. labour camps, stores, offices for contractors, work shop facilities, watch and ward, temporary structure for plants and machinery, well equipped site laboratory, water storage structure, tube wells, electric/ telephone/fax machine installation and charges, liaison work, protection work during execution and not included in the main items, any other

item/activity contained elsewhere in the tender documents which is necessary for execution of work in the opinion of the Engineer-in-charge. Tube well bores in good condition shall be handed over to the department after completion of the project.

xii. Pumping and bailing out water in suitable manner as directed by Engineer-in-Charge.

xiii. It is also made clear that intending tenderer shall visit the site of work, and site for batching plant, storage areas and contractor's offices and physically assess the activities which are involved for completing the work, including the quantum of work besides the information supplied in the tender document. No claim whatsoever shall be entertained on this account.

xiv. Activities related to setting out and layout of various items such as permanent bench-marks, reference points, central line of carriageway, layout of foundations and bearings etc. shall be performed by total station survey of having precision of at least 3 sec.

xv. The contractor will make overall layout of the entire scheme, along with verification of existing ground levels as mentioned in drawing, and get it checked from Engineer-in-Charge for the feasibility of same at site. In case of any infringement or any problems in layout and level, the same shall be brought to the notice of engineer-in charge for rectification of the same. The cost of all operations of setting out including construction of benchmarks is deemed to be included in the quoted rates. This work shall be done and to be got approved by Engineer In Charge prior to starting any construction activity on site.

xvi. The quoted rates of various items shall include approval of traffic diversion plans from traffic police, arrangement for traffic diversion such as traffic signs during construction at site for day and night, reflective signs, direction boards, suitable number of traffic marshals if required, markings, flags etc. as directed by the Engineer-in-charge.

xvii. Services like water supply lines, sewer lines, storm water drains, electricity lines, telephone lines, over head and under ground cables/structure, if any falling in the alignment of the work, (which is required to be removed or shifted in the opinion of the Engineer-in-charge) shall be identified by the contractor during survey and setting out of works and informed to department well in advance of his planned work. Removal/ shifting of the identified services/utilities shall be done by the service provider. The contractor, at his own cost, may temporarily support utilities/services not requiring permanent shifting in consultation with the utility provider and complying their requirements. No claim for delay or otherwise due to above reasons shall be entertained on this account.

xviii. Cleaning of site at regular intervals shall be done by the contractor to keep the working area clean. All debris generated by work activities or any other activities, spilled/unused materials or any other junk and scrap materials should be removed from the site immediately. Levy for compensation will be as per Clause 7.26 item of Table 7.1 given in Chapter 7 of Vol.-I. If the contractor spills anything on the existing roads, contractor shall clean the same and nothing extra will be paid for this. The provision for the tyre cleaning of the trucks, going out from contractor's yard to the carriage, shall be made by means of a pit filled with water and pressure washing of tyre through pipe at the point of exit.

xix. The contractor shall provide & erect barricading abutting the panels with each other (without leaving any gap in between) as per Site Conditions without hindering the traffic as per direction of Engineer-in-Charge. All management (including watch and ward) of barricades shall be the full responsibility of the contractor. The barricades shall be removed only after completion of the work or part of the work as per direction of Engineer-in-Charge. The temporary warning lamps shall be installed at all barricades during the hours of darkness and kept lit at all times during these hours. Levy for compensation will be as per Clause 7.26 item of Table 7.1 given in Chapter 7 of Vol.-I.

xx. Adequate lighting for night work and also wherever and whenever required by the Engineer-in-Charge.

xxi. Making arrangement for Helmets and leather shoes (meant for construction sites) for all field staff of the department and the labour and technical staff of the contractor, during the entire period of construction, for safety reasons. The contractor shall arrange one helmet and Two pairs of shoes per staff member (maximum ten members) of the department per year.

xxii. For the purpose of quality control requirements, the project has been considered to qualify class Q4 of IRC: SP-47. The various tests, frequency of tests, equipment required in the site laboratory etc. have been described in clause 3.19 of the tender document.

xxiii. Cost of preparation and compliance with the provisions of a quality assurance control programme of the department as per specifications.

xxiv. Construction and maintenance of jeep tracks along the project corridor with all its components required for execution / inspection / supervision of the work under all conditions of weather during the construction period.

xxv. Overall construction programme for the work using “MS-Project software”/ CPM giving the details of all activities shall be submitted in 2 copies. The measurement book shall also be prepared on computer and computer printouts along with soft copy shall be submitted for checking.

xxvi. Preparation and getting approval from the engineer in charge of all shop drawings for reinforcement. Bars, shuttering and staging, steel structures, bearings, expansion joints etc. shall be included in contractor’s scope of work.

xxvii. Concrete only from the contractor’s compound or approved RMC plant as per clause 4.22 shall have to be transported and used at site in transit mixers.

xxviii. Making all arrangements for inspection of materials, fabrication shop, visits to factories and establishments connected with the work and all other related activities.

xxix. The contractor shall furnish four prints of all shop drawings as advance drawing (for approval) and eight prints of all approved final shop drawings along with soft copy on CD for field use and record purpose. All 'AS-BUILT' drawings in 4 prints and 1 plot on Garware film or equivalent and on CD shall also be submitted at the completion of the project.

xxx. Measurements for items that are not defined in the respective items of schedule of quantities shall be done as per MORTH/CPWD specification. The Engineer-in-Charge has the option to withdraw any item of the SOQ if not needed.

xxxi. The road stretches which would be in possession of the agency for diversion scheme and construction works, shall be maintained by the agency for through and fair traffic till completion of the project. Nothing extra shall be paid on this account.

xxxii. It shall be ensured that the existing structures are untouched and any damage caused to the existing structures, due to improper planning of site activities, will be attributable to the contractor and the amount to commensurate the damages will be recovered from him.

1.3 Major Construction activities

This section describes the major construction activities involved in this project. Reference may be made to the section 1.1 for broad scope of works. This is given only for the purpose of contractor to plan his activities and shall get accustomed of the whole project by referring to the tender drawings. As guidance to the contractor, a phase wise detailed construction methodology is given along with this tender.

Before the commencement of any particular work, the temporary works design associated with that activity should be submitted, to the department for approval.

1. Site Clearance

2. True and proper setting out and layout of the works profiles by providing locations, benchmarks, preparation of reports and plans etc.

3. Excavation of existing ground/pavement surface up to desired including cutting road surfaces, dismantling existing foot path and kerb stones, filling earth, consolidation, preparation of sub grade, stacking of serviceable earth near the site and disposal of other unserviceable excavated material to disposal yard. Filling and consolidation of selected fill i.e. serviceable earth of suitable quality in embankments under OMC condition as per the specifications. Construction of roads including providing and laying coarse sand in drainage layer, sub base i.e. GSB, WMM, Base coarse with DBM with 60/70, and top wearing coat of bituminous concrete with PMB-40.

4. All slip roads/service roads shall be well maintained by the contractor during the construction period to avoid any inconvenience to traffic. This shall include periodic filling of pot holes/cuts by bituminous macadam, cleaning and sweeping the roads, cleaning of drains and bell mouths, temporary road marking/ zebra crossing etc. as per directions of Engineer-in-Charge. This is a very important requirement of the work and contractor shall take every care to see that such surfaces are properly maintained so as not to attract any adverse criticism from the road users. Any laxity on the part of the contractor will be viewed seriously and communicated to the contractor in writing. In case, the contractor still fails to make good, it shall be made good by the Engineer - in – Charge at the risk and cost of the Contractor.

5. Marking lanes with thermo-plastic road marking paint using necessary equipments in white/yellow colour on bituminous surface having minimum thickness of 2.5mm meeting with all requirements contained in para 803.4 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road and Bridge Works (4^{th} Revision, 2001) and

will have Type I glass beads (i.e. those which are constituent of the basic thermo-plastic compound) including cleaning the road surface to give an even shade and as per directions of Engineer-in-Charge.

1.3.1 Construction of Ramp/Slip road

The ramp consists of RCC solid slab superstructure and abutment with solid wall, RE/retaining wall, pile foundation, crash barrier with railing, expansion joint, spilling embankment etc.

The bidders are required to study the drawings and specifications and submit the details accordingly.

The main activities in the construction are as follows:

1. Construction of vertical or raker piles (Bored Cast-in-situ), with pile-caps
2. Abutment construction
3. Casting of I-girder or Box-girder span on installed pot bearings
4. Casting of RCC Crash Barrier
5. Filling of backfill material and road work. This shall include the provision of fixing the crash barrier to the ground as given in the tender drawings.
6. Installation of Expansion joints
7. Laying of wearing course on deck slab
8. Thermoplastic lane marking on road surface and painting of railings and crash barrier

1.3.2 Construction Of New Roads, Widening Of Slip Roads, Service Roads

The slip roads and service roads as per the tender drawing, shall be completed and to be integrated with the existing road.

Due to the proximity to the existing major flyover and existing major roads, the construction shall be such that the safety of the existing structure is of prime importance. Contractor shall make the construction scheme in such a way that there is least hindrance to the existing traffic and no effect on the existing flyover and its components.

Any other items relevant / necessary for completing the structure to handover the finished structure in all respects, with all operations and works mentioned in the tender documents including all testing etc. complete as specified and as per approved drawings.

2 SITE CONDITIONS

Site conditions given hereunder and elsewhere are given as guidelines and 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 department is erroneous or insufficient or at variance with site condition.

2.1 Location

Karkari More intersection has an existing flyover along Shahdara-Ghaziabad road (Road No. 57) spanning over Vikas Marg. Traffic coming from ITO side on Vikas Marg takes left turn for Shahdara and takes right turn for Ghaziabad side. At the intersection, straining traffic along Vikas Marg goes to Vivek Vihar / Anand Vihar ISBT. Presently intersection below the existing flyover has a signalled junction due to turning traffic and straight traffic along Vikas Marg. Drain No. 1 runs parallel to the existing flyover. Clover leaves are proposed over the drain on both sides of Vikas Marg for turning traffic to make the intersection signal free.

The approach road to the site of work shall be made and maintained by the contractor at his own cost. The tenderer has to plan most of their construction activities carefully as only limited space will be available for construction activities.

The yard for batching plant, pre-cast elements, stores, godowns, laboratory, site offices etc. shall be established by the contractor at location approved by DDA. Suitable location and scheme for establishment of this yard shall be submitted by the contractor to engineer-in-charge for approval. The contractor shall make all suitable arrangements for establishment of working yard at/near site including earth filling (if required) to raise the ground level, protection works to avoid flooding of yard during monsoon, construction of approach roads to/inside the yard, lighting, barricading and all incidental works required for operation of casting yard/working yard/batching plants and nothing extra shall be payable for making all these arrangements. No claim for lead shall be entertained from yard to the site.

The land for casting and working yard, batching plants etc. can be in one piece or more than one piece, depending on availability and requirement and no claim shall be entertained in this regard. The rent, if any, for this land shall not be borne by the DDA. The contractor shall use hired land for works related to this contract only and not for his any other contracts/works. Only the T&P, laboratories and material related to this contract shall be stored at this land(s). The area hired by the contractor must be cleaned and handed over in the original condition to the owner department as soon as the intended use is complete and/or before the recording of completion certificate by the DDA whichever is earlier.

2.2 Bench Mark

The contractor has to establish the correct positions of benchmarks precisely on site with respect to the arrangement shown in the drawings or as per the direction of the Engineer-in-charge and maintain the same till end of project.

2.3 Variation in water table

No extra payment will be admissible on account of any variations in the water levels including sub-soil level at the site of work from those given in the tender documents. Complete soil investigation report is available for study in the office of the Executive Engineer, Flyover Division – 4, DDA-Seed bed park,Shakarpur,Delhi – 110092.

The ground water table is a variable condition and the value given in the report is only indicative. It may vary from time to time depending upon the season.

2.4 Traffic diversion and utilities diversion.

The work has to be executed without disrupting the traffic. The contractor will have to carefully plan his sequence of operations so that the traffic moves unhindered at all times. The traffic diversion plan evolved by the contractor for execution of the work at all locations will require approval of Delhi Traffic Police and of the DDA. Modifications suggested by the Traffic Police and also by the Department shall be implemented by the contractor during execution of the work.

Diversion of traffic as required for construction activities shall be arranged by the contractor to the satisfaction of Engineer-in-Charge/Delhi Traffic Police. However for diversion of traffic, if additional road/pavement is required to be constructed, the same shall be decided by the Engineer-in-Charge.

There are certain services running along the existing carriageway of bridge over drain and service road/footpath etc. There may also be certain services fouling with the alignment of proposed bridges and approaches. The contractor shall verify these services at site and identify additional services, if any, well in advance by co-ordinating with local authorities/agencies or by making trial pits and if required these shall be removed/shifted by the contractor in consultation with the service provider agency. Payment for this shall be made as per terms and conditions of the contract. No claim for delay or otherwise due to above reasons shall be entertained on this account.

2.5 Climatic Conditions

The climate in this region is extreme with three major seasons - winter, summer and rainy. The winter season lasts from October to March, summer season from April to June and rainy season from July to September. This is only for guidance and there may be variations.

2.6 Housing, Water supply, drainage and electricity.

No accommodation is available at the site of work. The contractor has to make his own arrangements for electric connection, housing, stores and field offices, accommodations for his labour and other employees etc. including drainage arrangements. Contractor should visit the site and see in what manner he is able to arrange the above. Arrangement of water for drinking

purpose in addition to the water required for construction work is also to be made by the contractor. For electric connection, the contractor shall obtain necessary connection as per requirement from NDPL/BYPL and the contractor shall be authorised to use the same for execution of work. The department shall provide necessary help for obtaining electric connection.

In case of flooding of site on account of rising of water table or for any other cause or any other damage whatsoever, no claim financially or otherwise shall be entertained, not withstanding any other provisions elsewhere in the tender documents.

2.7 Soil investigation report

Preliminary Soil Investigation has been carried out and is available for reference in the office of the Executive Engineer, Flyover Division– 4, DDA-Seed bed park, Shakarpur,Delhi –110092. This is produced in good faith and DDA does not take any responsibility of its correctness. In case of any variations between the data given in the report and the substrata actually found at the site, the consequences shall be borne by the contractor; no claim of any kind shall be entertained by DDA.

2.7.1 Geology

The soil at the project site belongs to the “Indo Gangetic Alluvium” and is river deposit of Yamuna and its tributaries. The Pleistocene and recent deposits of the Indo-Gangetic Basin are composed of silty sand, sand, silts and sandy silts with layers of fine sand. The alluvium is light coloured and contains beds of fine sand, silty sand with occasional occurrence of pebbles at lower depths.

2.7.2 Site Stratography

The top soil is predominantly sandy silt or filled up soil with lower layers of silty sand or fine sand up to the depth of exploration which was about 40 m below existing ground level.

Detailed description of the materials encountered at the borehole locations is presented on the individual soil profiles. The bore logs present the strata description along depth of the bores.

2.7.3 Sub-soil water table

Based on the measurement in the completed boreholes, groundwater was encountered at the time of field investigation (March 2008) varying from 3.20m to 6.75m depth. Fluctuation may occur in measured water level due to seasonal variations in rainfall and surface evaporation rates.

The site for the work shall be available in phases due to traffic diversion during construction phase as approved by DDA and Delhi traffic Police.

3 MATERIALS AND TESTING

3.1 General

The contractor shall provide all materials including water and electricity required for the works at own expense. No extra cost due to variation in cost of material, carriage, loading etc. at any time will be payable except as admissible under clause 10CA and 10CC of the tender document.

All materials to be provided by the contractors shall be in conformity with the specifications laid down in the contract. The contractor shall ensure about their suitability to the satisfaction of the Engineer-in-charge and nothing shall be paid extra on this account. The contractor shall procure and get the materials tested sufficiently in advance so that there is no hold up due to non-availability of materials. At least 15 days quantity shall be available with the contractor in advance.

A list of approved manufacture/supplier for various items of work has been enclosed in **Annexure-A** for guidance of the contractor. All the materials and the name of manufacture/supplier from whom the contractor intends to purchase the material shall be got approved from Engineer-in-Charge in advance.

3.2 Materials to be arranged by the contractor.

All materials are to be arranged by the Contractor. The Contractor shall submit test certificates of manufacture in respect of conformity to specifications in respect of each lot of supply of material. The materials arranged by the Contractor shall be jointly tested by the Contractor or his representative & the Engineer-in-Charge or his representative and as directed by Engineer-in-Charge. The Engineer-in-Charge shall have full liberty of getting the material tested independently through recognised Testing Laboratory. The Contractor shall supply the material required for tests free of charge. Cost for all tests in the field lab set up by the contractor or at the Manufacture's premises shall be borne by the contractor.

3.3 Cement

Ordinary Portland Cement of 43 Grade and 53 Grade conforming to IS: 8112 and IS:12269 respectively may be used for structural concrete. Blast furnace slag cement shall conform to IS: 455 with strength requirements as per IS: 8112.

The contractor shall procure cement from the approved **(Annexure – A)** manufactures of cement having a production capacity of one million tonne per annum or more and holding licence to use ISI certification mark for their product whose name shall be got approved from Engineer-in-Charge.

The cement shall be brought at site in bulk supply of approximately 50 tonnes or more as decided by the Engineer-in-Charge. Cement shall be arranged by the contractor in jute bags, paper bags or any suitable packing. The test certificate of the manufacture shall be submitted by the contractor for every lot of cement brought to site.

Supply of cement shall be taken in 50-kg bags bearing manufacture's name and ISI marking. Samples of cement arranged by the contractor shall be taken by the Engineer-in-charge and got tested in accordance with the relevant tender provision. In case test results indicate that the cement arranged by the contractor does not conform to the relevant codes, the same shall be rejected and removed from the site by contractor at his own cost within a week's time of written order from the Engineer-in-Charge to do so.

The actual issue and consumption of cement on work shall be regulated and proper accounts maintained as provided in clause 10 of "General conditions of contract for CPWD Forms 2005, amended upto the last day of issue of the tender". The theoretical consumption of cement shall be worked out as per procedure prescribed in clause 42 of GCC 2005. No payment for excess consumption of cement will be allowed. However, for consumption lesser beyond permissible theoretical variation, recovery shall be made in accordance with conditions of contract without prejudice to action for acceptance of work/item at reduced rate or rejection as the case may be.

Cement brought to site shall not be removed from site without written permission of the Engineer-in-Charge.

The cement godown of adequate capacity as per sketch shown in "General Conditions of contract for CPWD Forms 2005 (Form 7/8)" shall be constructed by the contractor at site of work for which no extra payment shall be made. The plan, dimensions and section of the proposed cement godown shall be submitted by the contractor for the capacity of 5000 bags. The general arrangement and stacking shall be as per form 7/8 that is shown for a lower capacity. Similar arrangement shall be followed for a higher capacity of 5000 bags. The contractor shall be responsible for the watch & ward and safety of the cement godown. The contractor shall facilitate the inspection of the cement godown by the Engineer-in-Charge or his authorised representative at any time.

Separate godowns shall have to be provided for different grades/types of cement. Cement godown shall have a minimum capacity of 5000 bags. Each godown shall display the grade/type of cement stored in it prominently. The testing of cement shall be carried out in advance and at least 15 days quantity shall be available in the godown.

The supplier of Ready Mix Concrete (RMC) shall test the cement as mentioned in Quality Assurance Plan and submit the test results through Contractor for reference and record.

3.4 Steel Reinforcement

3.4.1 Type of Steel Reinforcement

Only TMT reinforcing bars of grade Fe500 (0.2% proof stress / yield stress not less than 500 Mpa) conforming to relevant IS code shall be used. The contractor shall procure steel reinforcement bars conforming to relevant specifications from main producers as indicated in **Annexure – A** and use of re-rolled steel shall not be permitted.

3.4.2 Supply of Steel Reinforcement

The contractor shall have to obtain and furnish test certificates to the Engineer-in-Charge in respect of all supplies of steel brought by him to the site of work. Samples shall also be taken and got tested by the Engineer-in-Charge as per the provisions in this regard contained in Quality Assurance chapter. In case the test results indicate that the steel arranged by the

contractor does not conform to BIS codes, the same shall stand rejected and shall be removed from the site of work by the contractor at his cost within a week's time of written orders from the Engineer-in-Charge to do so. A record shall be maintained on batch numbers of reinforcement deliveries so that the part of works in which particular reinforcement is used can be readily identified.

The steel reinforcement shall be brought to the site in bulk supply of 9 MT or more for each dia. as decided by the Engineer-in-Charge. The contractor will produce copy of original challan/voucher for purchase of steel reinforcement from approved manufacture as a proof of having the steel reinforcement purchased from approved manufacture.

3.4.3 Storage

All reinforcement shall be stored horizontally above ground level (clear of any running or standing water) about 30 cm above the ground surface in such a way as to prevent distortion and deterioration by corrosion and nothing extra shall be paid on this account. Proper drainage of the platforms shall be ensured.

Bars of different diameters and lengths shall be stored separately and properly to facilitate easy counting and checking. Bars must be cleaned before concreting commences of all scale, rust, chloride contamination and other corrosion products or partially set concrete which may have been deposited there during placing of previous lift of concrete. Effective methods of cleaning will have to be used so that the steel is free from rust, scales and contamination. The decision of Engineer-in-Charge in this regard shall be final & binding.

Any reinforcement, which is certified as rusted by the Engineer-in-charge, shall be removed from the site within a week.

A record shall be maintained on batch numbers of reinforcement deliveries in such a form that the part of works in which particular reinforcement is used can be readily identified. At least 15 days quantity shall be available with the contractor in advance for taking account of time required for testing.

3.4.4 Bending and fixing

All reinforcement work shall be executed in conformity with the drawings supplied and instructions given by the Engineer-in-Charge.it shall generally be carried out as per bar bending schedule prepared in accordance with the relevant Indian Standard Specifications IS: 2502- Bending and Fixing of Bars for Concrete Reinforcement. Every bar shall be inspected before assembling on the works and any defective, brittle, excessively rusted or burnt bars shall be removed. Cracked ends of bars shall be cut out. All bars will be carefully and accurately bent by approved means in accordance with IS 2502, and relevant drawings. It shall be ensured that depth of crank is correct as per the bar cutting and bending schedule. Bent bars should not be straightened for use in any manner that will injure the material.

3.4.5 Consumption

Reinforcement shall be measured in length of different diameters as actually (not more than as specified in the drawings or authorised by engineer-in-charge) used in the work nearest to a centimetre. The standard sectional weights, as per CPWD specifications as mentioned below

will be considered for conversion of length various diameters of TMT bars into standard weight and it shall be considered for payment purpose.

The actual issue and consumption of steel on work shall be regulated and proper account maintained as provided in clause 10 of "General conditions of contract for CPWD works 2005, amended upto the last day of issue of the tender". The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 42 of the contract and shall be governed by conditions laid therein. No payment for excess consumption of steel shall be allowed. However, for consumption lesser beyond the permissible theoretical variation recovery shall be made in accordance with conditions of contract without prejudice to action for acceptance of work/item at reduced rate or rejection as the case may be.

The theoretical consumption of steel shall be worked out for measurement of payment. Steel brought to site and steel remaining unused shall not be removed from site without the written permission of the Engineer-in-Charge. The standard sectional weights are as given below.

Table No:-1 Standard Sectional weight

Dia. of Bar (mm)	**6**	**8**	**10**	**12**	**16**	**20**	**25**	**32**	**36**	**40**
Weight (Kg/m)	0.222	0.395	0.617	0.888	1.58	2.466	3.85	6.31	7.99	9.85

Records of actual sectional weights shall be kept dia wise and lot wise. The average sectional weight for each diameter shall be arrived from samples from each lot of steel received at site. The decision of the Engineer-in-Charge shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute one single lot for the purpose. The weight of steel by conversion of length of various sizes of bars based on the actual weight and average sectional weight shall be termed as Derived Actual Weight.

If the Derived Actual Weight as in sub-para (i) above is lesser than the standard weight as in the table above then the derived actual weight shall be taken for payment.

If the derived Actual weight in sub-para (i) above is found more than the standard weight, then the standard weight as given in table above shall be taken for payment. In such case nothing extra shall be paid for the difference between the derived actual weight and the standard weight.

3.4.6 Bar Bending Schedule

Prior to starting bar bending work, the Contractor shall prepare bar bending schedule from the structural drawings supplied to him and get the same approved by Engineer-in-Charge in conformity with IS: 2502. Any discrepancies and inaccuracies found by the Contractor in the drawings shall be immediately reported to the Engineer-in-Charge whose interpretation and decision there to, shall be accepted. No work shall be commenced without the Engineer-in-Charge's approval of the bar-bending schedule.

3.4.7 Lapping & welding

As far as possible bars of the maximum length available shall be used. Laps shown on drawings or otherwise specified by the Engineer-in-Charge will be based on the use by the Contractor of bars of maximum length. However the laps in the reinforcement are not to be measured separately. Payment for reinforcement shall be made only for reinforcement shown in drawings. Bars having butt or lap welds shall be provided as specified in the drawings and to the satisfaction of the Engineer-in-Charge.

3.4.8 Mechanical Couplers

Mechanical couplers shall be used wherever specified in the drawings for 25mm and above dia of bars to reduce congestion of reinforcement and to save on lap length costs. Mechanical couplers only from approved suppliers as per **Annexure-A** shall be used subject to approval of the engineer in charge. Minimum length of bar shall be 5m for using coupler. In specific situations a prior approval shall be obtained from Engineer in Charge before executing the work.

3.4.9 Placement and Positioning

All reinforcement shall be placed and maintained in the positions shown on the drawings. The Contractor shall provide approved types of supports for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as specified on the drawings. Cover blocks of required shape and size, MS Chairs and spacer bars shall be used to ensure accurate positioning of reinforcement. However, chairs and spacers shall not be measured for payment. Cover blocks shall be cast well in advance and shall consist of approved proprietary pre-packaged free flowing mortars (Conbextra HF of Fosroc or equivalent). They shall be circular in shape for side cover and square for bottom cover. The cost of cover block shall be deemed to have been included in the rates. Annealed wire shall be used for binding reinforcement.

3.4.10 Projecting Reinforcement

Reinforcement left projecting from newly placed concrete shall be supported in such a way that there is no sag or risk of damage to the newly placed concrete. The projecting bars, which are likely to be exposed for a long time, shall be protected by a coat of neat cement wash. These shall be thoroughly cleaned and wire brushed before depositing fresh concrete around it. No reinforcement bar shall remain exposed or projecting out of the finished concrete surface. These shall be removed or treated in a manner as directed by Engineer-in-Charge. The unwanted projected reinforcement bars shall be cut below the finished surface and the cut end painted with cement slurry. Thereafter the surface shall be repaired to match the colour, texture or pattern of adjoining concrete to the satisfaction of Engineer-in-Charge.

Welding

Wherever specified all lap and butt welding of bars shall be carried in accordance with IS: 2571. Only qualified welders shall be permitted to carry out such welding. Electrodes with rutile coating as per IS: 814 should be used. Bars shall be free from rust at the joints to be welded. Slag produced in welding after alternative run should be chipped and removed by brush. Electrode should not be lighted by touching the hot bar. The welding procedure shall be

approved by the Engineer-in-Charge and tests shall be made to prove the soundness of the welded connection.

3.5 POT-cum-PTFE Bearings

POT-cum-PTFE Bearings have to be suitably designed for the service as well as construction stage loading and movement. These designs shall be performed by the supplier selected by the Contractor and shall be duly approved by the Department. The Contractor shall purchase the bearings from the approved supplier as mentioned in **Annexure - A.**

"IRC: 83 (Part III): POT, POT CUM PTFE, PIN and Metallic Guide Bearings" shall form the basis of bearing design. The entire anchor sleeves, bolts, plates etc. shall be hot dip galvanised @ 300 gm/m^2. The contractor shall submit a detailed methodology for the installation of bearings for the approval of the Engineer-in-charge. The supplier of bearings shall also furnish maintenance manual for bearings. The supplier of the bearing shall be associated during installation of the bearings and the supplier shall give an undertaking certifying that the bearings have been installed as per specifications.

All the bearings shall carry at least **15 years warranty** in a prescribed format in Annexure **- G**. The bearings shall be replaced free of cost by the contractor, if any defects are observed during this period.

3.6 Expansion Joints

Expansion joints shall be obtained from the manufactures as mentioned in the **Annexure- A** of this tender document. The expansion joint shall cater for expected movement and rotation of the structure at the joints and providing smooth riding surface. It shall also be easy for inspection, maintenance and replacement. The expansion joint shall be robust, durable, water tight and able to safely withstand all the imposed loads including the impact load from live load and other sources.

The expansion joints shall conform to and be installed as section 2600 of MORTH Specification and duly supplemented by manufacture's recommendations. IRC: SP 69-2005 shall also be followed on guidelines for expansion joints.

All the expansion joints shall carry at least **15 years warranty** in a prescribed format in the **annexure F**. The expansion joints shall be repaired/replaced free of cost by the contractor to the satisfaction of the Engineer-in-charge, if any defects are observed during this period.

3.7 Black Bolts and Nuts

Black bolts, nuts and screws (Class 4.6) shall be in accordance with IS:1363 "Black Hexagonal Bolts (6 mm to 39 mm) with "Nuts and Black Hexagonal screws (6 mm to 24 mm)".

3.8 Road Work

3.8.1 Granular Sub-base.

3.8.1.1 Type of material

The Material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag, crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer-in-Charge.

3.8.1.2 Grading

While the grading in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding grading for the coarse-graded materials for each of the three maximum particle sizes are given in Chapter 5, the grading to be adopted for a project shall be as specified in the Contract.

3.8.2 Coarse Aggregates

3.8.2.1 Type of material

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36mm sieve. They shall be clean, hard, and durable of cubical shape, free from dust and soft of friable matter, organic or other deleterious substances. Where the Contractor's selected source of aggregates have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacture's recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping.

3.8.3 Fine Aggregates

3.8.3.1 Type of material

Fine aggregates shall consist of crushed or naturally occurring mineral material or a combination of the two, passing the 2.36mm sieve and retained on the 75-micron sieve. They shall be clean, hard durable, dry and free from dust, and soft or friable matter, organic or other deleterious matters.

The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part 37).

The plasticity index of the fraction passing the 0.425 mm sieve shall not exceed 4 when tested in accordance with IS:2720 (Part 5).

3.8.4 Lime

3.8.4.1 Type of material

Lime for use, as filler in bituminous mixes shall be commercial dry lime, pre-slaked, and delivered to site in suitable packing. It shall have a purity of not less than 80 per cent by weight of quick-lime (CaO) when tested in accordance with IS: 1514.

3.8.4.2 Storage of Lime

Lime shall be properly stored to avoid prolonged exposure to the atmosphere and consequent carbonation.

3.8.5 Bitumen

3.8.5.1 Type of material

Bituminous materials shall be of the following two types, as specified in the contract:

1. Bituminous emulsion
2. Penetration grade bitumen

3.8.6 Bituminous emulsion

The bituminous emulsion shall comply with the requirements of IS: 8887 and Penetration grade bitumen Penetration grade bitumen shall comply with the requirements of IS: 73. They are referred to by a single-figure designation. Thus, grade 35 refers to bitumen in the range of 30 to 40.

3.8.7 Polymer modified Bitumen

Polymer modified binder shall comply with the requirements of IRC: SP-53-2002 and Elastomeric Thermoplastic Specifications. The modifier shall be Styrene-Butadiene-Styrene, and the blending of the modifier with bitumen shall be accomplished either in the refinery or an approved plant at site capable of mixing the modifier and bitumen uniformly. The minimum content of (SBS) Styrene-Butadiene-Styrene shall be 4% with appropriate sulphur content.

The contractor shall procure bitumen of required grade as specified conforming to IS: 73-1992 with upto date amendments and other relevant codes from the manufactuers of repute like Indian Oil Corporation Ltd. Hindustan Petroleum Corporation Ltd. and Bharat Petroleum Corporation Ltd. as approved by Ministry of Petroleum, Govt. of India and holding licence to use ISI certificates mark for their products.

3.8.7.1 Mode of Procurement

Bitumen/Bitumen emulsion for tack coat shall be brought at site in sealed drums only bearing following marking (legible)

1. Name of Manufactures.
2. Gross Wt., Net Wt. And Tare Weight.
3. Month and Year of Manufacture.
4. Use before_____(date)
5. Type and Grade.
6. Batch Number
7. "ISI" Certification and Standard Mark.
8. Name of Contractor/Supplier.
9. Serial No. & Total Nos. of drums in each batch.

For providing bituminous surface like BM, DBM, DBC etc. the bitumen shall be procured either in sealed drums or in bulk and stored at the hot mix plant site. The drums/container shall bear the marking as mentioned in above para.

The contractor will produce original challan/voucher for purchase of bitumen and emulsion from IOCL/HPCL/BPCL/BP/HINCOL as a proof of having purchased the material from manufacture. The voucher/challan shall be returned to the contractor after verification and making necessary endorsement.

Bitumen of specified grade shall be brought to plant site in one lot for theoretical requirement upto 20 tonnes and in lots of 20 tonnes or more for theoretical requirement of more than 20 tonnes. The day to day receipt and issue accounts of bitumen shall be maintained by the Junior Engineer in charge and signed daily by the contractor or his authorised agent on the following proforma:

PROFORMA FOR THE BITUMEN REGISTER RECEIPT

Date of Receipt	Quantity Received	Progressive Total	Date of Issue	Qty issued	Total issued	Balance in hand	initials
1	2	3	4	5	6	7	8

JE's initials	Item of work of which issued	Appx. Qty of work done on each day	Theoretical req. of bitumen for work done on each day	Remarks of AE/AEE,	Ex.Eng
9	10	11	12	13	14

When bitumen is issued/brought in drums, the same shall be stacked in fenced enclosures, to be provided by the contractor, at his own cost, as directed by the Engineer-in-Charge, on one side of the roadway. The contractor shall be responsible for the watch & ward and safety of bitumen. The contractor shall facilitate the inspection of bitumen stockyard by the Engineer-in-Charge or his representative at any time.

Materials shall be kept in the joint custody of the contractor and the removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge. Heating of bitumen in drums for any purpose whatsoever shall not be allowed.

3.8.7.2 Sampling and Testing

The contractor shall have to obtain and furnish test certificates issued by manufacture to the Engineer-in-Charge in respect of bitumen procured by him. The samples shall be collected at discretion of Engineer-in-Charge and got tested as per provisions of IS: 73/MORTH/CPWD specifications from the laboratories approved by him.

The contractor shall supply, free of charge, the bitumen required for testing.

In case the test result indicate that the bitumen procured by the contractor does not confom to the relevant BIS codes/specifications, the same lot shall stand rejected and shall be removed from the site of work by the contractor at his own cost within a week's time of written order from Engineer-in-Charge to do so.

The bitumen content in bituminous mix shall be checked by conducting the bitumen extraction test conforming to IRC: SP 11 at regular interval during the progress of work, the actual consumption of bitumen shall be worked out based on such test results. The theoretical consumption shall be worked out based on the design mix formula and the actual consumption (based on extraction test as well as MAS account). If found less than theoretical one, the recovery shall be made from contractor for bitumen 60/70 grade and PMB-40 @ Rs.**********and Rs********** per MT respectively. The work found executed with bituminous mix having bitumen content lesser than permissible variation of (-) 0.3% shall be considered as sub-standard work and hence shall be liable for rejection. However, nothing extra shall be paid if actual consumption so worked out is higher than theoretical consumption. This is without prejudice to action under other relevant clause of the agreement.

Bitumen brought to site/Hot Mix Plant and bitumen remaining unused after completion of work shall not be removed from site without permission of the Engineer-in-Charge.

In case the items for roadwork like GSB, WMM and Bituminous layers are taken by contractor from outside manufacture, all quality assurance tests and procedures on raw materials shall be applicable at source and random samples for checking will be taken from materials delivered at site.

***At the justified rates at the time of tendering**

3.9 Coarse Aggregates

Coarse aggregates shall consist of naturally occurring crushed stones. The aggregates shall be hard, strong, dense, durable, clear and free from adherent coating, injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. The presence of flaky, deleterious and elongated pieces shall be avoided.

The nominal maximum size of aggregate to be used shall be 20 mm for reinforced concrete works. However large size aggregate upto 40mm may be allowed by engineer-in-charge for

plain concrete. The other requirements of coarse aggregates shall as per IS: 383 and MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001.

The contractor shall satisfy himself that the material complies with the requirement of IS: 383 and shall furnish a certificate to this effect to the Engineer-in-Charge. In case the aggregates tested do not comply with any requirement of the relevant codes the source for the same shall be rejected. No further samples from the rejected source shall be considered for approval.

3.9.1 Blending of Aggregates

In order to obtain optimum workability, individual aggregates of nominal size 20mm, 10mm, 4.75mm and 2.36mm will be blended in such a way that the grading curve for all aggregates will be a smooth curve from size 0.15mm to 25mm falling within the established envelop grading curve. Contractor shall establish envelop grading curve for each grade of concrete for given maximum size of aggregates and get it approved by Engineer-in-Charge before finalising the mix design. However, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in correct proportions as and when required.

The aggregate shall be stored in such a way as to prevent mixing with foreign materials. Different sizes of coarse aggregate shall be stored in a separate stockpile sufficiently distant from each other in order to prevent intermixing of the materials at the edges of the stockpiles.

3.10 Fine Aggregate

The quality, tests and acceptance criteria for fine aggregates shall be as per IS:383 and MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001. The fine aggregates shall conform to Zone II or Zone III as per requirement of trial mix design (or any combination of the two as approved by the Engineer-in-charge). The decision of Engineer-in-Charge in this respect shall be final.

The fine aggregate shall be river sand, stone dust or other approved sand. It shall be free from clay, loam, earth or vegetable matter and from salt or other harmful chemical impurities. It shall be clean, sharp, strong, angular and composed of hard siliceous material.

The silt content of fine aggregate used for trial mixes shall be recorded & the silt content in fine aggregate used shall neither exceed 6% nor 1% more than that of the fine aggregate used in the trial-mix. Regarding storage of fine aggregates, provisions as stated above for coarse aggregate shall apply.

3.11 Water

Potable water only shall be used for the works. Water to be used for mixing and curing shall be clear and free from injurious impurities like oils, acids, alkalis, salts, sugar, organic material or other substances that may be deleterious to concrete or steel. The pH value of the water shall not be less than 6.

Water shall be from the source approved by the Engineer-in-Charge and shall be in accordance with clause 5.4 of IS: 456. Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete for approval of the Engineer-in-Charge. No water shall be used until tested and found satisfactory.

The Contractor shall make his own arrangements for storing water, if necessary, in drums or tanks or cisterns, to the approval of the Engineer-in-Charge. Care shall be exercised to see that water is not contaminated in any way.

As a guide, the following concentration represents the maximum permissible value.

To neutralise 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The details of tests are given in 8.1 of IS: 3025 (Part 23).

To neutralise 100-ml sample of water using mixed indicator, it should not require more than 25 ml of 0.02 normal H_2SO_4. The details of tests are given in 8.1 of IS: 3025 (Part 23).

Table 3-1 maximum permissible limits of solids

S.No	particles	Permissible Limit (Max)	Tested as per
1	Organic	200 mg/l	IS: 3025 (Part 18)
2	Inorganic	3000 mg/l	IS: 3025 (Part 18)
3	Sulphates (as SO_3)	400 mg/l	IS: 3025 (Part 24)
4	Chlorides (as Cl^-)	500 mg/l	IS: 3025 (Part 32)
5	Suspended matter	2000 mg/l	IS: 3025 (Part 17)

3.12 Admixtures

3.12.1 Use of Admixture

Engineer-in-charge may permit the use of approved admixture for imparting special characteristics to the concrete on satisfactory evidence that it does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no deleterious effect on the reinforcement. The minimum cement content specified shall not be reduced on account of the use of the Admixtures. Cost of all admixtures shall be borne by the contractor and deemed to have been included in his offer.

3.12.2 Type of Admixtures

Retarding admixtures based on Lingosus-Phonates with due consideration to clause 5.2 and 5.3 of IS: 7861 shall be permitted to use. Admixtures generating hydrogen and nitrogen etc. shall not be used. The admixtures used shall conform to IS: 9103. Contractor shall submit the details of the Admixture proposed to be used for the prior approval of the Engineer-in-charge along with a copy of the Manufacture's Test Certificate not earlier than 6 months. The suitability of all admixtures shall be verified by trial mixes of concrete with 0.5% & 1% of admixtures to ascertain compatibility between particular cement and a particular admixture at no additional cost and as per direction of Engineer-in-Charge.

3.12.3 Dosage

The contractor shall further provide the required information concerning each admixture to the Engineer-in-charge.

1. Normal dosage and detrimental effects of under dosage and over dosage.

2. The chemical names of the main ingredients in the admixtures.

3. The chloride content, if any, expressed as a percentage by weight of admixture.

4. Whether or not the admixture leads to the entrainment of air, when used in the manufacture's recommended dosage?

3.12.4 Blending of Admixtures

Where two or more admixtures are proposed to be used in any one mix, the manufacture's written confirmation of their compatibility must be obtained and submitted to the Engineer-in-charge for prior approval.

3.13 Embankment

3.13.1 Earth

3.13.1.1 Type of material

The materials used in embankments, subgrades, earthen shoulders and miscellaneous backfill shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer-in-Charge. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/subgrade.

3.13.1.2 Material considered unsuitable

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

- Materials from swamps, marshes and bogs;

- Peat, log, stump and perishable material; any soil that classifies as OL, OI, OH or Pt in accordance with IS: 1498;

- Materials in a frozen condition;

- Clay having liquid limit exceeding 70 and plasticity index exceeding 45; and Material with salts resulting in leaching in the embankment.

Expansive clay exhibiting marked swell and shrinkage properties (free swell index exceeding 50% as per IS 2720-part40) shall not be used as a fill material.

3.13.1.3 Sulphate Content

Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO_3) per litre when tested in accordance with BS: 1377 test 10, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the contract, of concrete, cement bound materials or other cementitious material forming part of the permanent works.

Materials with a total sulphate content (expressed as SO_3) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

3.13.1.4 Size of coarse material

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

3.13.1.5 Density Requirement:

Ordinarily, only the materials satisfying the density requirements given in following table shall be employed for the construction of the embankment and the subgrade.

Table 3-2 Density Requirements of Embankment and Subgrade Materials

S.No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS:2720 (Part 8)
1.	Subgrade and earthen embankment, shoulders/verges/backfill	Not less than 17.5 kN/ cu. m.

Notes This is not applicable for lightweight fill material e.g cinders,fly ash etc.

The Engineer-in-Charge may relax these requirements at his discretion taken into account the availability of materials for construction and other relevant factors.

The material to be used in subgrade should also satisfy design CBR at the dry unit weight applicable as per above table

3.14 Fly Ash

Deleted

3.15 Waterbars / Waterstops

Deleted

3.16 C.C. Kerb Stones

3.16.1 Procurement

Pre-cast C.C.kerb stones conforming to M-25 grade of concrete and size as mentioned in the nomenclature of items, shall be procured only from reputed manufacture approved by Engineer-in-Charge. The plant/ factory to be approved by the Engineer in Charge shall strictly adhere to following norms before supply is entrusted to them:

1. The mix shall be prepared in batch mix plant only.
2. The plant shall remain open to inspection at any time for above lot.
3. A suitable vibrating and curing mechanism shall be maintained to ensure the quality as desired.
4. Minimum grade of concrete shall be M-25 i.e. compressive characteristic strength of concrete at 28 days shall not be less than 25 N/mm^2.
5. Proper Logo of manufacture shall be engraved on each kerb stone.

The contractor shall provide original challan / voucher as a proof of having the material purchased from the approved manufacture. The original challan/voucher shall be returned after verification and making necessary endorsement.

3.16.2 Laying

Before laying at site compressive strength test in accordance with specifications shall be mandatory. Laying shall be as per specifications and direction of Engineer-in-Charge.

3.16.3 Sampling And Testing

The contractor shall have to obtain and furnish test certificates issued by manufacture to the Engineer-in-Charge in respect of material purchased by him. However, sample shall be collected, at discretion of Engineer-in-Charge and got tested as per relevant B.I.S. Codes and specifications from the laboratory provided by him.

The contractor shall supply, free of cost, the required samples of kerbstones for testing. Cost of tests shall also be borne by the contractor.

In case the test results reveal that the kerb stones procured by the contractor do not conform to the relevant B.I.S. Codes and specifications, the same lot shall stand rejected and the contractor shall have to remove that material from site at his own cost within a week's time of written order from Engineer-in-Charge to do so.

For the execution of any items of work where any incidental work is actually required but not specifically stated in the tender, it is to be understood that the rate quoted by the contractor shall cover such charges also and nothing extra on account of such incidental charges, if any, shall be paid.

3.17 Inserts and Embedments

Various steel inserts and Embedments are required under the contract to be fabricated, galvanised to minimum 200 gm/sq.m, positioned and secured firmly into place inside the formwork prior to concrete being poured. There are also requirements of jointing, threading, bolting and welding inserts and Embedments of different concrete and structural steel elements in order to establish structural continuity and connection. Great care shall be exercised by the contractor in executing all aspects of the work related to inserts and Embedments, including tolerances, primers, galvanising etc. so that the final assembly of the concrete elements can meet satisfactorily the requirements intended in the structure.

3.18 Conditions For Thermoplastic Paint

The Thermoplastic paint material shall conform to relevant specifications & standards as described in Particular Specifications and shall be procured from approved manufacture as given in **Annexure – A.**

3.18.1 Documents to be submitted along with the tender:

The catalogue / brochure containing manufacture's name and address with trade mark, brand name and test certificates from CRRI / BIS or approved institution for the thermoplastic paint proposed to be used in the work.

List of the roads, highways and expressways where the thermoplastic paint have been provided by the principal manufacture / applicant during the last five years and the performance reports from the concerned authorities /owners.

List of in house testing facilities available with the applicant of thermoplastic paint and the principal manufacture of thermoplastic paint.

List of the independent laboratories where testing facilities similar to in house testing facilities are available.

List of the independent laboratories where the manufactures have been sending samples for quality assurance tests and copies of the test reports duly linked with the applicable standards.

An undertaking to the effect that the contractor will necessarily deploy Fully/semi Automatic paint applicator machine on the work.

In case of procurement of thermoplastic paint from the foreign based manufactures, the following documents shall have to be submitted by the Indian Associates (Marketing agents) before material is allowed to be used in the work.

1. Order placed on the foreign-based manufactures.
2. Proforma invoice received from the foreign-based manufactures.
3. Letter of credit established for release of payment to the foreign-based manufactures.
4. Bill of loading, invoice, packing list and all other related shipping documents.
5. Proof of payment of custom duty.

6. Catalogue / brochures published by the manufacture for the product.

The Contractor shall produce documentary evidence from manufacture having valid license for manufacturing of the product conforming to relevant standards under BS: 3262 and to use "KITEMARK" (British Standard Institution Logo or equivalent on Thermoplastic raw material bags.

Full quantity of material required as per theoretical consumption shall be deposited by the contractor with the Engineer-in-Charge of the work before commencement of the work. Procurement shall be from maximum of two batches from the manufacture. If the material is procured from more than two batches, the cost of additional tests shall be borne by the contractor. All the material shall be kept in joint custody of the contractor and the representative of the Engineer-in-Charge.

Batch wise Test report with satisfactory results for the each supply of thermoplastic material & glass beads duly tested from National Test House, Alipur or equivalent as approved by the Engineer – in – Charge, shall be produced by the contractor. However Engineer-in-Charge shall be at liberty to get the materials tested and from any testing laboratory at his sole discretion. Test result thus obtained shall be binding upon the contractor for acceptance. However nothing extra shall be paid to contractor for cost of material tested.

Consumption of paint shall be regulated by preparing a theoretical consumption statement with each Running Account / Final Bill for which rate of consumption of paint shall be 50.00 kg. Per 10 Sqm. comprising of glass beads @ 30% by weight of paint. A variation of (-) 5%, however, shall be allowed. If actual consumption is found below the permissible limit and upto (-) 10% variation, a recovery @ Rs.140/- per Kg. shall be made from the contractor and beyond (-) 10% variation, work shall out rightly be rejected and for excess consumption, if any, nothing extra shall be paid.

Unless otherwise specified, nothing extra shall be payable for compliance of the aforesaid conditions.

Other Materials

All other materials like Silicone Sealant, PVC coated MS foot rests for drains, etc. not specifically mentioned above shall be of best quality and shall conform to relevant IRC / BIS codes/BS codes/MORTH/CPWD specifications. Wherever no specific code of practice of IRC/BIS is applicable, the decision of the Engineer-in-charge shall be final and binding regarding specification to be adopted for any particular material.

3.19 Tests and Quality Control

For the purpose of Quality assurance requirements, the project has been considered to qualify class Q4 of IRC: SP- 47. The various tests and frequency of tests specified in this contract shall be strictly followed unless specifically agreed to be modified by the Engineer-in-Charge otherwise. Every material shall undergo a pre testing by the Contractor before the same is proposed to be incorporated in the project. For certain materials, this pre-test may be in the form of manufacture's test certificates. The various tests and frequency of tests to be carried out by the contractor at the site laboratory and / or external laboratory are given in the tabular form in **Annexure - C** of the tender. For other materials not covered in **Annexure - C** the various tests and frequency for the test shall be decided by the Engineer-in-Charge as per the relevant provision of BIS/MORTH/IRC/CPWD specification. Any other test (site laboratory

and/or external laboratory) if required by the Engineer-in-charge shall be done as per the directions of the Engineer-in-charge. In the tables in **Annexure C**, under the column designated “Laboratories” the numerals imply as follows:

1 Pre-testing

2 A Testing at site laboratory

2 B Testing at external laboratory as the same can not be carried out at site

3 & 3A Testing at an external independent laboratory for more important and sensitive material. This laboratory shall be different from the external laboratory mentioned in 2B above.

The Contractor shall be required to establish a full-fledged site laboratory in good working condition and housing at least the equipment indicated in **Annexure - D**. Within the mobilisation period, the Contractor shall establish this complete site testing laboratory and arrange all relevant Indian and International codes and standards. If the contractor fails to conduct field/lab tests at his site laboratory as per **Annexure-C**, the same shall be got done by the Engineer in Charge and twice the cost of such testing will be recovered from the contractor. However, for these tests, the contractor shall supply free of charge all the materials required for testing.

The contractor shall depute a full time qualified Engineer, exclusively for supervising the entire laboratory tests to the satisfaction of Engineer-in-Charge. The contractor shall also identify external testing laboratories, to be approved by The Executive Engineer, DDA, for various tests that are required to be carried out in the external independent laboratories. Some of the approved laboratories are listed in Annexure – D1. The quoted rates shall include cost of all test material and their tests to be conducted at field laboratory for the purpose of quality assurance.

At least 25% testing of materials as mentioned in **Annexure-C** shall be got done by DDA from external laboratories. However, for the tests to be carried out by the external laboratories, the contractor shall supply free of charge all the materials required for testing. The testing charges shall be born by the Contractor.

All the testing machines and equipment (including batching plant) shall be calibrated prior to first use and recalibrated periodically as determined by the Engineer-in-charge to detect errors. The calibration certificates/charts (from an approved laboratory) shall be submitted to the Engineer-in-charge well in advance of execution of work. The moulds for cubes shall be checked at regular interval as decided by Engineer-in-Charge and made to conform to specifications contained in IS-516.

The contractor or his authorised representative shall associate in collection, preparation, forwarding and testing of such samples. In case he or his authorised representative is not present or does not associate himself, the Engineer-in-Charge shall do the needful for getting the samples collected and tested, the results of such tests and consequences thereof shall be binding on the contractor.

3.19.1 Third Party Quality Assurance

In order to achieve a high standard of quality, it may be required to go for Third Party Quality Control. For this purpose, a separate agency shall be appointed by the owner who will carry out

independent testing of materials and checking and ensuring over all quality procedures. The contractor shall be required to fully cooperate with agency and facilitate them in taking samples, transportation and examination of various activities including documentation at no extra time and cost to the owner. In case of any adverse findings by the agency, the contractor shall do the needful rectification at no extra time and cost to the owner. The Engineer-in-charge shall be at liberty for getting quality assurance work done through agencies like CRRI, IIT Roorkee, Delhi College of Engg and IIT, Delhi (any one agency as approved by Chief Engineer) at the cost of contractor. The successful tenderer shall include the provisions mentioned below while framing the proposed methodology for tests.

At least 25% testing of materials as mentioned in **Annexure-C** shall be got done by DDA from external approved laboratories as mentioned in **Annexure-D1**. However, for the tests to be carried out by the external laboratories, the contractor shall supply free of charge all the materials required for testing, including transportation. The testing charges shall be born by the Contractor.

The representatives of DDA Lab shall be at liberty to inspect the testing facilities at site and conduct testing at random in consultation with Engineer in Charge. The contractor shall provide all necessary facilities for the purpose. Preferably 25% testing of materials as mentioned in **Annexure-C** may be conducted through DDA Lab, situated at Games Village, New Delhi, as directed by Engineer in Charge. No extra claims whatsoever on this account shall be admissible.

3.20 Notice to the Engineer–in-charge

The contractor shall give not less than 7 days notice for all tests in order that the Engineer-in-Charge may be present. Two copies of all test certificates shall be supplied by the contractor to the Engineer-in-Charge for approval immediately after the completion of the tests. Test certificates shall invariably be supplied to the Engineer-in-Charge well in advance before the materials or components are used in the works, unless the Engineer-in-Charge directs otherwise.

3.21 Storage

Material, cement, steel & bitumen shall be kept in joint custody of the contractor and the representative of Engineer-in-Charge. Department shall not provide any storage. Separate storage of adequate capacity shall be provided by the contractor without any extra cost to the Department.

Materials required for the work shall be stored by the contractor only at places in standard profiles and in the manner approved by the Engineer-in-Charge. Storage and safe custody of materials shall be the responsibility of the contractor. Special care shall be taken as per relevant specifications for storage of bitumen etc. The contractor shall make sure that the materials shall be brought in, at a time, in adequate quantities to suffice for the whole work or for at least a month's work.

The contractor shall construct suitable godowns at the site of work for storing the materials safe against damage due to sun, rain, dampness, fire, theft etc. He shall also employ necessary watch and ward establishment for this purpose at his own cost. The materials which are likely to get deteriorated shall be stored under covered sheds with waterproof roofs constructed on

consolidated elevated platform with adequate seepage control measures as per direction and satisfaction of Engineer-in-charge. The quoted rates shall be deemed to have included the cost of all such storage. The storage space shall be open for inspection as and when required by the Engineer-in-charge.

The procedure for storing and stacking the important materials which the contractor must adhere to during the currency of contract work shall be as described hereunder and/or as directed by the Engineer-in-Charge.

3.21.1 Cement

Separate godowns shall have to be provided for different grades of cement. The storage godowns to be provided shall be on elevated platform on consolidated ground with water proof roof and provisions of prevention of seepage.

The cement shall be stacked in rows of 2 and not more than 10 bags high. The bags shall be stacked atleast 10 to 20 cm clear above the floor. A space of 60 cm all around should be kept between the exterior walls and the stacks. Cement bags should be placed close together in the stack to reduce air circulation to a minimum. For extra safety during the monsoon or when it is expected to store the cement for usually long periods, the stacks shall be completely covered with polythene sheets or any other suitable water proofing covering. The covering shall close on the top of the stack. Care should be taken that the polythene sheet is not damaged any time during the use. Wherever bulk storage containers are used, these should be cleaned at least once in every month. When removing bags from storage, it shall be made sure that they are taken from two or three tiers back rather than all from one tier. If the piles of bags are thus stepped back they are less likely to fall over. When removing cement bags for the use, apply the first in first out rule i.e. use the oldest stacks first. Cement bags shall, therefore, be stacked separately in order to permit easy access for inspection and facilitate removal.

Storage of cement at site of work shall be at contractor's expenses and risk. In the event of any damage occurring to cement due to faulty storage in contractor's sheds, or on account of negligence on his part, such damage shall be the liability of the contractor.

3.21.2 Aggregates

The aggregate shall be stored in such a way as to prevent mixing with foreign materials. Different sizes of fine or coarse aggregate shall be stored in a separate stock piles sufficiently distant from each other in order to prevent intermixing of the materials at the edges of the stock piles.

3.21.3 Bitumen

Materials shall be kept in the joint custody of the contractor and the representative of the Engineer-in-Charge. No heating of bitumen in drums for any purpose whatsoever shall be allowed.

3.21.4 Materials Found At Site of Work

The liability and disposal responsibility for the material obtained during excavation, dredging, boring, cleaning of site etc., which is not to be reused in the work, shall remain with the

contractor unless otherwise provided in the relevant items of work or else where in the tender document.

However, all fossils, coins, articles of value or antiquity and structures or other remains or things of geological or archaeological interest discovered on the site shall be the absolute property of the Department and the contractor shall take reasonable precautions to prevent his workmen or any other person from removing or damaging any such articles or valuables and shall immediately upon discovery thereof and before removal, acquaint Engineer-in-Charge and obtain his directions as to the disposal of the same at the expense of department. The material belonging to other agencies/ local bodies, if recovered during excavation, shall be handed over to them, if required by them.

3.21.5 Unsuitable Material

In addition to routine tests as specified above, if at any stage of execution of work, Engineer-in-Charge feels that the particular materials are not suitable to be used in any component of the structure covered under "The Scope of Work", the Engineer-in-Charge may order re-testing of the materials as per relevant specifications, IS code and sound engineering practice from any approved laboratory. The cost of samples for such testing shall be borne by the contractor. The test charges shall be borne by the department if the material is found meeting the acceptance criteria during re-testing. In such case, the cost of testing, for originally failed test sample shall be borne by the contractor only. If the sample is found not acceptable even on re-testing, the cost of such re-testing shall be borne by the contractor. The rejected material either after the routine tests or after re-testing, as the case may be, shall be immediately removed from the site of work by the contractor at his own cost.

Any material (s) used on work without prior inspection, testing and approval of the Engineer-in-Charge is/are liable to be considered unauthorised, defective and not acceptable. The Engineer-in-Charge shall have full powers to remove any or all of the materials brought to site by contractor which are not in accordance with the contract specifications or do not conform in character or quality to samples approved by him. In case of fault on the part of the contractor in removing rejected materials and any work executed with such unaccepted materials, the Engineer-in-Charge shall be at liberty to have them removed and/or dismantled by other means at the risk and cost of the contractor.

3.22 Explosives and Inflammable Material

If explosives or inflammable materials are to be used for execution of the works, the contractor shall at his expense obtain such licences as may be required for storing and using explosive and/or inflammable materials. Contractor shall at his own cost locate, construct and maintain magazines if such are required for storage in accordance with the requirements of the appropriate rules in force for their use and safety.

4 PARTICULAR SPECIFICATIONS

GENERAL:

All the works unless otherwise specified hereinafter or permitted by Engineer-in-Charge shall be done in accordance with the latest editions of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001, CPWD Specifications, IRC codes, with up to date correction slips & relevant BIS Codes as applicable, issued up to the date of issue of Tender. In case of any inconsistency among different Codes/Specifications, the order of precedence given in Chapter-7 (Special Conditions of Contract) will govern.

Unless otherwise expressly stated to the contrary either in Schedule of Quantities or elsewhere in this Tender, the method of measurements and other guide-lines as generally laid down in the MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 and CPWD specifications will be applicable as per the order of precedence given in Chapter-7.

The work shall be executed and measured as per metric units given in the Schedule of Quantities, drawings etc. (FPS units where indicated are for guidance only). Except where distinguished by BOQ, the rates apply to all heights, depths, sizes, shapes and locations. Absence of terms such as providing, supplying, laying, installing, fixing etc in the descriptions does not even remotely suggest that the Contractor is absolved of such providing, supplying etc unless an explicit stipulation is made in this contract. In the absence of any definite provisions on any particular issue in the above mentioned specifications, the design and construction shall be in conformity with the Sound Engineering Practice and in all such matters the decision of the Engineer-in-Charge shall be final and binding on the contractor and nothing shall be paid extra on such account. The Owner shall bear no costs of materials, labour, equipment, duties, taxes, royalties etc.

The Work shall be carried out in accordance with the "Good for Construction" drawings as would be issued to the Contractor by the Engineer-in-Charge duly signed and stamped by him. The Contractor shall be conscious not to take any drawings, designs, specifications, etc. not bearing Engineer-in-Charge's signature and stamp. Similarly the Contractor shall be conscious not to take instructions given by any other Authority except the instructions given by the Engineer-in-Charge in writing.

The specifications may have been divided into different sections / sub-heads for convenience only. They do not restrict any cross-references. The Contractor shall take into account inter-relations between various parts of works/trades. No claim shall be entertained on the basis of compartmental interpretations.

4.1 Protection of the Environment

This section of the Specification sets out limitations on the Contractor’s activities specifically intended to protect the environment.

The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on site or off-site are carried out in conformity with statutory and regulatory environmental requirements including those prescribed elsewhere in this document.

The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.

In the event of any spoil, debris, waste or any deleterious substance from the Site being deposited on any adjacent land, the Contractor shall immediately remove all such material and restore the affected area to its original state to the satisfaction of the Engineer.

4.2 Water quality

The Contractor shall prevent any interference with the supply to or abstraction from, and prevent any pollution of water resources (including underground percolating water) as a result of the execution of the Works.

Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall to specially constructed settlement tanks to permit sedimentation or particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.

All water and other liquid waste products arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.

The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer-in-Charge and the regulatory authorities concerned.

The Contractor shall at all times ensure that all existing stream courses and drains within, and adjacent to, the site are kept safe and free from any debris and any materials arising from the Works.

The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution as a result of the execution of the Works.

4.3 Air quality

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

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

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

In the event that the Contractor is permitted to use gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the Engineer-in-Charge, necessary. Such measures may include spraying the road surface with water at regular intervals.

4.4 Noise

The Contractor shall consider noise as an environmental constraint in his planning and execution of the Works.

The Contractor shall take all necessary measures so that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimise the noise emission during construction works.

4.5 Control of Wastes

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

4.6 Emergency Response

The Contractor shall plan and provide for remedial measures to be implemented in the event of occurrence of emergencies such as spillage of oil or bitumen or chemicals.

The Contractor shall provide the Engineer-in-Charge with a statement of the measures he intends to implement in the event of such an emergency which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.

No separate payment shall be made in respect of above compliance by the Contractor with the provisions of this Section of the Specification. The Contractor shall be deemed to have made allowance for such compliance with these provisions in the preparation of his lump sum price and the prices for items of work included in the Bills of Quantities and full compensation for such compliance will be deemed to be covered by them.

4.7 Provisions by Contractor

The Contractor shall provide and maintain at site throughout the period of works the following at his own cost and without extra charge, Except for the items specified in the Bill of Quantities the cost being held to be included in the Contract Rates:

1. General works such as setting out site clearance before setting out and on completion of works. All weather approach roads to the site office should also be constructed and maintained in good condition.

2. All labour, materials, plant, equipment and temporary works, Over head charges as well as general liabilities, obligations, insurance and risks arising out of GCC, required completing and maintaining the works to the satisfaction of the Engineer-in-Charge.

3. Adequate lighting for night work, and also whenever and wherever required by the Engineer-in-Charge.

4. Temporary fences, guards, lights and protective work necessary for protection of workmen, supervisors, engineers, General public and any other persons permitted access to the site. Contractor shall provide proper signage as directed. All fences, barricade shall be painted with colour shades as specified by the Engineer-in-Charge. The barricading should be as per drawing to ensure visual obstruction of work from public view. The barricading for the contractor's yard will not be payable.

5. All equipment, instruments, labour and materials required by the Engineer-in-Charge for checking alignment, levels, slopes and evenness of surfaces measurements and quality etc.

6. Design mixes and testing them as per relevant clauses of specifications giving proportion of ingredients, sources of aggregates and binder along with accompanying trial mixes. Test results to be submitted to the Engineer-in-Charge for his approval before adoption on works.

7. Cost of Preparation and compliance with provision of a quality assurance control programme.

8. Cost of safe guarding the environment as mentioned under section 8.1.

9. A testing laboratory as specified by the Engineer-in-Charge equipped with the following minimum apparatus, materials and competent trained staff required for carrying out tests, as specified elsewhere in the tender document.

4.8 Drawings and Dimensions

Figured dimensions on drawings shall only be followed and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

The dimensions where stated do not allow for waste, laps, joints, etc. but the Contractor shall provide at his own cost sufficient labour and materials to cover such waste, couplers, laps, joints, etc.

The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the contractor should verify them for himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

4.9 Setting Out of Works

The Contractor shall set out the Works indicated in the Conditions of Contract. The Contractor shall provide suitable stones with flat tops and build the same in concrete for temporary benchmarks. All the pegs for setting out the Works and fixing the levels required for the execution thereof shall, if desired by the Engineer-in-Charge, likewise be built in masonry at such places and in such a manner as the Engineer-in-Charge may direct.

The Contractor shall carefully protect and preserve all benchmarks and other marks used in setting out the works. The contractor will make overall layout of complete work and get it checked from Engineer-in-Charge. The cost of all operations of setting out including construction of benchmarks is deemed to be included in the quoted rates as per Bill of Quantities.

All the survey work except levelling shall be carried out using total stations with 3-second accuracy. The levelling work shall be carried out using Auto level.

The triangulation's point to be given in the detailed drawings or by Engineer-in-Charge before start of work shall be maintained during execution and handed over back to Engineer-in-Charge after completion of work.

4.10 Codes and Standards

A list of relevant IRC Codes, other publication of IRC and Recommended Codes of Practice is given in Annexure -B, which is not exhaustive but informative only. The contractor shall make available at site all relevant Codes of practice as applicable. Any additional standard specifications or criteria for design and construction of roads and bridges that may have been published by the IRC and in practice up to the date of issue of tender shall also be taken into account. In the absence of any definite provisions on any particular issue in the above mentioned specifications, the design and construction shall be in conformity with the Sound Engineering Practice and in all such matters the decision of the Engineer-in-Charge shall be final and binding on the contractor and nothing extra shall be paid on such account. For order of precedence, please refer to clause 7.1 of Chapter-7 (Special Conditions of Contract)

4.11 Load Testing on Completed Structures

During the period of construction or within the defect liability period the Engineer-in-Charge may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

1. Results of compressive strength on concrete test cubes falling below the specified strength.

2. Premature removal of form work.

3. Inadequate curing of concrete.

4. Over loading during the construction of the structure or part thereof.

5. Carrying out concreting of any portion without prior approval of the Engineer-in-Charge.

Honey combed or damaged concrete, which in the opinion of the Engineer-in-Charge is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.

Any other circumstances attributable to alleged negligence of the contractor, which in the opinion of the Engineer-in-Charge may result in the structure or any part thereof being of less than the expected strength.

All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Engineer-in-Charge, IS:456 and as indicated hereunder. Such tests shall be carried out only after expiry of minimum 28 days or such longer period as directed by the Engineer-in-Charge.

4.11.1 Methodology

The structure shall be subjected to a super-imposed load equal to 1.0 times the specified superimposed load assumed in the design. This load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members as directed. The deflection due to the superimposed load shall be recorded by sufficient number of approved deflectometers capable of reading up to 1/500 of 1 cm and located suitably under the structure as directed by the Engineer-in-Charge.

The structure shall be deemed to have passed the test if the maximum deflection at the end of 24 hours of loading does not exceed the deflection given by the following expressions

$D = 0.001\ L^2/25\ T$, where,

D = max deflection due to imposed load only

L = span of the member under load test (the shorter span in case of slabs). The span is the distance between centres of the supports or the clear distance between the supports and the depth of the member, whichever is smaller. In case of cantilever, this shall be taken as twice the distance from the support to the end and deflection shall be adjusted for movement of the support.

T = depth of member.

If within 24 hours of the removal of the superimposed load, the structure does not recover at least 75% of the deflection under the superimposed load, the test loading shall be repeated after a lapse of 72 hours. If the recovery after the second test is less than 80% of the maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

In such cases the portion of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Engineer-in-Charge. However such remedial measures shall be carried out to the complete satisfaction of the Engineer-in-Charge.

4.11.2 Cost of Testing

All costs involved in carrying out the tests and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost including consultancy charges for suggestion of remedial measures.

4.11.3 Other Test

In addition to the above load tests, non-destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the contractor at his own expense if so desired by the Engineer-in-Charge. Such tests shall be carried out by an agency approved by the Engineer-in-Charge and shall be done using only recommended testing equipment. The acceptance criteria for these tests shall be as specified by the testing agency or good engineering practice and as approved by the Engineer-in-Charge.

4.12 Specifications

Specifications of following items are covered in this chapter. All these specifications are in reference to the particular items of Schedule of Quantities.

1. Foundations
2. Concrete Works
3. Reinforced soil wall Works
4. Road Work
5. Embankments
6. Drainage works
7. Assembled Accessories (Bearings and Expansion Joints)
8. Civil works for Traffic Signages
9. Miscellaneous Works

Design Requirements

All the design shall conform to and comply with all the requirements given in the latest editions of the relevant Indian Road Congress Standard Specifications and Codes of Practice of Road Bridges, and other technical Specifications as detailed else where in the tender document. These standard specifications and codes of practice shall be supplemented, wherever necessary, by Ministry of Road Transport and Highways Specifications for Road and Bridge Works (Fourth Revision, 2001) published by Indian Roads Congress, CPWD Specifications (1996) the latest BIS, BS or AASHTO Codes of Practice and Specifications, CEB/FIP publications and Codes of Practice, so far as applicable. These shall also deem to incorporate any subsequent amendments that may be recommended by respective authorities of the above mentioned specifications and codes of practices, upto the date of issue of tender.

For all work for which the contractor has to submit design for approval of the Department, the same shall be got prepared by the contractor from consultants who are specialised in the field. The particular item of scaffolding, staging and shuttering, use of any proprietary method of staging, bearings and expansion joints etc. shall be supplemented with proper designs of such systems to be approved by the Engineer-in-Charge.

The tenderer shall assess with due care the supplementary site investigations needed to verify all topographical, hydrological and other site data indicated in the tender documents and also collect such additional site data/geotechnical data as may be necessary for doing the job.

4.13 Foundations

Mainly the following items have been covered in the specifications of concrete.

1. Open Foundations

2. Pile Foundations

4.13.1 Open Foundations

Results of the sub-surface investigations conducted at the Project Site are available with the department. This information about the soil and sub-soil water conditions is being made available to the Contractor in good faith and the Contractor is advised to obtain details independently as may be considered necessary by him before quoting rates in the tender. No claim whatsoever on account of any discrepancy between the sub-surface conditions that may be actually encountered at the time of execution of the work and those given in these Tender Documents shall be admissible to the Contractor under any circumstances whatsoever.

Ripping and breaking open of road or pavement or any other obstruction met with and all operations and incidental charges, etc. are deemed to be included in the rates. The bailing out of all sorts of water including rainwater, seepage water, sewage/sludge mixed water etc. or de-watering for lowering the ground water table required for construction is included in the scope. No separate payment for dewatering shall be payable.

Before the excavation is taken up, contractor shall follow the specifications as given below.

The contractor shall ensure all benchmarks and reference points likely to be disturbed during excavation are protected or transferred appropriately to enable their subsequent use. The excavations shall be done with safer slopping sides and/ or with soldier piles, in the longitudinal direction as approved by the Engineer-in-charge. At any point of time, it shall be ensured that the foundation of existing structures are safe.

At identified locations, the excavations shall be carried out after the installation of soldier piles and timber lagging.

The initial depth of excavation shall be done manually, if presence of underground utilities is suspected. Machine excavation can be resorted to for the remaining depth only with the permission of the Engineer-in-charge. The excavation shall proceed from the middle of the cut towards the walling so that the unsupported period to which the walling is exposed is the minimum. The last 0.5m of excavation shall be taken up only after full arrangements for laying the base concrete have been made. After the excavation is completed to the final level, the

base shall be prepared by dressing, ramming, consolidating and then base concrete shall be laid and compacted. It shall be ensured that at no time, the bottom of the cut is left exposed in the final level for long duration.

During excavation, if water percolation takes place through the joints in the pit, the contractor shall take remedial measures either by grouting or by caulking or plastering as approved by the Engineer-in-charge. If despite the precautions taken, there is water percolation and water is required to be pumped out, the contractor shall make arrangements to lead the water by appropriate surface drain to a convenient sump from where the same could be pumped out. The rate for excavation in all construction works includes all the expenses incurred in stopping water percolation and also includes the cost of arrangement for provision of sumps in the cut and collection of seepage and all sorts of other water such as rain waters, flood water, sewage or sludge mixed waters etc. towards the sumps.

The Contractor shall be required to maintain the water table over the entire area and in the vicinity of the foundation at or below 0.5m or more below the bottom level of the foundation at the lowest point of the same so that the dry working surface is available until the foundation is completed. Thereafter, the water table can be allowed to rise to its natural level. The Contractor shall also ensure that there is no danger to nearby properties and installations on account of such lowering of the water table. If needed, suitable measures shall be taken by the Contractor at no extra cost. Lump sum price offered by the contractor should be deemed to be inclusive of such incidental works. In trenches where surface water is likely to get into cut during monsoon a ring bund of puddle clay shall be formed outside to the required height and maintained at no cost to the department. The contractor shall also take steps to prevent back inflow of pumped water.

The contractor shall arrange to stack separately at locations or at dumping areas indicated by the Engineer-in-charge, the excavated spoils which are fit for use for back filling at no extra cost being paid for such stacking. Spoils from excavation shall be disposed off the construction site as per the directions of the Engineer-in-charge.

Any special treatment for improving the soil qualities to stabilise bottom against heaving conditions by way of any chemical or quick lime treatment, any grouting of soil-mass etc. in advance of excavation shall have to be done without any extra cost.

Excavation for all works and of materials required for filling shall be done with stable slopes as per contractor’s calculations or as directed by the Engineer-in-Charge. The contractors at his own expense shall put up the necessary shoring, strutting and planking with due regard to the safety of personnel and works and to the satisfaction of the Engineer-in-Charge. If required driving of rolled section / sheet pile of suitable size is required to be done into the soil to retain earth as directed by Engineer-in-Charge. Measurement of plan area of excavation for payment shall be permitted only up to the end of PCC under foundations. Nothing extra shall be paid for making any arrangement.

If excavation is carried out to greater depth than required beyond the level specified, for any reason whatsoever, such volume shall be made good by filling with PCC M15 having coarse aggregates 40 mm and down graded and brought to level to receive the levelling course below foundations. If excavation is carried out to greater width and length, such extra width and length shall be filled in by well consolidated earth / sand or if the Engineer-in-Charge thinks it is necessary for the stability of the work, by masonry or concrete as he may direct.

Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontal from the bottom of the excavation. No extra payment will be made on this account.

The Contractor shall, at the contract rates make provision for all shoring, dewatering, dredging, bailing out or draining water whether subsoil or rain or other water and the excavation shall be kept free of water while the masonry work or concrete work is in progress and until the Engineer-in-Charge considers the work well set (Refer IS: 3764 Safety Code for Excavation Work). The Contractor shall be deemed to have satisfied himself with regard to feasibility of all aspects of dewatering including site constraints due to existing structures. Though the method of dewatering is left to the contractor, he shall be required to submit method statement of dewatering scheme including requisite justifications to the Engineer-in-Charge and seek his prior written approval. Approval of the Engineer-in-Charge however shall not relieve the contractor of the responsibility of adequacy and appropriateness of dewatering and protection arrangements for the quality and safety of the work.

The contractor shall satisfy the Engineer-in-Charge as to the capacity of the drains or disposal site to take the required quantity and flow of water to be pumped out at various stages of excavation. The Contractor shall obtain necessary approvals of local bodies for discharging the pumped out water. All the dewatering pumps shall therefore also have dedicated DG Power supply that shall come on automatically in case of failure of electrical supply from the mains. Monitoring of water table shall be done using electronic probes located at least one each of the four corner of excavation.

The Contractor shall erect and maintain during progress of works temporary fences with all safety measures around dangerous excavations at contractor's cost.

Excavation material required for filling shall be stacked or dumped where indicated by the Engineer-in-Charge. Excavated material not required for filling and any surplus material shall be removed and spread on the site anywhere within the premises and as directed by the Engineer-in-Charge or carted away from the site as directed by the Engineer-in-Charge. Dumping of this surplus material shall be in an environmental friendly manner using tarpaulin cover, dumper, placer etc. and according to the levels/grades as indicated by the Engineer-in-Charge. The cost of such removal and spreading shall be borne by the Contractor and deemed to be included in the Contract Rates. Necessary approval from the local authorities for carting and dumping surplus material is to be obtained by the contractor.

The Contractor shall notify to the Engineer-in-Charge when the excavation is completed and no base or Concrete shall be laid until the Engineer-in-Charge has inspected and approved of the soil conditions obtained for each individual footing or the full raft area.

In case any underground structures that need to be protected (like underground sewer lines etc.) are encountered, the Contractor shall bring the same to the notice of the Engineer-in-Charge immediately and shall take all such steps as the Engineer-in-Charge may instruct for protection of such structures. Such protective measures shall be done at the Contractor's cost If any damage occur to such items which were required to be protected during excavation, the same shall be made good by contractor at his own cost otherwise client will arrange to make it good at the risk and cost of contractor.

The Contractor is free, within the framework of rules and regulations of the local authorities, to deal with the surplus earth in any manner suitable to him. The Contractor may dispose off the surplus earth from the project site to place/ places as may be permitted by the Engineer-in-Charge/ appropriate authority/ body. The transportation of the surplus earth shall be done by mechanical means only. The Contractor shall at his own cost obtain necessary clearances/ permissions statutory or otherwise needed for the purpose. Dumpers may be used for transporting slushy, material excavated from pile boring / pile cap / Open Foundation with precautions for non-spillage of muck.

In case earth or sand is used for backfilling in foundation, it shall be got approved by the Engineer-in-Charge. In the foundation the backfilling shall be done in layers not more than 200mm thick and shall be thoroughly watered and consolidated by approved method. The rate for backfilling in foundation using earth is deemed to have been included in the excavation rate.

4.13.2 Pile foundations

4.13.2.1 General

1200mm and 750mm diameter, bored cast-in-situ, reinforced concrete piles are proposed to be used for foundations. The accompanying drawings and schedule of quantities have been prepared accordingly. The Contractor is advised to go through the sub-soil investigation report kept in the office of EXECUTIVE ENGINEER, Delhi Development Authority, Seed Bed Park, Shakarpur for reference purpose. The information provided in the sub-soil investigation report is for the guidance and indicative only. The Contractor shall assess all other necessary information at his own cost. **The diameter of finished concrete inside the casing shall be equal to the specified diameter of the piles on the drawings.**

For bored cast-in-situ piles various operations such as finishing/cleaning of the bore, lowering of reinforcement cage and concreting of pile for full height shall be completed in one continuous operation without any stoppage. Complete methodology for the piling operation shall be submitted by contractor for approval. In case the piling work is sublet, the sub-contractor employed shall be approved by DDA.

Cast-in-situ bored piles in soil is required to be done with hydraulically operated self propelled, self erecting, crawler mounted rig with rotary guide mast using partial depth casing for vertical piles and full depth casing for raker piles with Bentonite and oscillator arrangement. The bottom of the steel lining shall be sufficiently in advance of the boring tool so as to prevent settlement of outside soil and formation of cavities.

The piling rig should have minimum following specifications

Rotary Torque – 180 KNm

Power Plant – 200 KW min.

Crowd Force – 180000 Kg.

Mast Levelling – Adjustable through mast inclinometer

Depth Measurement – Electronic Depth Meter

Kelly – Heavy duty telescopic lockable Kelly capable of transmitting crowd force to boring tool.

4.13.2.2 Length

The average basic length of the piles mentioned in the Schedule of Quantity is tentative. The final length of the pile shall be decided on the basis of resistance actually observed during initial load test at site. It will be the responsibility of the contractor to ensure by subsequent routine load tests that the installed length of piles shall be able to carry the specific safe load and the resulting deflections shall be within permissible limits as specified in IS: 2911 Part-IV. In case of failure of any pile in routine load test, the additional cost on account of remedial measures including the consultant fees for suggesting remedial measures shall be born by the contractor and no claim shall be entertained on this account.

The pile length shall be measured from cut off level to the tip of the pile.

4.13.2.3 Boring

Boring equipment and accessories shall generally conform to IS: 2911 and MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001. Boring shall be done by high capacity hydraulically operated power rotary boring rig (with hydraulic feed). The sides of the bore hole shall be stabilised by the use of the bentonite slurry (drilling mud) throughout its length and a temporary liner at the top having a minimum length of 5m as indicated in the drawing or as directed by the Engineer-in-Charge at no extra cost.

4.13.2.4 Drilling Mud (Bentonite Slurry)

The drilling mud shall be used at least 1.5m above from the level of sub-soil water depending upon site conditions and the hole shall then be always kept almost full with the fluid which shall preferably be kept in motion during boring operation. The density and composition of the fluid shall be such as to suit the requirements of the ground conditions and maintain the fine materials from the boring in suspension. Bentonite suspension shall meet the following specifications:

Density = 1.05 g/cc

Marsh Cone Viscosity between 30 and 40

The pH value between 9.5 and 12

The silt content < 1%

The liquid limit of bentonite not less than 400%

The level of drilling mud shall be maintained at least 1.5m above the contemporary ground water level. The bentonite slurry shall not be allowed to be discharged into any nallah/drain or on the ground. The waste slurry shall be removed by tanker/vehicles as directed by Engineer-in-Charge. In order to avoid collapse of upper soft soil into the borehole, temporary liner of thickness not less than 6 mm shall be provided up to at least 5 m from the existing

ground level for vertical piles. The liner shall be provided by hydraulically operated mechanism. After concreting of pile the liner shall be extracted by vibrators or jacking.

4.13.2.5 Cleaning of Borehole Bottom

The bottom of the hole shall be cleaned very carefully prior to commencing the concreting. The cleaning of the hole shall be ensured by careful operation by reverse circulation. Alternative method shall be employed only with the prior permission of Engineer-in-Charge in writing. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud at a relatively higher pressure than that used during boring, or by air jetting through a pipe attached with the tremie pipe and flushing with bentonite slurry simultaneously. The specific gravity of the mud suspension in the vicinity of the bottom of bore hole shall be determined by using a suitable slurry sampler in a first few piles and at suitable interval of piles as per the directions of the Engineer-in-charge and recorded. Consistency of the drilling mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the sides of the hole stabilised as well as to avoid concrete mixed up with the thicker suspension of the mud.

The bore must be washed by fresh bentonite solution flushing to ensure clean bottom at two stages viz. after completion of boring and prior to concreting after placing the reinforcement cage. Flushing of bentonite shall be done continuously with fresh bentonite slurry till the consistency of in-flowing and out-flowing slurry is similar.

4.13.2.6 Concreting

The concrete used for piles shall conform to the provisions of the specifications. Concreting of borehole shall start as soon as possible after boring has been completed. Should a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer-in-charge before placing concrete. Concreting shall be done by tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the bentonite slurry/water. Concreting should not be taken up when the specific gravity of bottom slurry is more than 1.2. When the specific gravity of bottom slurry is more than 1.2 the same shall be replaced by the fresh bentonite slurry.

4.13.2.7 Tremie Method

The tremie pipes and funnel shall be filled with concrete and lifted 15 cm above the bottom of the hole before releasing the concrete column in order to facilitate flushing it out. The concrete levels in the tremie shall be checked for every few feet in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This serves when fixing the position of over cut during pouring.

In case the actual quantity of concrete poured in the bore hole is less than 90% of the theoretical quantity of concrete for the pile, the pile shall be subjected to rejection.

The diameter of tremie pipe shall be 200mm minimum and the funnel should be capable of holding 0.4 cum of concrete.

Following rules shall strictly be observed prior to and during the tremie method, cited above.

1. The concreting of a pile must be completed in one continuous operation.

2. The concrete shall be coherently rich in cement and having slump in the range of 150mm to 200mm.

3. For vertical piles, a temporary liner should be installed for at least top 5 m depth of soil as mentioned elsewhere in the tender documents which would ensure that fragments of comparatively loose soil cannot drop from the sides into the concrete. Arrangement for lowering and withdrawal of temporary liner should be independent of those for the tremie pipe etc.

4. The tremie shall be large enough in order to cater for the size of aggregates thereby allowing a smooth uninterrupted flow of concrete. For instance, a tremie of 200 mm diameter shall suffice the requirements with 20 mm aggregate. The tremie should be of robust construction conforming to the approved standards.

5. The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of concrete and water/bentonite slurry. However, the plug shall not be left in the concrete as a lump.

6. The tremie pipe shall always penetrate deep enough (at least 1m) into the concrete with an adequate margin of safety against accidental withdrawal.

7. The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile in order to prevent the latency from being entrapped within the pile.

8. The tremie shall essentially be watertight in order to avoid mixing of bore fluid with the concrete.

9. All tremie tubes shall be scrupulously cleaned after every use.

To ensure compaction of concrete by hydraulic static head, rate of placing of concrete in the pile shaft shall not be less than 6m length of pile per hour.

Normally the concreting of the piles shall be uninterrupted. In case, under the unavoidable circumstances, the operation has to suspend for a period of 2 hours maximum the tremie shall not be taken out of concrete. Instead it shall be raised and lowered slowly from time to time which would prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete (10% additional cement) with a higher slump for easy displacement of the partly set concrete. In case of complete withdrawal of tremie out of partially concreted pile, the pile shall be subjected to rejection.

If the concreting cannot be resumed before final set of the concrete already placed, the pile so cast may be liable for rejection. Acceptance with modifications shall be at the sole discretion of the Engineer-in-Charge provided Contractor is able to prove to the satisfaction of the Engineer-in-Charge that the modifications suggested by him are acceptable. Nothing extra shall be paid on this account. Similarly, Contractor shall be liable to carry out all remedial measures at no extra cost to the Department.

4.13.3 Cut-off Level

The top of concrete in the piles shall be brought above the cut-off level (as approved by the Engineer-in-charge) in order to remove all latency and weak concrete before capping and ensure the design concrete at the cut-off level for the proper embedment into the pile cap.

The concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of 1.5 meter above cut-off level whichever is more. In the circumstances where cut-off level is below ground water level the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and provided without any extra cost to the Department.

4.13.4 Sequence of piling

During installation of piles, the sequence of pile construction in a group shall be followed as directed/approved by the Engineer-in-Charge.

4.13.4.1 Defective Pile

In case defective piles are formed, they shall be removed or left in places whichever is convenient without affecting performance of the adjacent piles or the cap as a whole. Additional piles shall be provided at contractor's cost to replace them as directed by the Engineer-in-Charge and in this regard the decision of the Engineer-in-charge shall be binding on the contractor.

Any deviation from the designed location, alignment or load capacity of any pile shall be noted and adequate measures shall then be taken well before the concreting of the pile cap if the deviations are beyond the permissible limit. All such alterations shall be done at contractor's cost and to the satisfaction of Engineer-in-Charge. The contractor shall have to submit requisite design calculations for the changes arising out of the above situation for approval by the department. The contractor shall have to bear the cost of such redesigning and its checking by the consultant appointed by the department.

4.13.5 Control of Alignment

Piles shall be accurately installed as per designs and drawings. Vertical and raker piles shall be bored straight without any kink in the profile. During installation of piles, the following limits shall not be exceeded:

4.13.5.1 Verticality /Rake or Batter

The tilt of vertical piles shall not exceed 1 in 150. Also, the rake or batter of raker piles shall not vary by more than 1 in 150 from the design value. For this purpose, the alignment of boring shall be checked during boring operation for every 5 m depth of bore or at closer intervals as desired by the Engineer-in-Charge. Suitable corrective measures shall be taken to rectify any tendency of the bore to go beyond this limit at no extra cost. Contractor shall have to maintain the record of profile of boring as a part of pile data to be submitted by him.

4.13.5.2 Shift

The resultant shift in any direction from the designed position at cut off level shall not exceed 75 mm. This shall be measured at pile top at cut-off level. This data shall also be submitted by the contractor alongwith standard record of pile boring.

In case during installation, above limits are violated, the contractor shall be liable for action in the following manner:

Submit revised calculation for the pile groups and pile caps and bear all costs related to such designs and its checking by the consultant of the Department. In addition, he shall not be entitled to any additional extension of time relating to such design and approval by the Department. All additional work arising out of such redesigning of pile and pile caps shall be executed by the contractor at no extra cost to the department.

In case deviations are exceeded beyond above limits to the extent that the resulting eccentricity cannot be taken care of by redesigning of the pile group and pile caps, the piles shall be replaced or supplemented by one or more additional piles by the contractor at his own cost alongwith any additional cost for pile cap being oversized. The decision taken in this regard by the Engineer-in-Charge shall be final and binding on the contractor.

4.13.5.3 Chipping of Pile Top

Manual chipping shall be permitted after three days of pile casting. Pneumatic chipping if permitted by the Engineer-in-charge shall not be started before 7 days or as directed by the Engineer-in-charge. Full care should be taken to prevent any damage/distortion of pile reinforcement.

4.13.6 Adjacent Structure

When working near the existing structures care shall be taken to avoid any damage to such structures. In case of bored piles, care shall be taken to avoid the effect due to loss of ground.

In case of deep excavations carried out adjacent to piles, proper shoring or other suitable arrangement shall be done to guard against the lateral movement of soil stratum or releasing the stresses confining the soil.

4.13.7 Reinforcement

Main longitudinal reinforcement, preferably in one length, in the length of the piles as well as links or spirals shall be provided as shown in the drawing. Reinforcement cage shall be handled and installed carefully without damaging its shape. Quality, workmanship and all other requirements of reinforcement bars shall satisfy the corresponding specifications referred in this contract. Completely fabricated reinforced cage for the full length of pile shall be lowered with help of crane or any other approved method. The clear cover to the reinforcement in pile shall be 75 mm not with standing any other provision mentioned in the codes and specifications mentioned elsewhere.

4.13.8 Recording of Data

During installation of pile the following data shall be recorded along with any other relevant data as directed by the Engineer-in-charge. These data shall be submitted to the Engineer-in-charge in triplicate after installation of each pile.

1. Sequence of installation of piles in a group.
2. Dimensions of the pile, including reinforcement details and marks of the pile.
1. Details of mild steel liner where provided along with stiffener.
2. Depth bored and founding level along with a bore log indicating nature of stratum.
3. Time taken in penetration of every 15 cm for last 2 m depth above founding level.
4. Method of cleaning bottom of hole at founding level before commencing the concreting.
5. Time taken in concreting.
6. Cut-off level/working level/RL of top of concrete.
7. No. of Cement bags consumed, slump of concrete.
8. Any other relevant observations suggested by the Engineer-in-charge and which may eventually affect the overall performance of piles.

4.13.9 Load Test on Pile

4.13.9.1 General

The load test on a concrete pile shall not be carried out unless the concrete has achieved its specified 28 days strength. Also the age of concrete at the time of testing shall not be less than 14 days.

There shall be two categories of static tests on piles, namely, initial load tests and routine load tests. Initial tests should be carried out on test piles, which are not to be incorporated in the work. Routine tests shall be carried out as a check on working piles. The number of initial and routine tests on piles shall be as determined by the Engineer-in-charge depending upon the number of foundations, span length, type of superstructure and uncertainties of founding strata. In any case, the initial load tests shall not be less than 2 in number, while the routine load tests shall not be less than 2% of the total number of piles in the structure nor less than 2 in number. These tests shall be carried out at a cut-off level wherever practicable. Otherwise, allowance shall be made in the interpretation of test results if the test is not made at cut-off level.

Reaction may be applied using kentledge, anchor piles or ground anchors with the prior approval of the scheme by the Engineer-in-Charge. Reaction to be made available shall be 25% more than the test load.

The methodology of carrying out load tests and of arriving at safe load on piles shall conform to IS: 2911 (Part IV).

All pile tests shall be duly recorded and analysed with calculations in format approved by the Engineer-in-Charge.

4.13.9.2 Method

The test load shall be applied by jacking against kentledge and ground anchors or reaction piles. The reaction piles shall not be selected amongst the working piles. Any kentledge-loading truss if used shall be adequately supported in order to enhance its stability particularly in the event of a sudden change in the load reaction from the pile. The reaction from kentledge to be made available for the test shall be 25% more than the final test load proposed to be applied.

The load test shall be carried out either at cut-off level or maximum 1.5 m below G.L. as directed by the Engineer-in-Charge. Details regarding the test set up and the loading scheme shall be submitted to the Engineer-in-Charge well in advance for approval.

4.13.9.3 Load

The hydraulic jack shall be powered by an electric pump whose discharge can be adjusted in order to suit the required rate of loading. The load applied to the pile shall be recorded either by a gauge in the hydraulic system or a proving ring with fresh calibration from an approved laboratory. The sensitivity of the recording device shall not exceed 1.2% of the full load. However, in any event the accuracy and sensitivity of the system shall be checked against an approved instrument.

A test certificate and fresh calibration chart from an approved laboratory for jack and pump is to be produced to the Engineer-in-charge well in advance before their application in any load testing on piles.

4.13.9.4 Deflection Measurements

The settlement of the pile shall be recorded by a minimum three dial gauges recording to 0.02 mm and placed at equal angles round the test pile. The dial gauges shall be fixed to datum bars whose ends rest upon non-movable supports. The supports for datum bars with reference to which the settlement of the pile would be measured, shall be at least 5 m away clear from the test piles.

4.13.9.5 Initial Test

The test shall generally conform to IS: 2911 (Part IV)-1985. Pile head shall be prepared for load test by suitably cutting /bending the projecting pile reinforcement. Use of RMC (without flyash) can be allowed in the initial test pile after getting approval from engineer in charge. Testing of pile after 14 days of concreting is allowed. A bearing plate with a hole at centre shall be placed over the pile head for placing the jacks. Approximately 25mm gap between the bearing plate and pile head shall be kept which will be filled with pre-packaged free-flowing, high strength, non-shrink grout such as FOSROC's Conbextra-HF or approved equivalent. Nothing extra shall be paid on this account.

Interpretation of pile load capacity shall be done as per clause 8.1.5 of IS: 2911 (part IV)-1985.

4.13.9.6 Routine Test

The test shall generally conform to IS:2911 (Part IV)-1985. Preparation of pile head and placement of bearing plate including non-shrink mortar shall be as explained in the above clause.

Test load shall be equal to 1.5 times the estimated capacity of pile determined as per above clause. Interpretation of results shall be done as per clause 6.1.5 of IS:2911 (Part IV)-1985. The test shall be carried out not earlier than 28 days after concreting of the pile unless specifically permitted otherwise by the Engineer-in-Charge.

Selection of the piles for routine load test, which is often the MORTH inferior set of piles, shall be made by the Engineer-in-charge, determined by integrity tests.

4.13.9.7 Lateral load Testing

Lateral load testing of single pile as per the specifications duly supplemented with IS 2911(partIV) with latest amendments thereto all complete. Test shall be conducted using reaction pile and it shall be carried out by a reputed agency approved by engineer-in-charge. Item to include all works to execute the job.

The test shall be performed after removal of bad/weak concrete at top so that the wave propagation is steady through hard concrete. The test shall not be carried out unless the concrete has achieved its specified 28 days strength. Also the age of concrete at the time of testing shall not be less than 14 days after concreting the piles. A specialist approved agency shall be employed for the test and the tests shall generally be as per recommendations of the agency, unless directed otherwise by the Engineer-in-Charge.

4.13.9.8 Integrity Test / Low Strain Dynamic Testing

This low strain dynamic test using pile driving analyser or approved equivalent for pile integrity shall be performed on random selected piles. The top of pile shall be made accessible, chipped off upto hard concrete, levelled by trimming it back as far as practicable. The reinforcing bars of the piles to be tested shall be bent sideways.

The test shall be performed after removal of bad/weak concrete at top so that the wave propagation is steady through hard concrete. The test shall be carried out at least 15 days after concreting of the piles. The test shall be carried out at minimum of 3 location on each pile in such a way that the entire cross section of pile is evenly covered. A specialist approved agency shall be employed for the test and the tests shall generally be as recommendations of the agency, unless directed otherwise by the Engineer-in-Charge.

4.13.9.9 As-Built Drawings

On completion of the work, the Contractor will submit a plan showing the exact location and length of each pile as constructed at site, as well as dates of concreting, cube test results etc. The original tracing of this drawing shall be submitted to the Engineer-in-Charge.

4.14 Cement Concrete

Only design mix concrete shall be used for various structural members. The contractor shall carry out the mix design and the mix so designed shall be approved by the Engineer-in-Charge within the limitation of parameters and other stipulations laid down in the contract.

4.14.1 Strength Requirement of Concrete

The trial mixes shall be designed to have target mean strengths as specified in Table-6 of IRC:21-2000. The trial mix shall be prepared with approved aggregates, cement, water and admixtures. The Engineer-in-Charge shall be at liberty to inspect the operations and the quality of materials being used by the contractor for trial mixes. The samples of materials used for trial mix shall be submitted with the Engineer in charge for reference and the contractor shall ensure that the materials used for actual production of concrete conforms to the samples of material used in preparation of trial mix. The trial mixes, which do not conform to the specification, shall be rejected. The other parameters shall be as under:

- Grade of concrete - As specified.
- Type of cement - As specified in relevant item of work of chapter “Materials and Testing”
- Type and Size of Coarse Aggregate
- As per chapter 7 for “materials and testing ”

4.14.2 Workability

The concrete mix proportions chosen should be such that the concrete is of adequate workability for placing condition of the concrete to ensure proper compaction. The slump for various members shall be suitably decided as per the requirement and got approved from the Engineer-in-charge prior to mixing and placing the concrete into the position. However the following range shall be applicable for slump at the point of placing the concrete:

- Bored Cast-in-situ piles : 150-200mm
- Pile cap : 75-90 mm
- Other cast-in-situ members : 90-120mm
- Precast members : 75-90 mm

These slump parameters are broad guidelines, which shall be suitably modified and approved by the engineer-in-charge based on site conditions, reinforcement congestion, mode of concrete placement, weather conditions etc.

4.14.3 Limits Of Water and Cement Contents

Maximum Water/Cement Ratio shall be as per IRC 21

Minimum Cement Content shall be as per IRC-21

Maximum Cement Content - 540 kg/cum

Total water soluble sulphate (SO_3) content of concrete mix expressed as (SO_3) shall not exceed 4% percent by mass of cement used in the mix.

Total chloride content in the concrete expressed as chloride ion shall not exceed 0.2 percent by mass of cement used in the concrete mix for RCC/PCC members and 0.1% by mass of cement for PSC members.

4.14.4 Trial Mixes

Trail mixes shall be prepared using samples of approved materials for all grades of concrete.

The concreting plant and means of transportation employed to make the trial mixes and to transport them to representative distances shall be similar to the corresponding plant and transport to be used in the works. A clean dry mixer shall be used and the first batches shall be discarded. Test cubes shall be taken for trial mixes as follows.

For each mix, set of six cubes shall be made from each of three consecutive batches. Three from each set of six shall be tested at an age of 28days and three at an earlier age approved by the Engineer-in-Charge. The cubes shall be made, cured, stored, transported and tested in compression in accordance with the specification.

The average strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa. Nothing extra shall be paid on this account.

4.14.5 Additional Trial Mixes

Additional trial mixes and tests, shall be carried out during production before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out to minimise the variability of strength subject to approval of Engineer-in-Charge and to maintain the target mean strength subject to approval of Engineer-in-Charge. Such adjustments shall not be taken to imply any change in the current margin and nothing extra shall be paid on this account.

4.14.6 Sampling And Testing

4.14.6.1 General

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

4.14.6.2 Sampling Procedure

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, that is, the sampling should be spread over the entire period of concreting and cover all mixing units. The point and time of sampling shall be at delivery into the construction, unless otherwise agreed to.

4.14.6.3 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following Table:

Quantity of Concrete in Work (m^3)	Number of Samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 and above	4 plus one addl. Sample for each addl. 50m^3 or part thereof

At least one sample shall be taken from each shift of work.

4.14.6.4 Test Specimen and Sample Strength

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ±15% of the average.

4.14.6.5 Acceptance Criteria

Compressive Strength: The acceptance criteria shall be as specified in Clause 16 of IS 456: 2000. The details shall be as follows:

When both the following conditions are met, the concrete complies with the specified compressive strength:

The mean strength determined from any group of four consecutive samples should exceed the specified characteristic compressive strength by 3 Mpa.

Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

4.14.7 Chloride Content

Unless otherwise specified and agreed the method of calculation and test shall be based upon the chloride-ion contents of all constituents and the composition of the concrete. The chloride-ion content of each of the constituent used in the calculation shall be one of the following:

1. the measured value
2. the value declared by the manufacture
3. the maximum value where specified in the BIS for constituent as appropriate

The calculated chloride content of the chloride expressed as the percentage of chloride-ion by mass of cement shall not exceed the value specified in clause 302.6.5 of IRC: 21- 2000.

4.14.8 Density of Fresh Concrete

Where maximum density of fresh concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5% of the specified value. The specified value of density of fresh concrete shall be taken as that of the design mix concrete prepared in the controlled condition during mix design of respective concrete to meet the specified properties.

4.14.9 Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5% of the specified value. The specified value of density of hardened concrete just prior to crushing of cubes shall be taken as that of the design mix concrete prepared in the controlled condition during mix design of respective concrete to meet the specified properties.

4.14.10 Permeability Test

Contractor should carryout permeability test on concrete to meet the respective specified properties as directed by engineer-in-charge.

4.14.11 Proportioning of Concrete

In proportioning cement concrete, the quantity of both cement and aggregates shall be determined by weight. The cement 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. The amount of mixing water shall be adjusted to compensate for moisture content in both coarse and fine aggregates. The moisture content of aggregates shall be determined in accordance with IS: 2386 (Part III). Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weight of aggregates due to variation in moisture content.

4.14.12 Production of Concrete

The concrete shall be produced in a central batching and mixing plant with, computerised printing for contents and admixture dosage, producing at least 30 m^3 concrete per hour. The batching plant shall be fully automatic. Automatic batcher shall be charged by devices which, when actuated by a single starter switch will automatically start the weighing operation of each material and stop automatically when the designated weight of each material has been reached. The batching plant shall have automatic arrangement for dispensing the admixture and shall also be capable of discharging water in more than one stage. A print out from the batching plant for every lot shall be submitted. A batching plant essentially shall consist of the following components:

1. Separate storage bins for different sizes of aggregates,

2. Silo for cement; and water storage tank.

3. Batching equipment

4. Mixers

5. Control panels

6. Mechanical material feeding and elevating arrangements

The compartments of storage bins for aggregates shall be approximately of equal size. The cement compartment shall be centrally located in the batching plant. It shall be watertight and provided with necessary air vent, aeration fittings for proper flow of cement & emergency cement cut off gate. The aggregate and sand shall be charged by power operated centrally revolving chute. The entire plant from mixer floor upward shall be enclosed and insulated. The batch bins shall be constructed so as to be self-cleansing during draw down. The batch bins shall in general conform to the requirements of IS: 4925.

The batching equipment shall be capable of determining and controlling the prescribed amounts of various constituent materials for concrete accurately i.e. water, cement, sand, individual size of coarse aggregates etc. The accuracy of the measuring devices shall fall within the following limits.

- Measurement of Cement : ± 2% of the quantity of cement in each batch
- Measurement of Water : ± 3% of the quantity of water in each batch
- Measurement of Aggregate : ± 3% of the quantity of aggregate in each batch
- Measurement of Admixture : ± 3% of the quantity of admixture in each batch

4.14.13 Mixing Concrete

The mixer in the batching plant shall be so arranged that mixing action in the mixers can be observed from the operator's station. The mixer shall be equipped with a mechanically or electrically operated timing, signalling and metering device, which will indicate and assure completion of the required mixing period. The mixer shall have all other components as specified in IS: 4925.

4.14.14 Transportation, Placing and Compaction of Concrete

Mixed concrete from the batching plant shall be transported to the point of placement by transit mixers or through concrete pumps or steel closed bottom buckets capable of carrying 0.6 cum concrete. In case the concrete is proposed to be transported by transit mixer, the mixing speed shall not be less than 4 rev/min. of the drum nor greater than a speed resulting in a peripheral velocity of the drum as 70 m/minute at its largest diameter. The agitating speed of the agitator shall be neither less than 2 rev/min. nor more than 6 rev/min. of the drum. The number of revolutions of the mixing drum or blades at mixing speed shall be between 70 to 100 revolutions for a uniform mix, after all ingredients, have been charged into the drum. Unless tempering water is added, all rotation after 100 revolutions shall be at agitating speed of 2 to 6 rev/min and the number of such rotations shall not exceed 250. The general construction of transit mixer and other requirements shall conform to IS: 5892.

In case concrete is to be transported by pumping, the conduit shall be primed by pumping a batch of mortar/thick cement slurry through the line to lubricate it. Once the pumping is started, it shall not be interrupted (if at all possible) as concrete standing idle in the line is liable to cause a plug. The operator shall ensure that some concrete is always there in the pump-receiving hopper during operation. The lines shall always be maintained clean and shall be free of dents.

Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe. Grading of aggregate shall be continuous and shall have sufficient ultra fine materials (materials finer than 0.25mm). Proportion of fine aggregates passing through 0.25mm shall be between 15 & 30% and that passing through 0.125mm sieve shall not be less than 5% of the total volume of aggregate. When pumping long distances and through hot weather, set retarding admixtures may be used. Admixtures to improve workability can be added but no extra payment shall be accounted for. Suitability of concrete through pumping shall be verified by trial mixes and by performing pumping tests.

The special precautions shall be taken that surrounding temperature during concreting should not be more than 30 degree centigrade all stages.

For placing concrete with pumps, pipelines from the pump to the placing area should be laid out with a minimum of bends. For large concrete placement, standby pumps shall be available. Suitable valves (air release valves, shutoff valves..Etc.) Shall be provided as per the site needs. The pumping of concrete shall be preceded by a priming mix to lubricate the pump and pipeline. A rich mix of creamy consistency shall be required for lubricating the pipelines. Continuous pumping shall be done to the extent possible. After concrete has been placed, the lines and all related equipment shall be cleaned immediately. A plug sponge ball shall be inserted in the end near the pump and shall be forced through the line by either water or air pressure. Pipes for pumping should not be made from materials, which can harm concrete; aluminium alloy pipelines shall not be used.

Except where otherwise agreed to by the Engineer-in-Charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm. Unless agreed to by the Engineer- in-Charge, concrete shall not be dropped into place from a height exceeding 2 m. In order to avoid such situations chutes, tremie pipe or closed bottom buckets shall be used. These shall be kept clean and used in such a way as to avoid segregation. Slope of the chute shall be so adjusted that concrete flows without the use of excessive quantity of water. The delivery end of chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork. The concrete shall be compacted by using immersion type vibrators. When the concrete is being continuously deposited to a uniform depth along a member, vibrator shall not be operated within one meter of free end of the advancing concrete.

Every effort shall be made to keep the surface of the previously placed layer of concrete such that the vibration process can amalgamate the succeeding layer with it. In case the concrete in underlying layer has hardened to such an extent that it cannot be penetrated by the vibrator, but is still fresh (that is, just after initial set). Bond shall be achieved between the top and underlying layer by first scarifying the lower layer before the new concrete is placed by systematically and thoroughly vibrating the new concrete. The points of insertion of vibrator in the concrete shall be so spaced that the range of action overlap to some extent and the freshly filled concrete is sufficiently consolidated at all locations. The spacing between the dipping positions of vibrator

shall be maintained uniformly throughout the surface of concrete so that concrete is uniformly vibrated. The vibrating head shall be regularly and uniformly inserted in the concrete so that it penetrates of its own accord and shall be withdrawn slowly whilst running so as to allow redistribution of concrete in its way and allow the concrete to flow back into the hole behind the vibrator. The vibrator head shall be kept in one position till the concrete within its influence is completely consolidated. Vibration shall be continued until the coarse aggregate particle have blended into the surface but have not disappeared. The contractor shall keep at least one additional vibrator in serviceable condition to be used in the event of breakdowns and maintenance problems.

The form work shall be strong and great care shall be exercised in its assembly. It shall be designed to take up increased pressure of concrete and pressure variations caused in the neighbourhood of vibrating head, which may result in excessive local stress on the form work. The joints of the formwork shall be made and maintained tight and close enough to prevent the squeezing out slurry or sucking in of air during vibration. The formwork to receive concrete shall be cleaned and made free from standing water, dust, etc. The contractor shall keep provision for screed and shutter vibrators at site.

No concrete shall be placed in any part of the structure until the approval of Engineer-in-Charge has been obtained. If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-Charge. Concreting shall be done continuously over the area between construction joints. Fresh concrete shall not be placed against concrete, which has been in position for more than 30 minutes unless a proper construction joint is formed. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept clean, thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. The 13-mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete.

Where concrete has not fully hardened, laitance shall be removed by scrubbing the wet surface with wire or bristle brushes. Care shall be taken to avoid dislodgement of particles of coarse aggregate. The surface shall then be thoroughly wetted, free water removed and then coated with neat cement grout. Particular attention shall be given to corners and close spots.

4.14.15 Concreting of Narrow Members

Wherever the concreting of narrow member (as adjudged by Engineer-in-Charge) is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall if so desired by the Engineer-in- charge, be provided to facilitate the pouring and consolidating of the concrete. Before any concreting is commenced, shutters and centring shall be carefully examined and the space to be occupied by the concrete is thoroughly cleaned out. The concrete in such members shall be compacted using suitable shutter vibrator as appropriate.

4.14.16 Surface Finish

The exposed surface of concrete of all grades shall be shutter finished. Any special surface finish such as form liner finish of outer surface of crash barrier/piers/ reinforced soil wall panels, RCC ground supported boxes, retaining walls and components of superstructure etc, as may be deemed necessary as per approved drawing or as desired by the Engineer-in-Charge shall be executed using special surface finish shutters. The quoted rates shall deemed to have included

such elements and nothing extra shall be payable on this account. Concrete with surface defects larger than 1/6th of the cover shall be liable to rejection. The engineer-in-charge shall have option to accept the so formed concrete at reduced rates for the defects exceeding this limit provided it is structurally adequate and due rectification done by the contractor to the entire satisfaction of the engineer-in-charge.

All members above ground or formation level shall have shutter-finished surfaces. Utmost care shall be taken by the contractor in erection of formwork for components cast in stages. Location of construction joints in between such stages shall be predefined and all such joints shall be treated in a manner approved by the Engineer-in-charge so as to match with the surrounding concrete without leaving any visual aberration or bad patches and/or bands. The contractor shall be deemed to have included the cost of such operation in his quoted rates and no claim whatsoever shall be entertained at a later date.

The formed finished concrete surfaces shall be free from honeycomb, blemishes, holes, surface defects, surface undulation etc. In no case such defects shall exceed 200 mm in any direction for individual spots or the continued area of such defects shall not exceed 0.2% of the entire area of related surface. Any variation beyond this limit shall be considered as a substandard work and shall be liable for rejection. The Engineer-in-Charge shall have the option to accept the so formed concrete at a reduced rate for defects exceeding this limit provided it is structurally adequate and due matching of defective patches is done by the contractor to the entire satisfaction of the Engineer-in-Charge.

Special care shall be taken to ensure that no stains are left on the formed concrete either from formwork or exposed reinforcement bars. Such stains shall be removed by the contractor at no extra cost so as to match with adjoining concrete surfaces to the satisfaction of the Engineer-in-Charge. Shutter stripping solution/chemical of approved quality shall be used on shutter plates and use of burnt oil shall be avoided.

Stages of concrete for individual components shall be as follows:

For pile cap - In single stage

For Piers, Abutments - In suitable stages as approved by the Engineer-in - charge

For retaining wall - In suitable stages as approved by the Engineer-in - charge

Crash barrier segments - In single stage

Box Girders - In not more than two stages

For other RCC and PSC components, the stages of casting shall be as per directions of engineer-in-charge.

4.14.17 Protection of Concrete below Ground Level

Concrete placed below the ground shall be protected from falling earth during and after placing. Concrete placed in ground containing deleterious substances shall be kept free from contact with such ground and with water draining there from during placing and for a period of seven days or as otherwise instructed thereafter. Approved means shall be taken to protect immature concrete from damage by debris, excessive loading, abrasion, vibrations, deleterious

ground water, mixing with earth or other materials, and other influences that may impair the strength and durability of the concrete.

Construction Joints

Before the concrete is fully hardened, all laitence shall be removed by scrubbing the wet surface with wire or bristle brushes. Care shall be taken to avoid dislodgement of particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. Particular attention shall be given to corners and close spots.

Construction joints in all concrete work shall be made as directed by the Engineer-in-Charge. Where vertical joints are required, these shall be shuttered as directed and not allowed to take the natural slope of the concrete. The stop end at construction joint shall be made from special expanded wire mesh of two / three layers to facilitate the reinforcement to pass through. Before fresh concrete is placed against a vertical joint, the old concrete shall be chipped, cleaned and moistened.

When a horizontal construction joint is formed, provision shall be made for interlocking with the succeeding layer by the embedment of saturated wooden blocks or wooden strips beveled on four sides to facilitate their removal. Prior to the next pour the wooden pieces shall be loosened and removed in such a manner as to avoid injury to the concrete. After about 8 to 12 hours of concreting, contact surface shall be hacked with a mechanical chisel or by sand blasting, to expose the aggregate surface and remove laitance. Immediately thereafter clean the surface using compressed air to remove the entire dirt. The surface shall then be compressed air cleaned to remove all dirt. Before applying fresh concrete, the contact surface shall be wetted for at least 6 hours. After the surface has dried, two coats of cement paint shall be applied uniformly using a brush over the old concrete just before placing the fresh concrete. The fresh concrete shall be placed immediately after applying the cement coats. The fresh concrete shall be thoroughly vibrated near the construction joint so that the mortar from the new concrete flows between the large aggregate and develop proper bond with old concrete. The construction joint shall ensure proper bond and leak proof joint.

Use of metal, rubber or plastic water stops is specified, this shall be cast into joints. Measures shall be taken by the Contractor to ensure that no displacement or distortion of water stops takes place during placing of concrete. The construction joints shall ensure proper bond and leak proof joint.

4.14.18 Defects In Concrete

4.14.18.1 Cracks

If external cracks developed in concrete construction are more than 0.2 mm and in the opinion of the Engineer-in-Charge, these are detrimental to the strength of the construction, the Contractor at his own expense will conduct ‘Loading Tests’ on the structure in the manner as specified elsewhere in this document. If under such test loads the cracks develop further, the Contractor shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto.

If any cracks develop in the concrete construction are not more than 0.2 mm or in the opinion of the Engineer-in-Charge, the cracks are not detrimental to the stability of the construction, the

Contractor at his own expense shall grout the cracks with neat cement grout or with other composition as directed by Engineer-in-Charge and also at his own expense and risk shall make good to the satisfaction of the Engineer-in-Charge all other works such as plaster, moulding, surface finish, which in the opinion of the Engineer-in-Charge have suffered damage either in appearance or stability owing to such cracks. The Engineer-in-Charge's decision as to the extent of the liability of the Contractor in the above matter shall be final and binding.

4.14.18.2 Honeycombing

If any concrete be found honeycombed or in any way defective, such concrete shall be cut out partially or wholly by the Contractor as per the directions of the Engineer-in-charge and made good at his own risk and cost using pressure grouting or any other technique. If Engineer-in-Charge feels that repaired structure will not be having same strength or shape or uniformity with other exposed surface as original desired structure / original structure, the same shall be rejected by Engineer-in-Charge and required to be dismantled and disposed by contractor at his own cost as instructed by Engineer-in-Charge. Decision of the Engineer-in-Charge shall be final binding in this regard.

On no account shall concrete surfaces be patched or covered up or damaged concrete rectified or replaced until the Engineer-in-Charge or his representative has inspected the works and issued written instructions for rectification. Failure to observe this procedure will render that portion of the works liable to rejection. Contractor shall submit methodology for rectification of defects for approval. Proprietary products for concrete repair shall be used.

4.14.19 Holes & Fixtures and Grouting

4.14.19.1 Exposed faces, holes & fixtures

Holes for foundation or other bolts or for any other purposes shall be moulded, and steel angles, holdfasts or other fixtures shall be embedded, according to the drawing or as instructed by the Engineer-in-Charge.

4.14.19.2 Grouting of base plates & bolt holes:

4.14.19.2.1 Mixing

Dry grout should be mixed in a mechanical mixer: the conventional 200/400-litre capacity concrete mixer can be used to mix four bags of dry grout; alternatively, paddle type mortar mixers can be used. The quantity of grout to be mixed at one time should not exceed that amount which can be placed in approximately 10 to 15 minutes.

4.14.19.3 Batching

Batching of grout by fraction of a bag is not allowed. The quantity of mixing water should be the minimum commensurate with workability, compaction, and filling of the grout in all corners and crevices. Mixing should be done for a minimum of three minutes to obtain a fluid grout of uniform consistency.

4.14.20 Cleaning and preparation of the surface

The base concrete should be clean and strong, and its surface should be properly hacked; all dust should be removed suction or compressed air. The surface should be thoroughly wetted with water for several hours. Before the grout is poured, all free water should be removed and the flat surfaces coated with thin cement slurry.

4.14.20.1 Restraint

Heavy back-up blocks of timber or concrete should be fixed on all sided of the base plate to prevent escape of the grout, when poured through the openings provided in the base plate. Adequate restraint must be ensured on all the sides for a period of 7 days to obtain effective expansion and shrinkage compensation.

4.14.20.2 Curing

The grout should not dry out where external restraint is provided in the form of formwork, the top opening and all stray openings should be covered with wet sack for at least 7 days.

4.14.21 Placing and compaction

The grout should be placed quickly and continuously either through the holes in the base plates or from one side only to ensure complete filling without entrapment of air. Grout should be properly spread and compacted by roding. Excessive vibration should be avoided. Below the bed plates the grout should be compacted using long pieces of doubled-over flexible steel strapping or chains. The forward and backward movement of the strap or chain will assist in the flow of the grout into place. Steps must be taken to keep the grout in full contact with the underside of the bedplate until the grout sets; maintaining a small head of fresh grout in the forms.

4.14.22 Shrinkage compensated grout:

Shrinkage compensated grout or non-shrinkable grout of Associated Cement Companies Limited or any other approved manufacture (Fosroc, Roff, Sika or equivalent) should be used. The batching shall be as per the manufacture's specifications, other procedures being as above.

ADDITIONAL SPECIFICATIONS FOR PRECAST CONCRETE

The provision in this section shall be considered supplementary to general provisions for Concrete works covered under clause 4.14 and its sub-clauses.

HANDLING AND STORAGE

The precast units shall be stored as directed by the Engineer-in-Charge. The area intended for the storage of precast units should be surfaced in such a way that no unequal settlement could occur.

To prevent deformation of slender units, they should be provided with supports at fairly close intervals and should also be safeguarded against tilting. Lifting and handling positions should conform to the Engineer-in-Charge's directions and drawings. In addition, location and

orientation marks should be put on the members, as and where necessary. During erection the precast units should be protected against damage caused by local crushing and chafing effects of lifting and transport equipment.

4.14.23 Temporary Supports and Connections

Temporary supports provided during erection should take into account all construction loads likely to be encountered during the completion of joints between any combination of precast and in-situ concrete structural elements. The supports should be arranged in a manner that will permit the proper finishing and curing of any in-situ concreting and grouting associated with the precast member being supported when the gaps of joints have to be filled with concrete or mortar. They should first be cleaned and faces of the joints should be wetted. The mixing, placing and compacting of cement and mortar should be done with special care. Mortar of a dry consistency should be in the proportion of 1:1½ (1 part of cement to 1½ parts of sand) and should be placed in stages and packed hard from both sides of the joint.

4.14.24 Tolerances

The following tolerances apply to finished precast products at the time of placement in the structure. The forms must be constructed to give a casting well within these limits:

i Overall dimensions of members should not vary more than ± 6mm per 3m length with a maximum variation of ± 20mm.

ii Cross-sectional dimensions should not vary more than the following :

± 3mm for sections less than 150mm thick

± 4mm for sections over 150mm & less than 450mm

± 6mm for sections over 450mm to 1000mm

± 10mm for sections over 1000mm

iii Deviation from straight line in long sections should not be more than ± 6mm up to 3m, ± 10mm for 3m to 6m, ± 12mm for 6m to 12m.

4.14.25 Curing Of Concrete

Curing of concrete shall be complete and continuous using water that is free of harmful amounts of deleterious materials that may attack, stain or discolour the concrete. The water used for curing shall confirm to the requirements of clause 302.4 of IRC: 21- 2000.

Immediately after compaction and completion of concreting, the concrete shall be protected from evaporation of moisture by means of polyethylene sheets, wet hessian cloths or other material kept soaked by spraying water. As soon as the concrete has attained a degree of hardening sufficient to withstand surface damage, moist curing shall be implemented and maintained for a period of at least 14 days after casting.

Method of curing and their duration shall be such that the concrete will have satisfactory durability and strength and members will suffer a minimum distortion, be free from excessive efflorescence and will not cause undue cracking in the works by its shrinkage.

The top surface of the slabs and other horizontal surfaces shall be cured by impounding water (confirming to the requirements of clause 302.4 of IRC: 21- 2000) in cement mortar bunds. Steeply sloping and vertical formed surfaces shall be kept completely and continuously moist prior to and during the striking of formwork by applying water to the top surfaces and allowing it to pass down between the formwork and the concrete. After removal of form, moist curing to be done by wrapping hessian cloth, etc. and keeping it moist by suitable means.

Approved non-wax base curing compounds can be applied on vertical and inclined surfaces, where water curing cannot be done reliably. Prior permission of the Engineer-in-Charge will be necessary in such case, with no extra cost to the Department.

4.14.26 Grade Of Cement Concrete

Only design mix concrete shall be used in the works for various structural members. The grades of concrete for various components of work shall be as specified in the relevant item and/or drawing. In case of any discrepancy, the grade of concrete as specified in item shall prevail unless otherwise approved by Engineer-in-charge. However, this discrepancy must be brought to the notice of Engineer-in-charge by the contractor before start of said concrete work for final decision.

4.14.27 Cover Block & Spacers

The Contractor shall provide approved type of supports for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as called for in the drawings. Cover blocks of required shape and size, M.S. chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Cover blocks shall be cast well in advance and shall consist of approved proprietary pre-packaged free-flowing mortars (Conbextra HF as manufactured by M/s FOSROC Chemicals India Ltd or approved equivalent) of high early strength and same colour as surrounding concrete. Alternatively, plastic cover blocks conforming to approved international codes of practice shall be used. No extra payment shall be made for cover blocks and spacers.

4.14.28 Anticarbonation Coating On Concrete

The protective coating shall comprise a penetrating Silane/Siloxane primer and a single component aliphatic acrylate coating. The total dry film thickness (DFT) of the coating shall not be less than 150 microns and shall be capable of providing carbon di-oxide diffusion resistance and the depth of carbonation shall be proved to be nil through suitable tests when tested at 24 hrs by accelerated carbonation test as per BS: 1881.

ADDITIONAL SPECIFICATIONS FOR PRESTRESSED CONCRETE WORK (POST-TENSIONED) (MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001-1800)

The requirement of clauses relating to cement concrete shall be observed generally in case of prestressed concrete work so far as they are applicable as well as requirements mentioned hereinafter relating to prestressed work in particular.

Steel Reinforcement for Structure

GENERAL

The reinforcement bars bent and fixed in position shall be free from rust or scales, chloride contamination and other corrosion products. Effective methods of cleaning will have to be used so that the steel is free from rust, scales and contamination. The decision of Engineer-in-Charge in this regard shall be final & binding.

Bending Of Reinforcement

Bending of reinforcement shall be done as per bar bending schedule to be prepared and got approved by the contractor from Engineer-in-Charge or his authorised representative prior to commencement of work. The bar cutting and bending for 16mm and above diameters shall be done on bar cutting and bending machine only.

Placing Of Reinforcement

Reinforcement left projecting from newly placed concrete shall be supported in such a way that there is no sag or risk of damage to the newly placed concrete. The projecting bars that are likely to be exposed for a long time shall be protected by a coat of neat cement wash. These shall be thoroughly cleaned and wire brushed before depositing fresh concrete around it. No reinforcement bar shall remain exposed or projecting out of the concrete surface. These shall be removed or treated in a manner as directed by Engineer-in-Charge. The unwanted projected reinforcement bars shall be cut below the finished surface and the cut end painted with cement slurry and inhibitor solution-patient no 109784/67 or equivalent. Thereafter the surface shall be repaired to match the colour, texture or pattern of adjoining concrete to the satisfaction of Engineer-in-Charge.

Bar Splices

The location of joints in continuous reinforcing bars, not shown in drawings, shall be submitted to the Engineer-in-Charge for acceptance. If nothing contrary has been specified, the number of bars to be joined in any cross section shall not exceed one-third of the total.

4.15 Assembled Accessories

4.15.1 Bearings (POT CUM PTFE)

The work of bearings will include Design of bearings based on the load parameters given in the drawings and as directed by Engineer-in-charge, getting the design approved by Engineer-in-charge, their fabrication, supplying and fixing in position in accordance with details shown on drawings. Design of bearings will also include the design of all components individually. The work is to be carried out meeting the required Specifications, codes and standards quoted therein and as directed by Engineer-in-Charge. The installation of bearings shall be carried out under the supervision of the manufacture of the bearings. The Contractor shall provide a warranty for 15 years and the bearings shall be repaired or replaced free of cost by the Contractor, in case any defect is observed during this period. The Engineer-in-charge decision regarding replacement/repair of bearing shall be final and binding. “An amount of 10% of the cost of BOQ item will be retained as security deposit in the form of standard bank guarantee for 15 years. This is in addition to the security deposit under clause 1A of GCC2005”.

It shall be ensured that the bottoms of the segments to be received on the bearings are plane at the location of these bearings and care shall be taken that the bearings are not displaced while placing the segments. Detailed methodology for fabrication and fixing shall be submitted for the approval to the Engineer-in-charge and the work will be carried out as strictly as per the approved method statement.

4.15.1.1 Pot Bearing

Material specifications of Pot Bearings

All the components of Pot Bearings will meet the following standards :

The material such as PTFE lubrication, confined elastomer, stainless steel & internal seal shall conform to requirement of IRC: 83 Part-III.

The Pot base, saddle & top plate shall be of cast steel conforming to IS:1030 Gr 280-520 W. The anchor bolts shall conform to IS:1364.

All welding shall conform to IS:816 & IS:9595 with electrode as per IS:814.

Painting on non-working surface of bearing shall be as per IRC:83 Part-III.

The mating surface of Piston and cylinder shall be hardened to 350 BHN (Min).

Guides of sliding pot bearing shall be monolithic to parent component.

All the part of bearing such as anchor sleeves, anchor bolts, plates etc embedded in concrete shall be hot dip galvanized @ 300gm/m^2.

Modifications to the requirements of IRC:83 Part – III

All the design requirement for Pot bearing as specified in IRC:83 Part-III has to be fulfilled with following modifications.

No increase in permissible stresses in any steel component of Pot bearing or bearing stress between concrete and bearing is permitted in seismic condition.

No increase in permissible bearing stress between concrete and bearing is permitted in seismic condition.

Anchor sleeve

The anchor sleeves have to be designed taking account of difference in elasticity of steel of sleeve and concrete. The effect of shifting of center of rotation of sleeve should be also taken into account.

Testing of Pot Bearing

A.4.1 Proof Load Test

A test bearing shall be tested as defined in IRC-83 Part-III.

The bearing will be visually examined both during the test and upon disassembly after the test. Bearings having any resultant visual defects, such as extruded or deformed elastomer or PTFE, damaged seals, or cracked steel, will not be accepted.

During the test, the steel bearing plate and steel piston shall maintain continuous and uniform contact and if any lift-off is observed, the bearings will not be accepted.

4.15.1.2 Sliding Coefficient of Friction

For all guided and non-guided expansion type bearing, the sliding coefficients of friction shall be measured at the bearing's design capacity. The sliding coefficient of friction shall be calculated as the horizontal load required to maintain continuous sliding of one bearing, divided by the bearing's vertical design capacity.

The test result will be evaluated as follows:-

The measured sliding coefficients of friction shall not exceed 3%.

The bearing will be visually examined both during and after the test. If any resultant visual defects, such as bond failure, physical destruction, cold flow of PTFE to the point of de-bonding, or damaged components is found, the bearings will be rejected.

A.5 Sampling and Testing

A.5.1 Lot Size

Sampling testing and acceptance consideration will be made on a lot basis. A lot shall be defined as those bearings presented for inspection at a specific time or date. A lot shall be further defined as the smallest number of bearings as determined by the following criteria.

- A lot shall not exceed a single contract or project quantity
- A lot shall not exceed 25 bearings
- A lot shall consist of those bearing of the same type regardless of load capacity. Bearing types shall be fixed or expansion bearings types. Guided and non-guided expansion bearing shall be considered a single type.

A.5.2 Sampling and testing requirements

The manufacture shall furnish the required number of samples to perform testing in accordance with Table Given below:-

Test	Sample Required
• Proof load	One production bearing per lot
	One production bearing per lot

• Coefficient of Friction • Physical Properties of elastomeric rotational elements • Physical properties of PTFE sheet	One elastomeric element per lot One 10" x 15" sheet of PTFE material per project

A minimum of thirty (30) days shall be allowed for inspection, sampling and testing of production bearings and component materials. All exterior surfaces of sampled production bearings shall be smooth and free from irregularities or protrusions that might interfere with testing procedures. The manufacture will select, at random, the required sample bearing(s) from completed lots of bearings for testing by the manufacture. He will complete the required testing and determine compliance with this specification before submitting the lot(s) for inspection, sampling, and acceptance consideration.

The Engineer-in-Charge or his authorised representative shall select, at random, the required sample bearing(s) from completed lots of bearings.

Necessary test certificates for all raw material shall be furnished by manufacture .Test specified in IS:1030 for cast steel shall be performed . Casting shall be ultrasonically got tested by approved testing agency.

A.6 Fabrication details

The Contractor shall provide the Engineer-in-Charge with written notification thirty (30) days prior to the start of bearing fabrication. This notification shall include all of the information shown on the shop drawings which are required as explained in subsequent section.

The finish of the mould used to produce the elastomeric rotational element shall conform to good machine shop practice.

All steel surfaces exposed to the atmosphere, except stainless steel surfaces and metal surfaces to be welded, shall be shop painted in accordance with the Contract Plans. Prior to painting, the exposed steel surfaces shall be cleaned in accordance with the recommendations of the coating's manufacture. Metal surfaces to be welded shall be given a coat of clear lacquer, or other protective coating approved by the Engineer-in-Charge, if the time of exposure before welding takes place is to exceed three months, the coating shall be removed at the time of welding. No painting will be done to these surfaces prior to the completion of welding.

Stainless steel sheet shall be attached to its steel substrate with an approved epoxy to ensure complete contact and then sealed with a continuous seal weld.

The steel piston and the steel pot shall each be machined from a solid piece of cast steel. The outside diameter of the piston shall be no more than 1mm less than the inside diameter of the pot at the interface level of the piston and elastomeric rotational element. The sides of the piston shall be bevelled to facilitate rotation. Except as noted all bearing surfaces of steel plates shall be finished or machined flat in accordance with tolerance written below:

Tolerances :-

Manufacture tolerance shall be as per IRC:83 Part-III. All these measurements will be taken using dial height gauges, vernier calipers, surface finish measurement instrument etc has to be arrange by manufacture at the workshop. Every bearing shall have the Project identification number, lot number, and individual bearing number indelibly marked with ink on a side that will be visible after erection.

After assembly bearing components shall be held together with steel strapping, or other means, to prevent disassembly until the time of installation. Packaging shall be adequate to prevent damage from impact as well as from dust and moisture contamination during transportation and storage.

A.7 SHOP DRAWINGS

Along with detailed design of different types of bearing, shop drawings shall be submitted .The shop drawings shall contain the following information, which is necessary for proper design and detailing of the bearings.

Quantity, type (fixed, guided expansion, non-guided expansion), and location of all bearing units.

A table containing maximum and minimum vertical and horizontal loads, design rotation requirements, and magnitudes and directions of movements.

Allowable contact stresses, maximum dimensions, and anchorage requirements at the bearing interfaces; grades, bevels, and slopes at all bearings; and allowable coefficients or friction of all sliding surfaces.

The painting system to be used on the steel components to guard against corrosion.

Any special consideration such as earthquake requirements, uplift details, or temporary attachments.

Installation scheme of pot bearing

4.15.2 Expansion Joints

4.15.2.1 General

Relevant clause of IRC:SP:69-2005 would be applicable. For other details regarding fabrication, fixing, sealing, etc. specifications are as follows:

4.15.2.2 Strip seal expansion joint

Expansion joint type described here is the “strip seal” type.

A.1 COMPONENTS:

Strip seal expansion joint shall comprise the following items:

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 10mm all along its cross section (flanges and web). The minimum height of the edge beam section shall be 80mm. The minimum cross sectional area of the edge beam shall be 1500mm^2.

Anchorage:

Edge beams shall be anchored to the deck by reinforcing bars or bolts or anchor plates cast in concrete or a combination of anchor plate and reinforcing bars. 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 12mm. Total cross sectional area of bar on each side of the joint shall not be less than 1600 mm^2 per meter length of the joint and the center to center spacing shall not exceed 250mm. The ultimate resistance of anchoress shall not be less than 600 KN/m in any direction.

A.2. MATERIALS FOR COMPONENTS

1. Suitability of material for different components of the expansion joints will be as detailed below.

2. 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 G40.21 Grade 300W or equivalent.

3. Anchorage steel shall conform to IS:2062 or equivalent.

4. All steel sections shall be protected against corrosion by hot dip galvanizing or any other approved anticorrosive coating with a minimum thickness of 100 micron.

5. 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.

A.3 FABRICATION (Pre-installation)

Fabrication details for the expansion joints are given below.

The strip seal joint system and all its component parts including anchorages shall be supplied by the manufacture /system supplier.

Sealing element is made of chloroprene and must be extruded section. The working movement range of each sealing element shall be at 70mm.

The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacture. Depending upon the temperature at which the joint is to be installed, the gap dimension shall be preset.

Each strip seal expansion joint system shall be fabricated as a single entity 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 manufacture prior to transportation. Presetting shall be done in accordance with the joint opening indicated on the drawing.

The finally assembled joint shall then be clamped and transported to the work site.

TABLE-1 STRIP SEAL ELEMENT SPECIFICATION

PROPERTY	SPECIFIED VALUE
Hardness	
▪ DIN 53505	63 ± 5 Shore A
▪ ASTM D 2240 (Modified)	55 ± 5 Shore A
Tensile Strength	
▪ DIN 53504	Min 11 MPa
▪ ASTM D 412	Min 13 .8Mpa
Elongation at fracture	
▪ DIN 53504	Min 350 %

▪ ASTM D 412	Min 250 %
Tear Propagation Strength	
▪ Longitudinal	Min 10 N/mm
▪ Transverse	Min 10 N/mm
Shock elasticity	Min 25 %
Abrasion	Min 220 mm^3
Residual Compressive Strain (22h/70℃/30% Strain)	Max 28 %
Aging in hot air (14days/70℃)	
▪ Change in hardness	Max + 7 Shore A
▪ Change in tensile strength	Max –20 %
▪ Change in elongation at fracture	-20 %
Ageing in Ozone (24h/50pphm/25℃/20% elongation)	No cracks
Swelling behaviour in oil (168h/25℃) **ASTM Oil No. 1**	
▪ Volume Change	Max + 5 %

▪ Change in hardness	Max –10 Shore A
ASTM Oil No. 3	
▪ Volume Change	Max + 25 %
▪ Change in hardness	Max –20 Shore A
▪ Cold Hardening Point	Max –35℃

Only one set of specification viz. ASTM or DIN shall be followed depending on the source of supply.

A.4 HANDLING AND STORAGE

Following precautions shall be followed for the handling and safe storage of the joints before putting them into the job at site.

For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.

The manufacture/supplier shall supply either directly to the Engineer-in-Charge 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.

Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding.

A.5 SUPPLY/ INSTALLATION:

Components of expansion joint such as edge beam and strip seal shall be imported from the specified foreign manufacture / collaborator with the prior approval of Engineer-in-charge. Contractor shall furnish a warranty on pre-approved format for trouble free performance for at least **fifteen years** and free rectification of defects / replacement, if any, during this period. “An amount of 10% of the cost of BOQ item will be retained as security deposit in the form of standard bank guarantee for 15 years. This is in addition to the security deposit under clause 1A of GCC 2005”.

The joints shall be installed by the manufacture/supplier or their authorised representative who will ensure compliance to the manufacture’s instructions for installation.

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 manufacture. 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. The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be rigid and firm.

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.

The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall levelled 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.

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 M40 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.

The neoprene seal shall be field installed in continuous length spanning the entire roadway width. In order to ensure proper fit of 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.

The deck surfacing shall be finished flush with the top of the steel sections. 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.

A.6 ACCEPTANCE CRITERIA

All joints will meet the following acceptance criteria before these are accepted for lowering and installation at the required location as per the drawings.

All steel elements shall be finished with corrosion protection system.

For neoprene seal, the acceptance test shall conform to the requirements stipulated in Annexure-C Table G-(5) of this NIT . The manufacture/supplier shall produce a test certificate accordingly, conducted in a recognized laboratory, in India or abroad.

The manufacture shall produce test certificates indicating that anchorage system had been tested in recognized laboratory to determine optimum configuration of anchorage assembly under dynamic loading.

Prior to acceptance 25 % of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously pounded along the entire length for a minimum period of 4 hours for a depth of 25mm above the highest point of deck. The width of ponding shall be at least 50mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

As strip seal type of joint is specialized in nature, generally of the proprietary type, the manufacture shall be required to produce evidence of satisfactory performance of this type of joint.

A.7 TEST AND STANDARDS OF ACCEPTANCE:

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacture/supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

4.16 Temporary Work

All designs for temporary work shall conform to and comply with all the requirements given in the latest edition the relevant IRC Codes, Standard specifications and codes of practice for Road Bridges and other technical Specifications as detailed in this tender. These standard specifications and codes of practices shall be supplemented wherever necessary by, 'MORTH Specifications' for Road and Bridge works' published by Indian Roads Congress, and relevant BIS codes specifications etc., so far as applicable. These shall also deem to incorporate any subsequent amendments that may be recommended by respective authorities of the above mentioned specifications and codes of practices, upto the last date of the month prior to month of receipt of tender.

For all work for which the contractor has to submit design for approval of the Consultant appointed by the Department, the same shall be got prepared by the contractor from approved consultants who are specialised in the field. For particular item of scaffolding, staging and shuttering, use of any proprietary method of staging should be supplemented with proper designs of such system after getting approval from the Engineer-in-Charge.

4.17 Reinforced Soil structures

4.17.1 Description

The work shall consist of Reinforced Soil Structures/ Reinforced Earth walls constructed of precast concrete facing, galvanized steel strip reinforcement/geogrid and backfill material in accordance with the following specifications and in conformity with the lines, grades, design and dimensions shown on the drawings (supplied by the manufacture) or established by the Engineer-in-Charge. The contractor shall submit all the design calculations and drawings, well in advance, to the Engineer-in-charge for the purpose of approval.

4.17.2 Precast Concete facing

4.17.2.1 General

The facing shall consist of M 35 grade precast concrete blocks of finish approved by the Engineer-in-charge. Precast concrete facing elements shall conform to the details and dimensions shown on the drawings provided by the manufacture and approved by the Engineer-in-Charge. The area of single precast facia panel in elevation (after placing in position) shall not be less than 1.5 m^2 (height not less than 900mm, thickness 180mm min.). Concrete shall conform to the requirements given in this Specification document. Services, pipes etc are not allowed to pass through the reinforced soil wall portions.

4.17.2.2 Casting

The elements shall be cast on a flat area. The concrete in each unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator supplemented by such hand-tamping as may be necessary to force the concrete into the corners of the forms and prevent formation of stone pockets or cleavage planes. Release agent of the approved manufacture shall be used throughout the casting operation.

4.17.2.3 Curing

The precast elements shall be cured for a sufficient length of time (at least 14 days) so that the concrete develops the required compressive strength.

4.17.2.4 Removal of Forms

The forms shall remain in place until they can be removed without damaging the elements.

4.17.2.5 Scribing

The date of manufacture shall be clearly scribed on the rear face of each unit.

4.17.2.6 Concrete Finish

The surface finish shall be as per the instructions of the Engineer-in-charge.

4.17.2.7 Tolerances

All elements shall be manufactured within the following tolerances:

- All dimensions : within 5mm
- Evenness of the front face : $\pm$ 5mm over 1500mm
- Thickness : $\pm$ 5mm

4.17.2.8 Handling Storage and Transporting

All elements shall be handled, stored and transported in such manner as to eliminate the danger of chipping, cracks, fracture and excessive stresses.

4.17.2.9 Acceptability and Placement

Acceptability of the precast elements shall be determined on the basis of compression tests, as specified and visual inspection. The age of concrete of precast facia elements shall not be less than 14 days at the time of placement in position and shall have achieved specified 28 days strength.

Regular check shall be conducted for wall batter after every layer of placement of panels by plumb.

4.17.2.9 Rejection

Elements shall be subjected to rejection in case of failure to meet any of the requirements specified above. In addition, defects that indicate imperfect moulding, or defects indicating honeycombed or open textured concrete, shall be sufficient cause for rejection.

4.17.2.10 Levelling Concrete Pad

A levelling concrete pad with nominal reinforcement shall be provided under walls and seat beams (for bridges abutments) as per the recommendations of the manufacture. Concrete used for levelling pad shall be M20 grade.

Maximum size of aggregates shall be 20mm. The pad shall be cured at least for 24 hours prior to placing the precast facia elements.

4.17.2.11 Soil Reinforcement

The soil reinforcement shall be in the form of geogrids or galvanized steel strips. The soil reinforcements shall conform to the specifications of the manufacture and shall be subject to the approval of the Engineer-in-charge prior to supply of the material at the site.

4.17.2.11.1 Geogrid Soil Reinforcement:

The sample specifications for geogrids are given below for information only.

The geogrid shall be identified, handled, stored and installed in such a way that its physical property values are not affected and that the design conditions are ultimately met as intended.

4.17.2.11.2 Geogrid Material

The specific geogrid material shall be pre-approved by the Engineer-in-charge. For mono oriented geogrid, the characteristic design tensile strength (factored strength of the geogrid reinforcement at the end of its selected design life) at a strain not exceeding 10 percent in 100 years shall be at least 40kN/m when measured as per GRI:GG3.

The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture sufficient to permit significant mechanical interlock with the surrounding soil. The geogrid structure shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced.

4.17.2.11.3 Certification

The supply of geogrids shall carry a certification of BIS or ISO 9002 or BBA or FHWA. In case of disputes over validity of values, the Engineer-in-charge can require the Contractor to supply test data from approved laboratory to support the certified values submitted.

4.17.2.11.4 High adherence Galvanized Steel Strips and Fasteners for soil reinforcement:

The shape and dimensions of these elements shall be as shown on the drawings. Tie strips and high adherence reinforcing strips shall be hot rolled. Their physical and mechanical properties shall conform to European norms EN 10025 or equivalent IS 2062. Reinforcing and tie strips shall be hot dip galvanized to conform to the minimum requirements of ISO Standard 1460 and 1461 equivalent to IS 4759. The average zinc coating shall not be less than 1000gm/sqm.

Reinforcing and tie shall be cut to the lengths and tolerances shown on approved drawings. Holes for bolts shall be punched in the locations shown. They shall be carefully inspected to ensure that they are true to size and free from defects that may impair their strength or durability.

Bolts and nuts shall be hexagonal in shape and high strength screw conforming to European norms E25100 CLASS 10.9 or equivalent IS. They shall be 12mm in diameter 30mm in length hot dip galvanized in conformity with ASTM A153 or equivalent IS. The average zinc coating shall not be less than 1000gm/sqm

4.17.2.12 Construction

Material identification, storage and Handling

Contractor shall immediately inspect the material upon delivery to assure that the proper type and grade of geogrid have been received. The geogrid shall be ro rolled on cores having sufficient strength to avoid collapse and other damage from normal use. Each roll shall be wrapped with plastic covering to protect the geogrid from damage during shipping, handling, and shall be identified with a durable gummed level, or equivalent, clearly readable, on the outside of wrapping for the roll. The label shall show the manufacture's name, the style number and the roll number.

While unloading or transferring the geogrid from one location to another, care shall be taken to prevent damage to the wrapping, core, label, or the geogrid itself. The geogrid shall not be stored in an exposed condition and shall be located and placed in a manner that ensures the integrity of the wrapping, core, and label as well as the physical properties of the geogrid. The geogrid shall be placed on an elevated platform and adequately covered and protected from ultraviolet radiation including sunlight, chemicals that are strong acids and bases, fire or flames including welding sparks, and human and animal destruction. It shall also be ensured by the contractor that during shipping, handling and storage of the geogrid the surrounding temperature remains within the allowable limits as specified by the manufacture. However, in no case, the temperature shall be less than -6^{o}C or greater than 60^{o}C.

At the time of installation, the geogrid shall be rejected if it has defects, tears, punchers, flaws, deterioration, or damage incurred during manufacture, transportation, storage or placement. However, if approved by the Engineer-in-charge, torn or punctured sections may be repaired by placing a patch of suitable size (as recommended by the manufacture) over the damaged areas.

Geogrid Placement

The role identification, length, installation orientation, and location shall be verified with the construction drawings before unrolling of the geogrid. Inspection of damage or defects shall be made during unrolling of the geogrid.

The geogrid reinforcement shall be installed strictly in accordance with the manufacture recommendations. The geogrid reinforcement shall be placed within the layers of the compacted earth as shown in the construction drawings or as directed by the Engineer-in-charge.

The geogrid shall be laid in one continuous length in the principal strength direction; no jointing by overlap or sewing shall be allowed in the principal strength direction. However a bodkin joint may be allowed as per the recommendations of the manufacture and with a prior approval of the Engineer-in-charge. This joint shall be made for the full width of the strip as per the specifications of the manufacture. Joints in geogrid reinforcement shall be pulled and held taut during fill placement.

Place only that amount of geogrid reinforcement required for immediate pending work to prevent undue damage. After a layer of geogrid reinforcement has been placed, the next succeeding layer of earth shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geogrid layer shall be installed. The process shall be repeated for each subsequent layer of geogrid reinforcement and soil.

Geogrid reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of Geogrid reinforcement has been placed, suitable means, such as pins or small piles of soils, shall be used to hold the geogrid reinforcement in position until the subsequent soil can be placed.

During construction, the surface of the fill shall be kept horizontal. Geogrid reinforcement shall be placed directly on the compacted horizontal fill surface. Correct orientation of the geogrid reinforcement shall be verified by the Contractor and got approved by the Engineer-in-charge.

4.17.2.12.1 Precautions

Under no circumstances shall a track type vehicle be allowed on the geogrid reinforcement before at least 300mm of fill material has been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displaying the fill and the geogrid reinforcement. If approved by the Engineer-in-charge, Rubber-typed equipment may pass over geogrid reinforcement at slow speeds less than 15kmph. Sudden braking and sharp turning shall be avoided.

4.17.2.12.2 Joint Fillers

The facia unit joint filler shall be as per the recommendations of the manufacture and shall be durable resistant to the effect of air pollution and water.

Particularly in the case of galvanized steel strips, filler of vertical joints between panels shall be flexible open cell polyethylene foam strips or non-woven fabric strips (the latter used as joint cover instead of filler). Bearing pads for horizontal joints of panels shall be made of elastomer with vulcanised EPDM.

4.17.2.12.3 Backfill materials

The backfill material shall conform to the specifications of the manufacture and got approved by the Engineer-in-charge prior to placement in position. The filling material from the precast concrete facing to the end of the soil reinforcement (geogrids/galvanized steel strips) shall be

referred as 'reinforced fill' while the filling material beyond the soil reinforcement shall be referred as 'random fill'. Backfill material used in reinforced soil volume shall be reasonably free from organic or otherwise deleterious material and shall confirm to necessary mechanical requirements. The backfill soil shall also meet all chemical and electro-chemical properties required for Geosynthetic reinforcement. The soil used as 'reinforced fill' shall conform to the following specifications:

The filling material for reinforced soil structure shall have an angle of internal friction between the compacted fill and the reinforcing element of not less than 25^{o}, measured in accordance with IS: 13326 (Part 1). The soil shall be predominantly coarse grained and not more than 10 percent of particles shall pass 75 micron sieve. The uniformity coefficient (C_U), of the backfill material shall be greater than 2.5. The soil should have properties such that the salts in the soil should not react chemically or electrically with the reinforcing elements in an adverse manner.

The 'random fill' beyond the soil reinforcement shall also conform to the specifications given above for the reinforced fill material.

4.17.3 Construction requirements

4.17.3.1 Excavations

Excavation shall be in accordance with the relevant section of these Specifications and in conformity to the limits and construction stages shown on the drawings. In case of Excavation of slopes for building the retaining wall temporary protection work may be required to keep the traffic running on the embankment.

4.17.3.2 Foundation Preparation

Prior to the erection of wall, if required by the Engineer-in-charge, the foundation soil shall be compacted with smooth wheel vibratory roller. Any foundation soil/ loose pockets deemed unsuitable shall be removed and replaced.

4.17.3.3 Erection

The erection of precast fascia panels shall be in accordance to the instructions given by the manufacture. Panels shall be placed in successive horizontal lifts in the sequence shown on the drawings as backfill placement proceeds.

Vertical tolerances (plumbness) and horizontal alignment tolerance shall not exceed 25mm when measured along a 3m straight edge.

4.17.3.4 Backfill Placement and Compaction

Backfill placement shall follow closely the erection of each lift of fascia panels. At each reinforcing level, backfill should be roughly levelled before placing the soil reinforcement. The galvanised steel strips shall be placed normal to the face of the wall or as shown on the drawings. The program for filling shall be such that no construction plant runs directly on the reinforcement.

All construction plant having a mass exceeding 1000kg shall be kept at least 1.5m from the inner face of the wall. In this area (upto 1.5m from the inner face of the wall) the compaction shall be done with a vibratory plate compactor of maximum weight 1000kg.

Compaction by any other method shall only be permitted with the prior approval of the Engineer-in-charge. During construction the retained material beyond the reinforcement shall be maintained at the same level as reinforced fill.

The compacted layer shall not be more than 200mm, to achieve the compaction of 95 percent of maximum laboratory density when measured as per IS: 2720 (Part 8). Temporary formwork shall be used to support the precast concrete facing as per specified details given in the drawings. The forms, scaffolding, and props shall be sufficient in numbers to allow executing the job within the specified time schedule.

At the end of each day's operations, the Contractor shall shape the last level of backfill as to permit runoff of rainwater away from the wall face.

4.17.3.5 Measurement

The measurement shall be in terms of completed area of M35 grade concrete precast facing panels in square meter.

The unit rate shall include the supply of the precast fascia panels, all specialist fitments and accessories, placing and attaching galvanised steel strips, all sealant and fixings, filter media behind precast facing panels and at the base of the filling as per drawing, submission of detailed design and construction drawings (prepared by the manufacture of the soil reinforcement), supervision to site works and all labour, equipment, tools and incidentals to complete the work.

4.17.3.6 Supervision

A representative of the manufacturer or his licensee shall be present on site during the entire casting and erection phases to ensure that the quality of the works performed by the Contractor is in accordance to the specifications. The representative shall also assist the contractor whenever required during the entire construction period of reinforced soil wall or desired by the Engineer-in-charge.

All expenses related to his presence on site shall be borne by the Contractor.

4.18 Shuttering, Formwork

4.18.1 General

Steel formwork or any other internationally accepted “System Formwork” shall only be used for concrete work to produce a smooth and uniform finish on all exposed surfaces. The entire responsibility of planning, designing, erection, dismantling, shifting and safety of false work lies with the contractor. Individual steel shuttering plates shall have a minimum size of 0.9m x 1.5m (minimum area 1.35sq.m) except in the matching pieces, piers and smaller components. Formwork shall be made out of minimum 5 mm thick M.S. plates with stiffeners (thickness not less than 5mm) or as per design approved by Engineer-in-Charge. Planning of formwork shall

be got approved from the Engineer-in-Charge prior to actual mobilisation and use. All piers shall be cast in one operation and the formwork shall be planned and provided accordingly.

Substantial part of superstructure is in curved alignment. Contractor shall take special care to fabricate the shuttering for curved spans so as to achieve true curve radius, extra widening of deck and camber as per details shown in the superstructure drawings. Contractor shall prepare and submit fabrication drawings of the shuttering before undertaking shutter fabrication. Shuttering drawings shall give complete shutter details showing sequence of assembly and dismantling of shutters. Shuttering for box girders shall be designed so as to permit construction of box girder in two stages. Soffit slab shall be cast in first stage and webs and deck slab shall be cast in second stage. I-girders shall be cast in single stage and their shuttering shall be designed accordingly. Shutter details for I-Girders as well as box girders shall permit stage pre-stressing. Box girders shall have pre-stressing anchorages in internal blisters and shutter details at blister locations shall be modified to accommodate them.

All shuttering and supports shall be designed by the contractor in accordance with the loads, pressures, stresses, etc. stipulated in the "IRC: 87-1984, Guidelines for the Design and Erection of Formwork and Centring for Road Bridges" and relevant drawings. The Contractor shall submit design calculations for strength and deflection of the formwork/staging and portal for central span including its foundation in triplicate to the Engineer-in-charge for approval at least 30 days before the contractor is ready to erect the same in position. Any improvement to portals, shuttering, staging and its support system as suggested by the Department shall be binding on the contractor without any extra cost to the Department. These suggestions shall however not absolve the contractor of his full and final responsibility towards the safety and serviceability of the staging and formwork as well as men and equipment working on them during the preliminary works before concreting, during concreting and afterwards. Shutters shall be water tight, fixed in perfect alignment and shall be able to withstand, without any displacement, deflection or movement of any kind, the loads due to the pressure of concrete, the movement of construction personnel, materials and plant.

Attention is drawn to the form liner finish required for the outer face of crash barrier, reinforced soil wall panels (if required), piers etc. It may be noted that the formwork for the piers will have suitable number of pieces (in plan) to facilitate easy removal of formwork without breaking the vertical ribs on the pier face. Actual scale trials (mock ups) using FRP made form liners of piers for full height including foundation, voided deck slab portion and Box girder and full width of carriageway including voiders, using FRP made form liners for crash barrier, R.S.wall panels, External surfaces of RCC ground supported boxes and retaining walls shall be performed for demonstrating the efficiency of the system to the satisfaction of the Engineer-in-charge. The cost of one such final approved mock up of each type shall be payable as per respective items of concrete and reinforcement. No costs shall be payable for unsatisfactory mock-ups or trials. The concreting for the piers shall have to be done in single pour only using concrete pump. The location for making mock up items shall be as per the directions of engineer in charge. Temporary openings may be required in the formwork of the piers for proper compaction of concrete. Care shall be taken to maintain a single source of the raw material for concreting to achieve a uniform colour. Shuttering joints for all-important items shall be got approved.

4.18.2 Pre-Assembly Of Formwork

It shall be obligatory on the part of the contractor to pre- assemble the formwork for mock up piers, precast superstructure, crash barrier, pedestrian railing, Precast RCC railing, Kerb etc. on

ground of suitable scale/dimension as directed by engineer-in-charge, prior to actual use. The contractor shall arrange for all material, labour facilities, etc. to facilitate first hand checking and carry out necessary modifications as required to make the formwork true to line, level and shape at no extra cost. However, the contractor shall be responsible for the correctness of the formwork when erected in position finally. Pre-checking of formwork shall not be a ground for accepting any defective and bad formwork produced by the contractor.

The formwork shall be load tested for the probable anticipated loads before the same is put to actual use, at the direction of Engineer-in-charge. However, load testing of formwork shall not relieve the contractor of his responsibility for safety and serviceability.

4.18.2.1 Permissible Tolerances

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerance for in-situ casting unless otherwise specified or shown in drawings or directed by the Engineer-in-charge.

Sectional dimension	-	$\pm$ 5mm
Plumb	-	+ 1 in 1000 of height
Levels	-	3 mm (before any deflection has taken place).

The tolerances given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerance for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer-in-charge. Errors, if noticed, in any lift/tilt of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment provided always that prior approval of the Engineer-in-charge shall be obtained in respect of acceptability of such corrective measures without affecting the component structurally or aesthetically.

All shutters of beams, slabs and other members shall be so designed and constructed that the sides may be removed without disturbing the bottom plates or supports thereto. The bottom of each shutter shall be provided with a camber approximately to the final deflection of both shutter and beam under load as determined by the Engineer-in-charge. The supporting struts shall be adjusted and fixed in position by suitable means duly approved by the Engineer-in-Charge.

Tubular steel props, shores, bracing or similar rigid material approved by the Engineer-in-charge shall be used for shuttering, scaffolding and staging.

4.18.2.2 Preparation of Formwork before Concreting

The inside surfaces of forms shall, except in the case of permanent formwork or where otherwise agreed to by the Engineer-in-Charge be coated with an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacture's instructions and shall not be allowed to come into contact with any reinforcement. Different release agents shall not be used in formwork for concrete, which will be visible on the surface of finished works. Releasing agent should not leave any stain marks/difference in colour shades on finished exposed surface of the RCC member. Use of grease or burnt lubricant oil etc. on shutters, as release agent shall not be permitted.

Formwork shall be tight enough to prevent any loss of cement slurry during vibrations. Immediately before concreting, all forms shall be thoroughly cleaned.

Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the formwork as to their strength, alignment and general fitness, but such inspection shall not relieve the contractor of this responsibility for safety of men, machinery, materials and for result obtained.

4.18.2.3 Removal of Formwork

The minimum time period for the removal of formwork shall be as per section 1508 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road and Bridge Works (4th Revision, 2001). However this shall be taken as guidance only and the scheme for removal of formwork (de-shuttering and de-centering) shall be planned well in advance and furnished to the Engineer-in-charge for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Engineer-in-charge.

The contractor shall record in any approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer-in-charge. The contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by the Contractor without any extra cost to the Department. The Engineer-in-charge may, however, instruct to postpone the removal of formwork if he considers it necessary and no claim whatsoever shall be entertained on this account.

4.18.2.4 Re-Use Of Forms

Before re-use, all forms shall be thoroughly scrapped, cleaned, joints and planes examined and when necessary/repaired and inside surface treated as specified herein before. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer- in-charge. Nothing extra or any claim whatsoever shall be admissible on this account.

The contractor is to make good at his own expenses any injury to the concrete work and any damage caused by, or arising from the removal and striking of shutters and supports. Notwithstanding conditions and requirements mentioned in the foregoing paragraphs the shuttering should be such that all concrete work remains shutter finished as per pattern approved by the Engineer-in-charge.

4.18.2.5 Formed Surface and Finish

All members above ground or formation level shall have shutter finished surfaces.

The contractor in erection of formwork shall take utmost care for components cast in stages. Location of construction joints in between such stages shall be predecided and all such joints shall be treated in a manner approved by the Engineer-in-charge so as to match with the surrounding concrete without leaving any visual aberration or bad patches and/or bands. The contractor shall be deemed to have included the cost of such operation in his quoted rates and no claim whatsoever shall be entertained at a later date.

The formed finished concrete surfaces shall be free from honeycomb, blemishes, holes, surface defects, etc. In no case such defects shall exceed 200mm in any direction for

individual spots or the continued area of such defects shall not exceed 0.2% of the entire area of related surface. Any variation beyond this limit shall be considered as a substandard work and shall be rejected.

Special care shall be taken to ensure that no stains are left on the formed concrete either from formwork or exposed reinforcement bars. Such stains shall be removed by the contractor at no extra cost so as to match with adjoining concrete surfaces to the satisfaction of the Engineer-in-charge.

4.19 Embankment Works

4.19.1 Site Clearance

Road side trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipe lines, sewers and all road facilities within or adjacent to the road which are not to be disturbed, shall be protected from injury or damage. The contractor shall provide and install at his own expenses suitable safeguards and barricades as approved by the Engineer-in-Charge for this purpose.

Before the earth work is started, the area where site clearance is required shall be cleared of shrubs, rank vegetation, grass, brush-wood, trees and saplings of girth upto 30cm measured at a height of one meter above ground level and rubbish removed from site and disposed off to approved disposal site for all leads and lifts. The roots of trees shall be removed to a minimum depth of 60cm below ground level or a minimum of 50cm below formation level whichever is lower and the hollows filled up with earth.

4.19.2 Setting out and Making Profiles

After the site has been cleared and layout completed, the limits of embankment should be set out true to lines, curves, slope, grades and sections as shown on the drawings. The limits of the embankment should be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the construction. The embankment should be built sufficiently wider than the design dimensions so that surplus material may be trimmed, ensuring that the remaining material is of the desired density and in position specified, and conforms to the specified slopes. Bench marks and other stakes should be maintained as long as in the opinion of the Engineer-in-Charge, they are required for the work.

Masonry pillars shall be erected at suitable points in the area, which is visible from the largest area to serve as bench mark and survey instrument stations, for the execution of the work. The benchmark shall be connected with standard B.M. as approved by the Engineer-in-Charge. Necessary profiles with pegs, bamboo's and string or 'Burjis' shall be made to show the correct formation levels before the work is started and at the intervals indicated in general arrangement drawings. The setting out of the layout of alignment of approach embankments shall be done using total survey station.

The contractor shall supply labour and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete etc. required in connection with the setting out and making profiles and establishing bench marks and nothing extra shall be paid on this account. The contractor shall be responsible for maintenance of benchmarks and burjis.

The ground levels shall be taken at 5 metres intervals (or as directed by the Engineer-in-Charge) in uniformly sloping ground and at close intervals where local mounds, pits or undulations are met with the levels as directed by engineer in charge. The initial levels shall be taken for 15m on either side of centre line of slip road except in MCD landfill area where the levels shall be taken for 50m. The initial ground levels shall be recorded jointly by the representative of Engineer-in-charge and contractor and plotted on plans by the contractor. The plans shall be drawn to a scale of 5 metres to one cm or any other suitable scale as approved by the Engineer-in-Charge. North direction line and position of B.M. shall invariably be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge before the earth work is started. The labour and T&P required for taking levels shall be supplied by the contractor at his own cost. “The levels shall also be recorded in level book as per departmental procedure”.

4.19.3 Source of Supply

Good earth for turfing and subgrade for any other location in embankment shall be arranged by the contractor from any suitable borrow pit /outside source duly approved by the engineer-in-charge, before the start of the work.

The arrangement for supply of material is to be made by the contractor at his own responsibility and he shall pay necessary charges for the land/royalty, if required. The rate quoted by the contractor shall be inclusive of all labour, material, land charges, royalty, T &P , carriage for all leads and lifts etc. involved and nothing extra shall be paid over the rates quoted for any reason whatsoever. The department shall not be responsible for any dispute arising out in connection with the supply of material.

4.19.4 Excavation and Preparation of Ground Supporting Subgrade

In all cases, the original ground at the foundation level of embankment shall be consolidated by rolling, as directed by Engineer-in-Charge, but with a minimum of six passes of 8-10 tonne roller.

Existing structure such as old buildings, footpaths, culverts, pipe lines, sewers etc. within or adjacent to the area if required to be removed as part of site clearance shall be dismantled as per the direction of Engineer-in-Charge. The steel railings/trusses/signages etc. dismantled shall remain property of the department and shall be handed over to the Engineer-in-charge.

For construction of surface/sub-surface drains, excavation shall be carried out in proper sequence as per programme submitted by the contractor with other works as approved by the Engineer-in-Charge. Where so directed by the Engineer-in-Charge any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials, suitably compacted.

The cut formation shall be prepared by earth excavation upto the depth/founding level as shown in drawings and as directed by the Engineer-in-Charge, to receive the first layer of embankment. The top layer of earth not suitable for reuse in embankment shall be removed from the site as per directions of engineer-in-charge, at no extra cost, for all leads and lifts. The good earth suitable for reuse as side and top cover in embankment shall be stacked near the site.

Note: Where the material, in the existing subgrade or founding/bed level in cut formation has a density less than 97 per cent of the maximum dry density determined according to IS:2720 (Part VIII), the same shall be loosened to a depth of 500 mm and compacted in layers not exceeding 200 mm loose thickness. Any unsuitable material encountered at the bed level shall be removed to a depth indicated by the Engineer-in-Charge and replaced with suitable material. Payment shall be made for such loosening and compaction only**.**

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

In works involving widening of existing pavements, unless otherwise specified, the shoulder verge/median shall be removed to their full width and to levels shown on the drawings or as directed by the Engineer-in-Charge. While doing so, care shall be taken to see that no portion of the existing pavement designated to be retained is loosened or disturbed.

Finishing operations shall include the work of properly shaping, dressing and consolidating all excavated surfaces and founding surface of the embankment as mentioned in drawings.

When completed no point on the slopes shall vary from the designated slopes by more than 150mm measured at right angles to the slopes. In no case shall any portion of the slope encroach on the roadway.

In construction works involving small quantities or constructions of routine nature, the embankment and subgrade material shall be spread in a uniform thickness over the entire width of the embankment in layers not exceeding 250 mm in loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Before placing the next layer, the surface of the under layer shall be moistened and scarified with pickaxes or spades, so as to provide a satisfactory bond with the next layer.

In all embankment/subgrade construction works the whole work including spreading material and sprinkling water shall be done by mechanical means only, unless permitted by the Engineer-in-Charge otherwise.

In cases where mechanical means are adopted, a motor grader shall spread the material uniformly over the entire width of the embankment/Subgrade in layers not exceeding 250 mm in loose thickness. The motor grader blade shall have hydraulic control suitable for initial adjustments and maintain the same so as to achieve the specified slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder.

4.19.5 Spreading and Compaction of Fill Material

Embankment material shall be laid in layers not exceeding 250mm loose thickness, which shall be continuous and parallel to the finished grade. The placing of filling material shall be done in full width of embankment, and the section of formation shall be kept slightly sloping away from the centre to avoid pools of water forming due to rain. The height of filling in different sections shall be uniform. There should not be any undulations in the longitudinal section of the embankment also. All clods shall be broken to have maximum size of 75 mm when being placed in subgrade. Organic matter of any kind or any other ingredient which in the opinion of

the Engineer-in-Charge is likely to deteriorate or effect the stability of the embankment shall be removed and disposed off as directed by the Engineer-in-Charge. The jointing of the old and new embankment shall be done in stepping with an overall slope of 1:5.

Moisture content of the fill material shall be checked at the site of placement prior to commencement of compaction. Moisture content of fill material laid for compaction shall normally vary from OMC determined as per IS: 2720 (Part 8): 1983. Each layer of filling material shall be carefully moistened to give a field moisture content of about + 1% to –2% of the optimum moisture content (OMC). Each layer shall then be compacted by rolling with 8 to 10 tonnes power road roller and vibratory roller, if required. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test.

If the material delivered to the embankment layer is too wet, it must be dried by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to the wet weather, the moisture content can not be reduced to the required amount by the above procedure, work on compaction shall be suspended, as directed by the Engineer-in-Charge and no claim of the contractor shall be accepted on this account except extension of time for completion of the work.

At moisture contents higher than the appropriate range, earth may liquefy and would be difficult to handle and compact. Moisture content of cover soil shall be maintained at its OMC. Where water is required to be added to the fill material, it shall be sprinkled from a water tanker fitted with a sprinkler capable of applying water uniformly without any flooding. The water shall be mixed thoroughly by blazing, dicing or harrowing or by suitable means until uniform moisture content is obtained throughout the depth of the layer.

At all times during construction, the top of the embankment shall be maintained at such a cross fall as will shed water and prevent ponding.

The contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall be first submitted to the Engineer-in-charge for approval. Test strips to develop compaction method specifications (optimum compaction procedure to satisfy density requirements) for the construction of the embankment shall be prepared. A series of compaction trials shall be conducted on such test strips. In such trials, usually one parameter such as layer thickness, moisture content etc. Shall be varied at a time while the others remain constant. The final embankment/ filling and compaction methodology shall be approved by the engineer-in-charge based on results of such trials.

Each compacted layer shall be finished parallel to the final cross-section of the embankment. The following end product specifications as given in Table 1 below, have been suggested for construction of embankments.

Table 4-1 Compaction Requirement for Embankment and Subgrade

Sl.	Type of work/material	Field dry density as percentage of maximum laboratory dry density as per IS:2720 (Part VIII)
1.	Subgrade including the portion below earthen shoulders and verge	Not less than 97
2.	Embankment	Not less than 95

The Engineer-in-charge shall permit measurement of field density according to agreed procedure. Subsequent layers shall be placed only after the finished layer has been tested for its density requirements. The contractor shall maintain record of all such tests. When density measurements reveal any soft areas in the embankment, further compaction shall be carried out as directed by the Engineer-in-charge. In spite of that if specified degree of compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, moisture content brought to permissible limits and re-compacted to the required density

Embankment shall be constructed evenly over their full width and the contractor shall control and direct construction plant and other vehicular traffic uniformly across the width. Damage by the construction plant or other vehicular traffic shall be made good by the contractor with material having the same characteristics and strength as it had before it was damaged. Embankments shall not be constructed with steeper side slopes or to greater width than those shown in the drawings. Whenever embankment construction is to be taken up against the face of natural slope or sloping earth works face including embankments, cuttings, and excavations which are steeper than 1:2 (Vertical: Horizontal), such faces shall be benched immediately before placing the subsequent fill.

Where the embankment is to be constructed across low swampy ground that will not support the weight of trucks, road rollers or other hauling equipment, the lower part of the fill shall be consolidated by vibratory rammers/rollers/frog hammers till adequate strength has been achieved when rollers can move.

Each compacted layer shall be tested in the field for the density and accepted before the operations for next layer are begun.

4.19.6 Precautions against Corrosion and Seepage

Where significant volumes of seepage are encountered, pipes should be used to drain the water out of the embankment area. Perforated pipe is usually placed in the vicinity of seep. One-third solid wall pipe with two third slotted portions shall be used to drain the water out of embankment area. PVC/HDPE pipe materials are preferred because of their long-term performance. Analysis should be performed to confirm that they provide adequate wall strength to support the expected embankment loads. To prevent the internal erosion of the fill, filter protection should be provided around the pipes.

Nothing extra shall be payable for providing such protection works in the embankment/guide

4.19.7 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders/verge/road bed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the drawing or as directed by the Engineer-in-Charge subject to the tolerance. Both upper and lower ends of side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain. Wherever turfing is proposed, top soil shall be provided so that after seeding, a dense cover can develop. The depth of top soil should be sufficient to sustain plant growth, the usual thickness being 75 to 100 mm. Slopes shall be roughened and moistened slightly before the application of top soil in order to provide satisfactory bond. Embankments constructed in flood prone areas shall be protected, by stone pitching as shown in drawings, as per the provisions of IRC: 89-1985.

4.19.8 Embankment around Structure

Unless directed otherwise, during the execution the filling around culverts, bridges and other structure shall not be done upto a distance of twice the height of the embankment. The fill material shall not be placed against any abutment or wing-wall unless permission has been given by the Engineer-in-Charge but in any case not until the concrete or masonry has been in position for 14 days. The embankment shall be brought up simultaneously in equal layers of not more than 200mm in thickness on each side of the structure (where applicable) to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer-in Charge. The compaction shall be done with a vibratory plate compactor of maximum weight 1000kg.

Where the provision of any filter media is specified behind the abutment and reinforced walls etc. the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter media shall conform to the requirements given in the drawings and specifications duly approved by the Engineer-in-charge.

At locations where compaction using rollers is impracticable, such as fill portions adjacent to RCC structures/steep abutments or around concrete drain pipes embedded in embankment, earth vibrator / table vibrator hand held vibratory tampers shall be used for compaction. The required moisture contents and compaction requirements shall be same, as for the rest of the embankment. However, compacted layer thickness should not exceed 100 mm in such cases.

Care shall be taken to see that the compaction equipment does not hit or come too close to any structural members so as because any damage to it.

4.19.9 Earthwork Over Existing Road Surface

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

If the existing road surface is of granular or bituminous type and lies within 1 m of the new sub grade level, the same shall be scarified to a depth of 50mm or more so as to provide ample bond between the old and new material. Nothing extra shall be payable for the same.

If the existing road surface is of cement concrete type and lies within lm of the new sub grade level the same shall be removed completely without any extra cost.

If the level difference between the existing road surface and the new sub grade level is more than lm, the existing surface shall be permitted to stay in place without any modification.

4.19.10 Earth Work for Widening Existing Road Embankment

When an existing embankment is to be widened and its slope is steeper than 4: 1 (horizontal: vertical), continuous horizontal benches each atleast 0.3 metre wide, shall be cut into the old slope upto a depth of 300mm for ensuring adequate bond with the fresh embankment material to be added.

The material obtained from cutting of benches could be utilised in the widening of the embankment. However, when the existing slope against which the fresh material is to be placed is flatter than 4: 1 the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portion is insufficient to permit the use of standard rollers, compaction shall be carried out with the help of vibratory roller, mechanical tampers or other approved equipment. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other type of hauling equipment.

Where the embankment is to be placed against sloping ground the latter shall be appropriately benched or ploughed before the embankment material.

The surplus excavated earth and other material which could not be used in embankment shall be disposed off for which nothing extra shall be payable. The contractor shall identify the actual location of the disposal site. The contractor has to take prior approval of engineer-in-charge about place of disposal before the surplus earth/material is disposed off.

4.19.11 Plying Of Construction Traffic

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

4.19.12 Quality Control

Quality of compacted material shall be controlled through periodic checks on the compaction process or the end product, singly or in combination as directed. The end product must conform to the specifications.

4.19.13 Analysis and Acceptance of Density Results

Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained, as approved by the Engineer-in-Charge. At all times during construction, the top of the embankment shall be maintained at such a cross fall as will shed water and prevent pounding.

The control for earth work in top 500mm portion of embankment (sub-grade), shall be more strict as per the specifications with density measurement being done at the rate of one

measurement for 250 cum of compacted volume. Further for the determination of the mean density, the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.

When density measurements reveal any soft areas in the embankment, the same shall be compacted further. If the specified compaction is still not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted to the satisfaction of the Engineer-in-Charge for which nothing extra shall be paid.

After the completion of work to the required formation level, the embankment shall be dressed to the required shape, size, slopes etc. and to compute the quantity of filling in embankment. The final formation levels of embankment shall be taken at the points where previously the initial ground levels were taken and the level books got signed by the contractor in token of acceptance. The layout required for taking levels shall be supplied by the contractor at his own cost. The work shall be completed as per formation levels and side slopes (where applicable) supplied by the Engineer-in-Charge. No variation in levels or in slopes shall be done without the written approval of the Engineer-in-Charge. Any embankment work done in excess of designated formation levels and designed side slopes shall not be paid for and the contractor shall be liable to remove the extra earth at his own cost and risk while dressing the embankment to the required formation level, shape, size and slopes etc.

4.19.14 Measurements

The length and breadth shall be measured correct to 1.0cm. The height of filling shall be recorded correct to 5 mm. The compacted volume of earth/flyash work shall be computed from cross sections of the filling/embankment. The cubical contents of compacted earth/flyash shall be worked out in cubic metres to the nearest two places of decimal. No deduction shall be made for voids.

4.19.15 Rate

Rate for earth work in embankment shall including the following

1. Compensation/royalty for the filling material, if any, its excavation and transportation to site of work, including loading, unloading, stacking etc.

2. Depositing filling material as specified and the cost of all operations described above.

3. All leads and lifts involved in the above operations.

4. Working in foul conditions.

5. Bailing out water due to subsoil condition rains, springs and all incidental works required to execute the job and to keep the area dry when the work is in progress below water table.

6. Removal of slush etc. while excavation under water or sludge.

7. All incidentals including labour, machinery, T&P etc required to complete the embankment work as per drawing.

4.20 Road Work – (Flexible pavement)

4.20.1 Sub-Grade Construction

It shall be ensured prior to actual execution that the borrow area material to be used in the sub-grade satisfies the requirements of design CBR (not less than 5%, under soaked condition). For the purposes of specifications, the top 500mm thick layer of filling in the embankment (just below the sand drainage layer) over the entire formation width and directly supporting the road pavement will be termed as 'subgrade'.

Sub-grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed sub-grade shall be determined on remoulded samples. IRC: 37-2001 shall be referred to for details.

The 500mm thick of the sub-grade shall be compacted to achieve at least 97% of MDD at OMC.

4.20.2 Granular Sub-Base Course

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

The granular sub-base (GSB) material shall be closed graded of grading I and III, conforming to the requirements of clause 401 and table 400-1, 400-2 of MORTH, Specifications for Road and Bridge Works (4^{th} Revision).

4.20.3 Wet Mix Macadam Base Course

The work shall consist of laying and compacting clean, crushed, graded aggregate and granular material premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these specifications. The material shall be laid in one or more layers as necessary to lines, grade and cross section shown on the approved drawings or as directed by the Engineer-in-charge. The laying of WMM layer shall be done using paver only.

The wet mix macadam base course shall satisfy the requirements of clause 406 of MORTH, Specifications for Road and Bridge Works.

4.20.4 Bituminous Work

4.20.4.1 General

The contractor shall have to necessarily deploy self-propelled paver with electronic sensor having suitable hydraulically operated screeds capable of spreading, tamping and finishing the mix true to the specified lines, grades and cross sections of the road. The paver finisher shall have the following essential features:

1. Loading hoppers and suitable distributing mechanism.

2. All drives having hydrostatic drive/control.

3. The machine shall have a hydraulically extendable screed for appropriate width requirement.

The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.

The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

The paver shall be fitted with an electronic sensing device for automatic levelling and profile control within the specified tolerances.

The screed shall have the internal heating arrangement.

The paver shall be capable of laying 2.5 to 4.0 m width in service road and 4.0 to 7.0m width on main carriageway as per site requirement.

The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation.

The contractor shall have to necessarily deploy the road rollers, for BM, DBM & BC for their compaction as per relevant MORTH specifications.

Mix shall be prepared in a computerised hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregate. Hot Mix Plant shall be preferably of batch mix type with electronic load sensor device. The requirement of clause 504.3.4 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 shall be strictly adhered to.

4.20.4.2 Prime Coat

The work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous mix material. The work shall execute in accordance with clause 502 and sub clause thereto of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridge works 2001.

The emulsified bitumen for prime coat shall be medium setting conforming to IS: 8887-1995. The bitumen emulsion shall be brought at site in one lot in sealed drums and shall be got verified and checked by the representative of Engineer-in-Charge before its use. After priming coat the road can be opened to the traffic as directed by the engineer in charge.

4.20.5 Tack coat

The work shall consist of application of single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction over it. The binder used for tack coat shall be bitumen of suitable grade as specified in nomenclature of item.

The emulsified bitumen for tack coat on road shall be medium setting (MS) type conforming to IS: 8887-1995. The bitumen emulsion shall be brought at site in one lot in sealed drums and shall be got verified and checked by the representative of Engineer-in-Charge before its use. The work shall be done strictly in accordance with clause 503 and sub-clauses thereto of MORTH specifications for Roads & Bridges work (Fourth Revision), 2001.

4.20.5.1 Cleaning and Preparation of the Surface:

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material and be otherwise prepared in accordance with the requirements of clause 501.8 and 902 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Roads and Bridges work (Fourth Revision) 1995 as appropriate. Immediately before the application or the tack coat, the surface shall be swept clean with a mechanical broom and high-pressure jet or by other means as directed by the Engineer-in-Charge.

4.20.6 Bituminous macadam

The work shall consists of constructing a single layer of specified compacted thickness of bituminous macadam having crushed stone aggregate premixed with bituminous binder on a previously prepared base to the requirement of clause-504 and sub clause thereto of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridge works (Fourth Revision) 2001 and as directed by the Engineer-in-Charge.

4.20.6.1 Material

4.20.6.1.1 Bitumen

Bitumen shall confirm to grade and quantity as specified in nomenclature of item.

4.20.6.1.2 Aggregate

Aggregate shall consist of crushed stone aggregate as laid down in sub clause 504.2.2 to 504.2.5 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridge works (4^{th} revision). The grading shall conform to grading 2 of Table 500-4.

4.20.6.1.3 Rate

The contract unit rate for the Bituminous Macadam shall be payment in full for carrying out all the required operations as specified, and shall include, but not necessarily limited to all component listed in 504.8 (i) to (vi) as MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridges (Fourth revision) 20.01. The rate shall include the provision of bitumen @ 3.5% by weight of total mix with provision that variation of quantity on minus side shall be recovered @ Rs.********** - per MT of bitumen. However, no extra payment would be admissible for use of bitumen if the variation is on higher side i.e. beyond 3.5% of weight of total mix.

*** At the justified rate at the time of tendering**

4.20.7 Dense Bituminous Macadam

The work shall consists of constructing dense bituminous macadam in two layers of specified compacted thickness having crushed stone aggregate premixed with bituminous binder on a previously prepared base to the requirement of clauses 507 and sub clause thereto of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridge works (Fourth Revision) 2001 and as directed by the Engineer-in-Charge.

4.20.7.1 Material

4.20.7.1.1 Bitumen

Bitumen shall confirm to grade and quantity as specified in nomenclature of item.

4.20.7.1.2 Aggregate

Aggregate shall consist of crushed stone aggregate as laid down in sub-clause-507.2.2 to 507.2.5 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridge works. The grading shall conform to grading of Table 500-10/

4.20.7.1.3 Filler

Filler shall consist of hydrated lime of grade & specification conforming to clause 509.2.4 of MORTH Specification for Roads & Bridges.

4.20.7.1.4 Rate

The contract unit rate for the Dense Bituminous Macadam shall be payment in full for carrying out all the required operations as specified, and shall include, but not necessarily limited to all component listed in 504.8 (i) to (vi) as MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Road & Bridges (Fourth revision) 2001. The rate shall include the provision of bitumen @ 4.25% by weight of total mix with provision that variation of quantity on minus side shall be recovered @ Rs ********** per M.T. of bitumen. However, no extra payment would be admissible for use of bitumen if the variation is on higher side i.e. beyond 4.25% of weight of total mix.

***At the justified rates at the time of tendering**

4.20.8 Bituminous Concrete

The work shall consist of constructing a single layer of specified compacted thickness or dense bituminous concrete consisting of crushed stone aggregate mixed with bituminous binder to serve as wearing course laid immediately after mixing on a previously prepared base in accordance with the requirements of specifications as laid down in clause 512 and sub-clauses thereto of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001 for Roads & Bridges works and as directed by Engineer-in-Charge.

4.20.8.1 Material

4.20.8.1.1 Bitumen

Bitumen shall conform to grade and quantity as specified in nomenclature of item.

4.20.8.1.2 Aggregate

Aggregates shall consist of crushed stone aggregate conforming to grading & specifications as laid down in sub-clause 512.2.2 to 512.2.5 of MORTH specifications for Road & Bridges work. Only natural aggregate or sand shall be allowed. The grading shall conform to grading Table 500-23 of MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001.

4.20.8.1.3 Filler

Filler shall consist of hydrated lime of grade & specification conforming to clause 512.2.4 of MORTH Specification for Roads & Bridges.

4.20.8.1.4 Rate

The contract unit rate for the Bituminous Concrete using modified bitumen (PMB-40) shall be payment in full for carrying out all the required operations as specified, and shall include, but not necessarily limited to all component listed in 504.8 (i) to (vi) of MORTH Specifications for

Road and Bridge Works (Fourth Revision) 2001. The rate shall cover the provision of modified bitumen (PMB-40) in mix design @ 5.5% by weight of total mix with provision that variation of quantity on minus side shall be recovered @ Rs. -********** per M.T. of modified bitumen, less use as per design mix. However, no extra payment would be admissible for use of modified bitumen if the variation is on higher side i.e. beyond 5.5% of weight of total mix.

***At the justified rates at the time of tendering**

4.20.8.1.5 Compaction

The degree of compaction for the various bituminous layers shall be established by taking CORE from the laid bituminous layer. The bill of the contractor shall be paid only if the same qualifies as per the specifications / requirements. Sand replacement method for verifying the degree of compaction of laid bituminous layers will not be allowed.

4.20.8.1.6 Guarantee Bond

Five years guarantee in prescribed proforma as per Annexure**-'L'** must be given by the contractor in token of his overall responsibility regarding satisfactory performance of Bituminous Works. If any defect is noticed during the guarantee period, it should be rectified by the contractor within seven days by re-executing the defective Bituminous Works and if not attended to, the same will be got done through another agency at the risk and cost of the contractor.
General Form of Bank Guarantee is attached as Annexure- **"H"**. The above 'Guarantee Bond' will hold good for all the Bituminous Works i.e. Bituminous Macadam, Dense Bituminous Macadam & Dense Bituminous Concrete work.
Clause 35(iii) of the 'General Conditions of Contract for CPWD Works 2005' at Page 54 shall be read as 'The contractor shall be responsible for rectifying defects noticed within **Five years** from the date of completion of the **bituminous work** and the portion of the security deposit relating to **bituminous work** shall be refunded after the expiry of this period'

4.21 Road Work – (Rigid Pavement)

4.21.1 Dry Lean Cement Concrete Sub-Base

The Sub-Clauses Mentioned Below Are As Per MORTH Specifications (Forth Revision) 2001 for Roads And Highways. The deviation in various clauses from the book are listed below:

Sub-Clause 601.2 Materials

Sub-Clause 601.2.1 This Clause shall read as follows

Source of Materials "Provisions of Clause 1002 of these specifications shall apply to sources of material"

Sub-Clause 601.2.2 Cement

The clause shall read as follows:

"Any of the following type of cements, capable of achieving the Design strength may be used with the prior approval of the Engineer-in-Charge, but preference shall be to use 43 grade.

1. Portland cement 33 grade conforming to IS: 269
2. Portland cement 43 grade conforming to IS: 8112

If the soil around has soluble sulphates exceeding 0.5% the cement used shall be sulphate resistant and conform to IS: 12330

"Cement to be used shall be obtained in bulk form. The bulk cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test just prior to its use."

Sub-Clause 601.2.4 Water

This item shall read as under:

"Water used for mixing and curing concrete shall conform to Clause 1010 of Section 1000."

Sub-Clause 601.4 Sub-grade

Sentence 2 shall be read as:

"The Lean Concrete sub-base shall be laid on drainage layers as per drawings. The drainage layer shall be as per Grading 1 of Table 400-2. The material shall be crushed stone aggregate. The CBR of drainage layer shall be more than 30".

Sub-Clause 601.5 Construction

Sub-Clause 601.5.4 Placing

Add in the beginning of Clause 601.5.4:

One day before placing of the dry lean cement concrete sub-base, the surface of the drainage layer shall be given a fine spray of water and rolled with a smooth wheeled roller after a lapse of 2-3 hours after watering. The Engineer-in-Charge may instruct another fine spray of water to be applied just before placing of the dry lean cement concrete sub-base.

Sub-Clause 601.5.7 Curing

Add the following in last.

Two applications of an approved wax-based white pigmented curing compound shall be applied as per Additional Specifications A-12

Cement Concrete Pavement

Sub-Clause 602.1 Scope

Add the following at the end of this Clause:

"A site trial shall be performed in accordance with Clause 901.16."

Sub-Clauses 602.2 Materials

Sub-Clause 602.2.2 Cement

Replace the last para of Clause 602.2.2 with:

"It is the responsibility of the Contractor to test and propose the type of cement which will result in a concrete complying in all respects with the specifications. Cement to be used shall be

obtained in bulk. Bulk cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test just prior to use."

Sub-Clause 602.2.4.2 Coarse Aggregate

Delete the word 'crushed gravel' in third line of this para and add the following para at the end of clause:

The Stone Polishing Value, as measured by BS: 812 (Part 114), shall not be less than 55."

Sub-Clause 602.2.4.3 Fine Aggregate

Add the following at the end of this Clause:

"The fine aggregates shall be natural sand conforming to the grading Zone-II as per IS: 383."

Add the following as Clause 602.2.4.4

Sub-Clause 602.2.4.4 Combined All-In Aggregate

The grading limit for all-in aggregates shall be as per IS: 383 for 20mm nominal size aggregates and as given under:

IS Sieve Designation	**Percentage Passing**
40mm	100
20mm	95-100
4.75mm	30-50
600 micron	10-35
150 micron	0-6

Sub-Clause 602.2.5 Water

This clause shall read as under:

"Water used for mixing and curing shall conform to Clause 1010 of Section 1000."

Water for preparation of concrete during hot weather shall be from water chilling plant installed at site.

Sub-Clause 602.2.7 Premoulded Joint Filler

Replace Clause 602.2.7 with:

"Joint filler board for expansion joints shall be of the same thickness as the specified joint width within a tolerance of $\pm$ 1.5mm and shall comply with the requirements of IS: 1838 or BS Specification No.2630. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint. Holes to accommodate dowel bars shall be accurately bored or punched to give a sliding tilt on the dowel bars."

Sub-Clause 602.2.8 Joint Sealing Compound

Replace Clause 602.2.8 with:

“The joint sealing compound shall be hot applied elastomeric type, complying with AASHTO M282 for joints in asphalt pavements or joints between asphalt and concrete pavements, and cold applied polyurethane or polysulphide type complying with BS: 5212 –1 990 for joints in concrete pavements.

The joint sealant shall be resistant to age hardening and shall have flexibility to accommodate movements of minimum 25% of the joint width as shown in the drawings without risk of breaking of the sealant or adherence failure. The dimensions shall be so proportioned; that the adherence to the groove walls is fully intact within the movements limits.

Suitable primers as recommended by the manufactures of each type of joint sealant shall be used.

Each lot or batch of joint sealant compound and primer shall be delivered to the job-site in the manufacture's original sealed container. Each container shall be marked with the manufacture's name, batch or lot number, date of manufacture, storage life, safe heating temperature for hot applied sealant, and shall be accompanied by the manufacture's certification stating that the compound meets the requirements of these specifications.

The manufacture's health and safety precautions shall be available at the job-site for each joint sealing compound and primer and it is the responsibility of the Contractor to ensure that all precautions are met.

Sub-Clause 602.3 Proportioning of Concrete

Sub-Clause 602.3.3. Concrete Strength

Sub-Clause 602.3.3.1 Replace the entire Clause 602.3.3.1 with:

“The pavement concrete shall be a class M-40 concrete with a minimum 28 days compressive characteristic strength of 40 MPa and a minimum flexural characteristic strengths of 4.5 MPa."

While designing the mix in the laboratory, correlation between flexural and compressive strengths of concrete shall be established on the basis of at least thirty tests on samples. However, quality control in the field shall be exercised on the basis of flexural strength. It may, however, be ensured that the materials and mix proportions remain substantially unaltered during the daily concrete production. The water content shall be the minimum required to provide the agreed workability for full compaction of the concrete to the required density as determined by the trial mixes or other means approved by the Engineer-in-Charge and the maximum free water cement ratio shall be 0.45.”

Sub-Clause 602.3.3.2 Replace the entire Clause 602.3.3.2 with:

“The ratio between the 7 and 28 days strength shall be established based on the results of the design mix trials, refer Clause 602.3.5.1. The average flexural strength of the 7 days cured specimens shall be divided by the average strength of the 28 days cured specimens for each batch, and the ratio between 7 days and 28 days flexural strength R_7 shall be determined to an accuracy of three decimal places.

If, during the construction of the trial length or during normal working, the average value of any six consecutive 7 days test results divided by R_7 falls below 4.50+1.65*s MPa, (where s is the standard deviation of the group) then the Contractor shall stop paving and propose for the approval of the Engineer-in-Charge, corrections to the mix to improve the flexural strength. The Contractor shall provide evidence, that the proposed corrections result in the required flexural

strength before paving operations may be resumed by producing minimum six beams with the proposed corrected mix and testing these for 7 days flexural strength. No additional payment will be made for any changes to the mix."

Sub-Clause 602.3.5 Design Mix

Add the following at the end of sub-clause 602.3.5.1

Following parameters shall be used

i)	Characteristics flexural strength at 28 days	=	4.5 Mpa
ii)	Water cement ratio	=	0.45 maximum
iii)	Slump as per IS: 1199	=	31+15 mm.

Sub-Clause 602.5 Separation Membrane

Replace the sub clause with the following:

The use of plastic interface layer shall be eliminated. Two applications of an approved wax based white pigmented curing compound shall be applied as per clause 601.5.7 and Additional Specifications A-12

Sub-Clause 602.6 Joints

Sub-Clause 602.6.2 Transverse Joints

Sub-Clause 602.6.2.1Replace the first para as follows:

"Transverse joints shall be 'contraction and expansion joints. Contraction joints shall be provided at 4.5 m intervals, except where expansion joints are provided. Expansion joints shall be provided at the junction of the approach slabs of bridges and the rigid pavement. Furthermore, transverse joints shall be provided at special locations like transitions to structures, transition to flexible pavements, off carriageway areas as shown on the drawings. The exact position of transverse joints shall be coordinated with adjoining construction packages and shall be proposed by the Contractor in writing for the approval of the Engineer-in-Charge. Transverse joints shall be straight within the following tolerances along the intended line, which is the straight line perpendicular to the longitudinal axis of the carriageway at the position of the joint."

Sub-Clause 602.6.2.2 Contraction Joints

Replace the entire Clause 602.6.2.2 with

"Contraction joints shall be as shown in the drawings.

The crack inducing joint groove, as indicated in the drawing and to 1/3 depth of the slab shall be cut as soon as the concrete is hard enough to take the load of the joint sawing machine without causing damages to the slab. The Contractor shall furnish a method statement, which describes his proposed methods for determination of the time period available for sawing the crack inducing joint grooves together with the capacity and number of sawing machines for the approval of the Engineer-in-Charge. The, method statement shall include establishment of maturity-strength relationships in the laboratory and measurement of the in-situ maturity *of* the concrete by maturity meters (COMA-Meter by German Instruments A/S or similar) or other internationally recognized methods."

Sub-Clause 602.6.2.3 Expansion Joint

Add new para at the end of this sub-clause:

Joints at the junction of rigid and flexible pavements:

Joints shall be provided at the junctions of rigid and flexible pavement with transition slab as shown in drawings. Where due to unavoidable reasons, the joints cannot be constructed at the junction of the two contract packages dowel bars shall be provided in the rigid pavement and other measures as directed by the Engineer-in-Charge shall be undertaken. Joints between bituminous pavement and concrete pavements (at locations other than junction between contract packages) shall be constructed.

Sub-Clause 602.7.2 Concreting in Hot Weather

Add to the first para:

"If the concrete temperature exceeds 70℃ during ha rdening, the Contractor shall -at his own expense -prove to the Engineer-in-Charge that durability parameters are unaltered (for example micro cracking, compressive strength of sawn cylinders or other as agreed with the Engineer-in-Charge).

Sub-Clause 602.9 Construction

Sub-Clause 602.9.1 General

Add new para at the end of Clause 602.9.1 as follows: .

"Paving shall be carried out in full carriageway width, including paved shoulders, where required. The paver should be able to run at least at an average uniform speed of 1m per minute".

Sub-Clause 602.9.3.2 Batching Plant and Equipment

Add at the end of the Clause:

"Batching Plant should have output capacity at least 20% more than output required to meet the paving speed of 1m per minute. The Contractor shall not use more than two plants to meet the daily output requirement of concrete. The batching plant should have suitable devices for adjusting the slump of the mix and should have facility for the computer printouts of every batch produced".

Sub-Clause 602.9.4.1

Insert in the ninth line after uniform speed – “of at least 1 m per minute".

Sub-Clause 602.9.4.7

The new para to Clause 602.9.4.7 as follows:

“The marking shall be located on the horizontal surface at the edge of the paved shoulder and shall be carried out using prefabricated template figures approximately 80mm high and 5mm thick as approved by the Engineer-in-Charge. The figures shall be fixed to a plate which shall be inserted approximately 2mm into the plastic concrete by vibration and left in place until the concrete has hardened.”

Sub-Clause 602.9.8 Surface Texture

Replace the sub-clause with the following:

Surface texturing/mechanical tining of concrete pavement shall begin immediately after finishing of the concrete before application of curing membrane. Texturing/Tining shall be done with a specified machine specially designed for the purpose for providing grooves at an uniform spacing (c/c) of 18mm to 21mm, depth (3mm to 4mm) and width (3mm), parallel to the centre line of roadway extending over the entire roadway width but within 75 mm of pavement edge & omitting within +/- 20mm of the sawed longitudinal joints.

Sub-Clause 602.10 Trial Length

Sub-Clause 602.10.2 Add new para to Clause 602.10.2 as follows:

"All trials shall be carried out using the same paving width and slab thickness as used in the permanent works."

Sub-Clause 602.10.4 Replace the entire Clause 602.10.4 with:

“Transverse joints and longitudinal joints of each type that are to be included in the pavement work shall be constructed and assessed in the trial length.”

Sub-Clause 602.10.5.3 Density

Replace the entire Clause 602.10.5.3 with:

"(v) In-situ density shall be assessed as described in Clause 903.5.2.2 from at least 3 cores drilled when the concrete is not less than 7 days old. Should any of the cores show honey-combing in the concrete, the trial length shall be rejected and further use of the spreading and compacting unit shall not be permitted until further trials have shown that modification can be made which will result in adequate compaction."

Sub-Clause 602.10.5.5 Strength

Add new clause as under:

"Minimum of thirty (30) beams for flexural strength and thirty (30) cubes for compressive strength shall be prepared from the concrete delivered to the paving plant. Each pair of beams and cubes shall be from a different batch of concrete. Compressive and flexural strength shall be tested after 28 days curing.

At the age of 28 days thirty (30) cores with diameter 150 mm shall be saw cut from the slab. The cores shall be saw cut in both ends to provide a specimen height of 300 mm $\pm$ 5 mm and shall be tested for compressive strength at the age of 28 days.

The concrete strength shall be deemed satisfactory if:

The average flexural strength exceeds 4.50 + 1.65*s (MPa), where s is the standard deviation of the thirty tests, and the strength of any sample is not less than characteristic strength less 1.65 times standard deviation.

The average compressive strength of the cores divided by 0.8 is equal to or exceeds the average compressive strength of the thirty cubes.

Sub-Clause 602.10.5.6 Temperature Measurements

Add new clause as under:

“The temperature development in the concrete slab during hardening shall be recorded. The temperature shall be measured in the middle of the slab (vertically) at a horizontal distance of at least 1000-mm from any free edge. The temperature shall be recorded every 3 hours after instalment of the thermometer and the temperature-age relationship shall be determined. The maximum recorded temperature shall not exceed 70℃. If the temperature exceeds 70^{o}C the trial length shall be condemned and the Contractor shall propose methods to reduce the temperature development and carry out a new trial length at his own expense.

Sub-Clause 602.11 Preparation and Sealing of Joint Grooves

Sub-Clause 602.11.3 Sealing with Sealant

Sub-Clause 602.11.3.1 Replace first sentence with:

"Prior to application of the sealant the primer recommended by the manufacture shall be applied."

Clause 602.11.3.3 Replace the entire Clause 602.11.3.3 with:

“Sealant complying with Clause 602.2.8 shall be used. Cold applied sealant shall be mixed and applied within the time limit specified by the manufacture. Primers shall be applied neatly with an appropriate brush or as recommended by the manufacture.

Sub-Clause 602.11.4 Testing of applied Sealant

Replace the entire Clause 602.11.4 with:

"Each delivery of joint sealant compound and primer shall be tested in accordance with AASHTO M282 for hot applied joint sealant and BS : 5212: Part 2 for cold applied sealant at a recognized independent laboratory. In case deliveries are made more frequent than every three months, testing may be reduced to every three months. The laboratory shall be approved by the Engineer-in-Charge in advance."

Sub-Clause 602.13 Opening to Traffic

Replace the entire Clause 602.13 with:

"No vehicular traffic (including the Contractor's vehicles) shall be allowed on the finished surface until a field flexural strength of minimum 4.50 MPa has been achieved. It is the responsibility of the Contractor to produce a sufficient number of series of test specimens to verify the field flexural strength.

Each series of test specimens for measurement of field flexural strength shall consists of minimum 3 test specimens. The specimens shall be cured at conditions similar to the field conditions. The method for curing and storing of the test specimens in order to imitate field conditions shall be proposed by the Contractor and approved by the Engineer-in-Charge. The required minimum field flexural strength of 4.50 MPa is achieved when the average flexural strength of minimum 3 specimens exceeds 4.50 + 1.65*s, where s is the standard deviation of the group. “Prior to opening to traffic the joints shall be sealed and areas adjacent to the pavement shall be completed to a degree that will ensure traffic safety. Opening to traffic shall not constitute a final acceptance of the pavement."

4.22 DESIGN MIX/READY MIX CONCRETE

4.22.1 Design Mix (Ready Mix) Concrete shall be used in the work for all structural members. Computerized automatic batching plants with minimum production capacity 30 cum per hour shall be installed at the site or Ready Mixed Concrete with O.P.C. from reputed manufacturer to be approved by Engineer–in–Charge shall be allowed (Nothing extra shall be paid for the ready mix concrete).

Concrete for all reinforced concrete works in columns, walls, footings, slabs, girders and the like shall be deposited and well consolidated by vibrating, using portable mechanical vibrator. The rest of the places concrete shall be deposited and well consolidated by pouring & tamping, care shall be taken to ensure that concrete shall be poured through concrete pumps.

4.22.2 The concrete mix design with or without admixture will be carried out by the contractor through one of the following laboratories/Test houses and ready mix concrete shall conform to accepted design mix.

i. IIT, Delhi
ii. National Council for Cement & Building Materials, Ballabhgarh.
iii. CRRI, Delhi

4.22.3 In the event of all three laboratories being unable to carry out requisite design/testing, the contractor shall have to get the same done from any other laboratory with prior approval of the Engineer-in charge.

4.22.4 The contractor shall submit the mix design report from any of above approved laboratories for approval of Engineer-in-charge within 30days from the date of issue of letter of acceptance of the tender, No concreting shall be done until the mix design is approved.

4.22.5 The cost of packing, sealing, transportation, loading, unloading, cost of samples and testing charges for Mix design in all cases shall be borne by contractor.

a) For procurement of ready mix concrete from RMC plants, the contractor shall, within 15days of ward of the work, submit list of at least three RMC plant companies of repute along with details of such plants including details of transit mixture and pumps etc. to be deployed indicating name of owner/company, its location, capacity, technical establishment, past experience and text of MOU proposed to be entered between purchaser (the contractor) and supplier (RMC Plant) to the engineer-in-charge who shall give approval in writing (subject to draw of MOU). The contractor shall draw the MOU with approval RMC plant owner/company and submit to engineer-in-charge within a week of such approval. The contractor will not be allowed to purchase ready mixed concrete without completion of above stated formalities for use in this project.
b) Notwithstanding the approval grated by Engineer-in-Charge in foresaid manner, the contractor shall be fully responsible for the quality of concrete including input control, transportation and placement etc.
c) The Engineer in Charge will reserve right to inspect the RMC plant at any stage and reject the concrete if he is not satisfied about quality of product. The contractor should

therefore draw MOU/Agreement with RMC owner/ company very carefully keeping all terms and conditions/specifications forming a part of this tender document.

4.22.6 The Engineer-in –Charge reserves the right to exercise control over the :-

i. Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recording of tests results and declaring the materials fit or unfit for use in production of mix.
ii. Weight and quantity check on the ingredients, water and admixtures added for batch mixing.
iii. Time of mixing of concrete.
iv. Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective actions.

For exercise such control, the engineer-in-charge shall periodically depute his authorized representative at RMC Plant. It shall be responsibility of the contractor to ensure that all necessary equipment, manpower & facilities are made available to engineer-in-charge/or his authorized representative at RMC Plant.

4.22.7 Ingredients, admixture & water declared unfit for use in production of mix shall not be used. A batch mix found unfit for use shall not be loaded into the truck for transportation.

4.22.8 All required relevant records of RMC shall be made available to the Engineer–in-charge or his authorized representative. Engineer-in-charge shall, as required, specify guidance & additional procedures for quality control & other parameters in respect of materials and production & transportation of concrete mix, which shall be binding on the contractor & the RMC plant.

4.22.9 43 grade OPC (Conforming to IS-8112) of brand/make/source as approved by Engineer-in-Charge shall only be used for production of concrete.

4.22.10 The RMC produced concrete shall be accepted by Engineer-in-charge at site after receipt of the same after fulfilling all the requirements of mix mentioned in the tender documents.

The item of design mix concrete shall be inclusive of all ingredients including admixtures if required, labour, machinery T& P etc. required for a design mix concrete of required strength and workability. The rate quoted by agency shall be net and nothing extra shall be payable on account of change in quantities of concrete ingredients like cement and aggregates and admixtures etc. as per approved mix design.

4.22.11 Ready mix concrete shall be arranged in quantity as required at site of work. The ready mix concrete shall be supplied as per the agreed schedule approved by Engineer-in-charge.

5 MISCELLANEOUS WORKS

5.1 Stone Pitching of slopes (deleted)

5.2 Barricading of Construction Area

The contractor shall make adequate arrangement for barricading as directed by the Engineer-in-Charge to cover the entire construction site including all T&P and materials. No payment shall be made for the barricading done by the contractor. The barricading provided to stop trespassing to site of work and for public safety, at locations other than road/intersections shall not be payable separately and the decision of the engineer-in-charge in this regard shall be final and binding. The type of non payable barricading provided at such intermediate locations/ casting yard etc shall be similar to that shown in the tender drawing but its height can be varied as per the suitability at site of work. Semi permanent type barricading can also be provided around casting yard/batching plant with the approval of Engineer-in-Charge.

The requirement of providing and fixing new barricading or refixing the barricading already provided at site shall be decided as per the direction and approval of Engineer-in-Charge. The barricading shall be provided continuously during the execution of the entire work till completion and shall not be removed at any stage without prior approval of the Engineer-in-Charge. The barricading shall include the following:

1. Traffic signals during construction at site for day and night, reflective signs, direction boards, marking, traffic signages as per requirement, flags etc. as directed by the Engineer-in-Charge. However traffic police signals shall not be the responsibility of the contractor.

2. Cleaning of barricading every fifteen days with water and detergent so as to ensure that there is no dirt of splashes on the barricading. The dust accumulated along the barricades on the carriageway shall be removed every week.

3. Installation of temporary warning signs/lamps on all barricades during the hours of darkness and kept it lit there at all times during these hours.

4. Shifting and refixing in position as per the direction of Engineer-in-Charge and all incidentals to execute the job.

5. Repainting of the barricading after three months.

6. Proper maintenance of the barricading till completion of the work by repairing/replacing the damaged barricade.

Barricading and safety requirements are very important aspects and shall be followed as per the requirements given above. In case of failure the compensation as per clause 7.26 of the tender will be levied.

5.3 System of waterproofing treatment by CICO method (deleted)

5.4 Road Marking Using Hot Applied Thermoplastic Paint

5.4.1 General

The road marking symbols, patterns, sizes, colour and legends shall be adopted in accordance with the code of practice for Road Marking with paints, IRC 35-1997 and as specified in the drawings or as directed by the Engineer-in-Charge.

The colour of the compound shall be white or yellow (IS colour No.356) as specified in the drawings or as directed by the Engineer-in-Charge.

The thermoplastic compound shall be screeded / extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.

Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacture, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

5.4.2 Materials

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

5.5 Thermoplastic Paint

5.5.1 Material

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorising beads. Road markings shall be of hot applied THERMOPLASTIC COMPOUND that shall meet the requirements as specified below.

5.5.2 Requirements

5.5.2.1 Composition

The Thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorising beads. The pigment, beads and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 5-1 Proportions of Constituents Of Marking Material.

Table 5-1 Proportions of Constituents Of Marking Material.

(Percentage by Weight)

COMPONENT	WHITE	YELLOW
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 min.	----
Calcium Carbonate and Inert Fillers.	42.0 max.	**

Yellow pigments	----	**

** NOTE: Amount of Yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacture, provided all other requirements of these specifications are met.

5.5.2.2 Properties

The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262 (Part-I), shall be as below.

5.5.2.3 Luminance

White- Daylight luminance at 45 degree Celsius shall be 65 percent min. as per AASHTO M-249.

Yellow: Daylight luminance at 45 degree Celsius shall be 45 percent min. as per AASHTOM-249.

Drying time:-When applied at a temperature specified by the manufacture and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

Skid resistance:- Not less than 45 as per BS 6044.

Cracking resistance at low temperature:-The material shall show no cracks on application to concrete blocks.

Softening point:- 102.5 $\pm$ 9.5°C as per ASTM D-36.

Flow resistance:- Not more than 25 percent as per AASHTO M-249.

Yellowness index (for white thermoplastic paint):- not more than 0.12 as per AASHTO M-249.

The paint shall conform to the following technical specifications.

TECHNICAL DATA	WHITE	YELLOW
Type of Aggregate	Silica sand/Dolomite	Silica sand/Dolomite
Type of extender	Calcium Carbonate	Calcium Carbonate
Type of Binder	Synthetic resin	Synthetic resin
Glass beads content % (min) by weight	30% (reflective)	30% (reflective)
Heat Stability	65 min.	65 min.
Flash Point (COC ''C)	270 min.	270 min.
Relative Density	2.00$\pm$0.1	2.00$\pm$0.1
Application Temperature ^{o}C	165$\pm$ 15	165$\pm$ 15

Maximum Heating Temperature ^{o} C	210°	210°
Durability (Class)	2 Years (A)	2 Years (A)
Pigment	Consists of Titanium Dioxide Type-R(rubile)	Yellow pigment is substitute for a part of TITANIUM DIOXIDE. The pigment shall have a heating range upto 300^{o}C in order to withstand heating temp. range upto 250^{o}C without colour change.

5.5.3 Storage Life

The material shall meet the requirements of these specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacture/supplier / Contractor.

5.5.4 Reflectorisation:

Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in clause 9.4.6

5.5.5 Marking:

Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

1. The name, trade mark or other means of identification of manufacture.
2. Batch number
3. Date of manufacture.
4. Colour (white or yellow).
5. Maximum application temperature and maximum safe heating temperature.

5.5.6 Sampling And Testing

The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The contractor shall furnish to the Employer a copy of certified test reports from the manufactures of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this specification.

5.5.7 Reflectorising Glass Beads.

5.5.7.1 General:-

This specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type-1 beads are those which are a constituent of the basic thermoplastic compound as described in Table-1 and Type-2 beads are those which are to be sprayed on the surface as described in clause 9.4.7.

The glass beads shall be transparent, colourless and free from mildness, dark particles and excessive air inclusions. These shall conform to the requirements spelt out in clause 9.4.6.3.

5.5.8 Specific Requirements

Gradation: - The glass beads shall meet the gradation requirements for the two types as given in

Table 5-2 Gradation requirements for glass beads.

	Percent retained	
Sieve size	Type 1	Type 2
1.18 mm	0 to 3	----
850 micron	5 to 20	0 to 5
600 micron	----	5 to 20
425 micron	65 to 95	----
	----	30 to 75
180 micron	0 to 10	10 to 30
Below 180 micron	----	0 to 15

Roundness:- The glass beads shall have a minimum of 70 percent true spheres

Refractive index:- The glass beads shall have a minimum refractive index of 1.50.

(d) Free flowing properties:- The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

5.5.9 Test Methods

The specific requirements shall be tested with the following methods:

Free-flow test: Spread 100 grams of beads evenly in a 100-mm diameter glass dish. Place the dish in a 250-mm inside diameter desiccator, which is filled within 25 mm of the top of a desiccator plate with sulphuric acid water solution (specific gravity 1.10). Cover the desiccator and let it stand for 4 hours at 20 to 29 degree C. Remove sample from dessicator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100-mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.

The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part-1).

The contractor shall furnish to the Employer a copy of certified test reports from the manufacture of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of this specification. However, if so required, these tests may be carried out as directed by the Engineer-in-Charge.

Application Properties of Thermoplastic Material

The Thermoplastic Material Shall Readily Get Screeded / Extruded at temperatures specified by the manufactures for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

The material, upon heating to application temperatures, shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

5.5.10 Preparation

The material shall be melted in accordance with the manufacture's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacture, and shall on no account be allowed to exceed the maximum temperature stated by the manufacture. The molten material should be used, as expeditiously as possible and for thermoplastic material, which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.

After transfer to the paint applicator machine, the material shall be maintained within the temperature range specified by the manufacture for achieving the desired consistency for laying.

The maximum safe heating temperature should not exceed $210^{o}C$

The melted material may be allowed to use, provided the total time in melted state has not exceeded 4 hours.

5.5.11 Properties of Finished Road Marking

The stripe shall not be slippery when wet.

The marking shall not lift from the pavement in freezing weather.

After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperature upto 60°C.

The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.

The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.

The colour of yellow marking shall conform to IS colour No.356 as given in IS:164-1981.

5.5.11.1 Application

Marking shall be done by fully / semi-automatic paint applicator machine in order to maintain straight line, size and sharp edges. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer-in-Charge. The contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

The thermoplastic material shall be applied hot either by screeding or by extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacture for the particular method of lying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint. Priming coat as per manufacture's recommendation shall be applied.

Badly worn out bituminous surface and concrete road surface shall be treated with "BITEX" or equivalent primer prior to application of Thermoplastic Paint. Nothing extra shall be paid on this account.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over the old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise, having uniform width and sharp edges. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted specifications (BS:6088 clause-B) shall be sprayed uniformly with the help of glass beads spray pump into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per Sqm. area.

The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS-3262 (Part-3).

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

5.5.12 Performance Requirements

The road markings laid shall meet the performance requirements of Class-A road marking specified in the BS-3262 (Part-II)-1989. The wear index shall not exceed 35 at each regular inspection interval as per the Appendix “D” of B.S.-3262. The spread of the markings of each stripe measured between 600 mm & 900 mm from the near side kerb shall not increase at each regular inspection interval by more than 10% of its initial value.

GUARANTEE:- The Thermoplastic paint shall last at least for a period of two years. The marking, when tested, shall show no sign of cracking, flaking, peeling off or disintegration. Two years guarantee in prescribe proforma as per Annexure –'L' must be given by the contractor in acceptance of his overall responsibility regarding satisfactory performance of Thermoplastic Painting work. If any defect is noticed during the guarantee period, it shall be rectified by the contractor within 7 days by re-executing the defective Thermoplastic Painting Work, and if not attended to, the same will be got done from another agency at the risk and cost of contractor.

Clause 35(iii) of the ‘General Conditions of Contract for CPWD Works 2005’ shall be modified to read as ‘The contractor shall be responsible for rectifying defects noticed within *two years* from the date of completion of the work and the portion of the security deposit relating to road marking work using Thermoplastic Paint shall be refunded after the expiry of this period’

5.5.12.1 Measurements for Payment

The painted markings shall be measured in sqm. of actual area marked (excluding the gaps, if any).

5.5.12.2 Rate

The contract unit rate for road marking shall be paid in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these specifications complete as per the approved drawings or as directed by the Engineer-in-Charge and all other incidental costs necessary to complete the work to these specifications.

NOTE: In case of any discrepancy in particular specifications for Thermoplastic Paint and the specifications as per MORTH Specifications for Road and Bridge Works (Fourth Revision) 2001, Section 803, the later will prevail.

5.6 Precast concrete paver blocks

Manufacture of interlocking concrete paving blocks and their laying shall be done as per IRC: SP: 63-2004.

5.7 Brick Work

All brick work shall be carried out as per CPWD specifications using 75 class designation bricks in cement sand mortar of 1:4. Measurement shall be made as per specifications.

5.8 Anti Corrosive Treatment

Anti Corrosive Treatment for Reinforcement Bars the specification to be followed is given below.

1) PRODUCT SPECIFICATION:

The Manufacturer shall have valid license from CECRI, Kodaikanal Tamilnadu.

Appearance: Clear Colourless liquid

pH : 13.00±1.00

Specific Gravity: 1.04±0.01

2) SITE ARRANGEMENT REQUIRED:

i) A drying platform is required for drying of treated bars.

ii) Storage room for the chemical.

iii) Miscellaneous items like bucket, brushes, cotton, waste, small weighting balance etc. are required at site

3) APPLICATION:

1) Remove loose ruse/iron oxide remenants if any on the bar using iron brush.
2) Make slurry of cement by adding inhibitor solution to Ordinary Portland Cement in the ratio of 0.6:1 or as specified by the manufacturer.
3) Apply first coat of slurry uniformly on the surface of reinforcement iron & steel by brushing or dipping in shaded area.
4) Keep the coated bars for drying on the drying platform. Apply second coat of inhibitor after 12 to 24 hours interval and again dry the bars.

4) CAUTION:

If Reinforcement bar is to be bent or given some specific shape this must be done before applying the inhibited slurry. If it is done after inhibitor application it would result breakage of film and poor protection. The treated bars must be handled and stacked carefully.First coat of cement slurry (1 Kg cement and 600 cc of inhibitor) shall be applied on receipt of steel at site and second shall be applied on the reinforcement after cutting and bending of reinforcement but before placing in position.

6 APPENDIX - A

6.1 Sampling Blocks

6.1.1 Method of Sampling

Each lot of 5000 blocks or part thereof shall be divided into eight real or imaginary approximately equal groups. Two blocks shall be drawn from each group.

6.1.2 Marking And Identification

All samples shall be clearly marked at the time of sampling in such a way that the lots represented by them are clearly defined.

7 APPENDIX –B

7.1 Method For Measuring Dimensions

7.1.1 Length and Width

7.1.1.1 Apparatus

The apparatus used to measure the shape shall be a metallic, rectangular box large enough to put a concrete block in it. The horizontal base plate and the two adjoining vertical plates are fixed to each other. The two other vertical plates can be removed in the directions perpendicular to these plates. The parallel plates can be read off from a scale to an accuracy of 1 mm.

The apparatus construction shall be such that the accuracy of the measurements obtained to a whole number of mm can be trusted.

7.1.1.2 Procedure

Before measuring, remove any impurities and /or burrs from the blocks with a hard brush. Put the block, with its top surface facing downwards, on the horizontally positioned base plate of the apparatus and press it as far as possible between the two fixed vertical plates which are at the right angles to each other so that the long side of the block comes to lie completely flush with the long vertical plates. Determine the length and width of the block by successively pressing each of the movable plates against the block and reading off the distance between the parallel plates in mm on the scales.

7.1.2 Height

The height of each block shall be accurately measured in whole mm using a sliding head with callipers 50-mm long, measurements being taken at the four corners and at the centre. While measuring the height, the callipers of the sliding head are placed as flushed as possible with the top and bottom surfaces of the blocks and at the corners at an angle of 45 degrees on the long side surface of the block.

The height shall be taken as the arithmetic mean of these five values.

8 APPENDIX – C

8.1 Test For Compressive Strength

8.1.1 Testing Machine.

The testing machine shall be of suitable capacity and capable of applying the load at the rate specified. It shall comply with the requirements of Clause 2.1 of BS:1881 – Part-4 in respect of repeatability and accuracy.

8.1.2 Procedure

The sample specimen shall be tested in a wet condition after being stored for at least 24 hours in water maintained at a temperature of 20 degrees C ± 5 degrees C. Before the specimens are submerged in water, the necessary area shall be determined by the method described in Appendix-'B'.

The plates for the testing machine shall be wiped clean and any loose grit or other material shall be removed from the contact faces of the specimen. Plywood sheets normally 4 mm thick, shall be used as packing between the upper and lower faces of the specimen and the machine plates and these sheets shall be larger than the specimen by a margin of at least 5 mm at all points. Fresh packing shall be used for each specimen tested.

The specimen shall be placed in the machine with the wearing surface in a horizontal plane and in such a way that the axes of the specimen are aligned with those of the machine plates.

The load shall be applied without shock and increased continuously at the rate of approximately 15 N/sq.mm per minute until no greater load can be sustained. The maximum load applied to the specimen shall be recorded.

8.1.3 Calculation of Corrected Strength for Individual Blocks

The corrected compressive strength of each block specimen shall be calculated and recorded as described in Clause 7.0

8.1.4 Compressive Strength Calculation

The average corrected compressive strength for the designed lot shall be calculated.

8.1.5 Compliance

The average corrected compressive strength of the specimen samples shall comply with the requirements of Clause 9.5.7.

Annexure-A

LIST OF APPROVED MANUFACTURES/SUPPLIERS

Sl.No.	Item	Name
1.	Ordinary Portland Cement	ACC, GRASIM, Gujarat Ambuja, Birla (Vikram), Ultra-Tech
2.	Slag Cement	ACC, Grasim, Gujrat Ambuja
3.	Reinforcing Bars	Tata Steel, SAIL, RINL
4.	Bearings	J.Sons, METCO, Sanfield (India) P Ltd.
5.	Expansion Joints	J.Sons, METCO, Sanfield (India) P Ltd., Z-Tech (India) Pvt.Ltd
6.	Bitumen	IOCL, BPCL, HPCL
7.	Admixtures	FOSROC, SIKA, MBT, Asian Laboratories, Dura Build care, CICO Technologies Ltd.
8.	Release Agent	FOSROC, MBT, Dura Build Care , CICO
9.	Geotextile & Geogrids	AIMIL, Z-Tech, Netlon (India), Garware wall ropes Ltd, Maccaferri
10.	Void former	Spiral Tubes Pvt. Ltd. (Spiro), Steel auto industries
11.	Non-shrink grout	Fosroc Chemicals, Sika, Dura Buildcare
12.	Mild Steel Tubes	Tata, Llyods, NSL
13.	Structural Steel	Tata, SAIL, RINL.
14.	Welding Electrodes	ESAB, Advani-orlikon, Weld Alloy
15.	Water proofing	CICO, SWC, SIKA
16.	Paints	Akzo Nobel, Berger, Jenson and Nicholson, Asian Paints.
17.	Pile Integrity Testing	CBRI, AIMIL, NDM technology,
18.	Bar Couplers	Dextra, Moment
19.	Reinforced soil wall system	AIMIL, VSL, Garware wall ropes, Earthcon Systems, Z-tech india.

20.	Anti carbonation paints	CICO, MBT, FOSROC
21	Polymerised modified bitumen	Usha Lubes, Ooms polymers, Tiki Tar
22.	Thermoplastic paints	CBM, CMS
23.	PVC waterstops	Fixopan, Maruti Rubber
24.	RMC	ACC, BIRLA, L&T and other reputed manufacture of RMC subjected to approval of Engineer-in-Charge. The contractor shall submit the list RMC plant for the approval of Engineer-in-charge.
25.	Pre-stressing system	FPCC, BBR, VSL
26.	TMT Fe 500	TISCON, RINL, SAIL
27.	HTS Strands	Special steels LTD. (TATA)

Annexure- B

LIST OF CODES AND STANDARDS

Applicable Codes, Standards & Publications for Structural & Road Work :

The relevant Codes, Standards and Publications to Contract are listed (and shall not be limited to followings) hereunder :

A	**General**
CPWD specifications	
IRC:86-1983	Geometric design standard for urban road in planes
B	**Bitumen**
IS:702	Industrial Bitumen
D	**Cement**
IS:269	33 grade ordinary Portland cement
IS:455	Portland Slag Cement
IS:650	Specifications for standard sand for testing cement.
IS:6925	Methods of test for determination of water soluble chlorides in concrete admixtures.
IS:8112	Specification for 43 grade ordinary Portland cement.
IS:12269	Specification for 53 grade ordinary Portland cement.
IS:12330	Specification for sulphate resistant Portland cement.
E	**Concrete**
IS:456	Code of practice for plain and reinforced concrete.
IS:460 (Parts I to III)	Specification for Test Sieves
IS:516	Methods of test for strength of concrete.
IS:1199	Methods of sampling & analysis of concrete.
IS:1607	Method of Test Sieving
IS:2386	Parts I-VIII: Methods of tests for aggregates for concrete.
IS:2430	Methods of Sampling of Aggregates of Concrete

IS:2645	Specifications for integral cement water proofing compounds
IS:3025	Methods of sampling and test (physical and chemical) for water & waste water
IS:6925	Methods of test for determination of water soluble chlorides in concrete Admixtures
IS:7242	Specifications for concrete spreaders
IS:7251	Specifications for concrete finishers
IS:7969	Safety code for handling and storage of building materials
IS:8989	Safety code for erection of concrete framed structures
IS:8142	Methods of test for determining setting time of concrete by penetration resistance
IS:9103	Specifications for admixtures for concrete
IS:10262	Recommended guidelines for concrete mix design.
MORTH	Specifications for Road and Bridge Works, Ministry of Road Transport and Highways (Roads Wing)
IRC SP 64	Guidelines for the analysis and design of voided slab superstructure
IRC SP 69	Guidelines and specifications for expansion joints
IRC SP 70	Guidelines for the use of high strength concrete for bridges
IRC 21-2000	Standard Specifications and Code of Practice for Road Bridges Section III – Cement Concrete (Plain & Reinforced)(First Revision)
F	**Construction Plant and Machinery.**
IS:1791	Specification for batch type concrete mixers.
IS:2505	General requirements for concrete vibrators: Immersion type.
IS:2506	General requirements for screed board concrete vibrators.

IS:3366	Specification for pan vibrators.
IS:3558	Code of Practice for use of immersion vibrators for consolidating concrete.
IS:4656	Specifications for form vibrators for concrete.
IS:4925	Specification for concrete batching and mixing plant.
IS:11993	Code of Practice for use of screed board concrete vibrators.
G	**Formwork**
IS:4990	Specifications for plywood for concrete shuttering work.
IRC:87	Guidelines for the design and erection of false work for road bridges.
IS:806	Code of practice for use of steel tubes in general building construction.
IS:1161	Specification of steel tubes for structural purposes.
IS:1239	Specification for mild steel tubes. Tubulars and other wrought steel fittings.
H	**Handling and Storage**
IS:4082	Recommendation of Stacking and Storage of construction materials
J	**Instruments For Testing Cement and Concrete**
IS:5513	Specification for vicat apparatus.
IS:5514	Specification for apparatus used in Le-Chaterlier test.
IS:5515	Specification for compaction factor apparatus.
IS:7320	Specification for concrete slump test apparatus.
IS:7325	Specification for apparatus to determine constituents of fresh concrete.
IS:10080	Specification for vibration machine.
IS:10086	Specification for moulds for use in tests of cement and concrete.

IS:10510	Specification for Vee-bee consistometer.
K	**Joint Fillers**
IS:1838 (Part 1)	Performed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type): Bitumen impregnated fibre
L	**Paints and Coatings**
IS:102	Ready mixed paint, brushing, red lead, non-setting, priming
M	**Reinforcement & Structural Steel**
IS:280	Mild steel wire for general engineering purposes
IS:432	Part I. Mild steel and medium tensile steel bars. Part II Hard drawn steel wire.
IS:814	Parts I & II. Electrodes for metal arc welding of structural steel.
IS:815	Classification coding of covered electrodes for metal arc welding of structural steels
IS:816	Code of Practice for use of metal arc welding for general construction in mild steel.
IS:1566	(Part I) Specifications for hard-drawn steel wire fabric for concrete reinforcement.
IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS:14268	Specifications for uncoated stress relieved low relaxation strands.
IS:2502	Code of Practice for bending and fixing of bars for concrete reinforcement.
IS:2629	Recommended practice for hot-dip galvanising of iron and steel.
IS:2751	Code of Practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS:4759	Hot-dip zinc coating on structural steel and other allied products.

IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works
IS:9417	Recommendations for welding cold-worked steel bars for reinforced concrete construction.
IS:226	Structural steel (Standard Quality)
IS:800	Code of practice for use of structural steel in general building construction.
IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of structural steel. (Part I & Part II)
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:822	Code of practice for inspection of welds.
IS:961	Structural steel (High Tensile)
IS:1024	Code of practice for use of welding in bridges and structures subject to dynamic loading.
IS:1161	Steel tubes for structural purposes.
IS:1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates.
IS:2062	Structural steel (Fusion welding quality)
IS:3757	Specification for high tensile friction grip bolts.
IS:5624	Specification for foundation bolts.
IS:3600	Code of practice for testing of fusion welded (Part I) joints and weld metal in steel.
IS:4923	Hollow steel sections for structural use.
IS:6227	Code of practice for use of metal arc welding in tubular structure.
IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.

IS:811	Specifications for cold formed light gauge structural steel sections
IS:8500	Structural Steel Micro alloyed (Medium and high strength qualities)
IS:8910	General requirements of supply of weldable structural steel
N	**Sand**
IS:383	Coarse and fine aggregates from natural sources for concrete.
IS: 1498	Classification and identification of soils for general engineering purpose (first revision) (Amendments 2).
IS: 1500: 1983	Method for Brinell hardness test for metallic materials (second revision) (superseding IS 1789:1961, IS1790:1961 and IS 3054:1965).
IS: 1501: 1984	Method of Vickers hardness test for metallic materials
IS: 1586: 1988	Method of Rockwell hardness test for metallic material (Scales A-B-C-D-E-F-G-H-K) (second revision)
IS: 1786-1985	Specification of high strength deformed steel bars and wires for concrete reinforcement (third revision) (superseding IS 1139:1966) (Amendment 1).
IS 2062-1999	Steel for general structural purpose (fourth revision) (supersedes IS 225:1975).
IS: 2386 (Part 1)-1963	Method of test for aggregates for concrete : Part 1 Particle size and shape (Amendments 2)
IS. 2386 (Part 11)-1963	Method of test for aggregates for concrete : Part 2 Estimation of deleterious materials and organic impurities (Amendment 1
IS: 2386 (Part 111)-1963	Method of test for aggregates for concrete: Part 3 , Specific gravity, density, voids, absorption and bulking.

IS: 2386 (Part IV)-1963	Method of test for aggregates for concrete. Part 4 Mechanical properties (Amendments 3).
IS: 2386 (Part V)-1963	Method of test for aggregates for concrete : Part 5 Soundness.
IS: 2386 (Part VII)-1963	Method of test for aggregates for concrete. Part 7 Alkali aggregate reactivity.
IS: 2386 (Part VIII)-1963	Method of test for aggregates for concrete: Part 8 Petrographic examination)
IS: 2629-1985	Recommended practice for hot-dip.galvanzing on iron and steel (first revision) (Amendment 1)
IS.2633-1986	Method for testing uniformity of coating of zinc coated articles (second revision).
IS 2645-1975	Rectification for integral cement waterproofing compounds (first revision) (Amendment 1)
P	**Scaffolding**
IS:2750	Specification for steel scaffoldings
IS:3696 (Part 1)	Safety Code of scaffolds and ladders: Scaffolds
IS:3696 (Part 2)	Safety Code of scaffolds and ladders: Ladders
IS:4014 (Part 1)	Code of practice for steel tubular scaffolding: Definition and materials
IS:4014 (Part 2)	Code of practice for steel tubular scaffolding: Safety regulations for scaffolding
IRC:87	Guidelines for the design and erection of falsework for road bridges
Q	**Bearing**
IRC:83 (Part-II)	Standard specifications and code of practice for road bridges, Elastomeric Bearings
IRC:83 (Part-III)	Standard specifications and code of practice for road bridges, Pot Bearings
R	**UPVC Pipe For Drain**

IS 4985	Unplasticized PVC Pipes for portable water supplies
S	**PILING**
IS :2911 PART-I to IV	Bored Cast in-situ Concrete Piles
IRC:78	Standard specifications and code of practice for road bridges Foundation And Substructure
IS:3696 (Part 1)	Safety code for scaffolds and ladders.
IS:3696 (Part 2)	Safety code for scaffolds and ladders Part II ladders.
IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and drilling operations.
IS:4138	Safety code for working in compressed air
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety codes for construction involving use of hot bituminous materials.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for storage and handling of building materials.

Annexure-C

LIST OF TEST REQUIRED FOR QUALITY ASSURANCE.

A. CONCRETE WORKS.

1. COARSE AGGREGATES

Test	Frequency	Laboratories	Ref. Codes	Acceptance Standard
Particle Size and Shape a) Sieve Analysis b) Flakiness Index & Elongation Index	1. At the beginning for approval of each source and change of source 2. Sieve analysis once in day, Flakiness index and Elongation index once in a week	1 2A	IS: 383-1970 IS: 2386 (Part I)-1963	Sieve Analysis – IS:383-1970 35% Max. value of combined Elongation and Flakiness index
2.Deleterious Materials	1. At the beginning for approval of each source and change of source 2. Once in a month	1 2A/2B	IS: 383-1970 IS: 2386 (Par II)-1963	Table–I of IS:383-1970
3. Specified Gravity & Density	1. At the beginning for approval of each source and change of source 2. Once in three month	1 2A	IS: 383-1970 IS: 2386 (Part III)-1963	Testing is required for maintaining uniformity of material brought from the source.

4. Mechanical Properties a) Aggregate Crushing Value b) Impact Value c)10 percent Fines d) Abrasion Value	1. At the beginning for approval of each source and change of source 2. Once in a month 1. At the beginning for approval of each source and change of source 2.Once in a month	1 2A 1 2B	IS: 383-1970 IS: 2386 (Part IV)-1963	
Test	**Frequency**	**Laboratories**	**Ref. Codes**	**Acceptance Standard**
5. Soundness	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part V)-1963	IS: 383-1970
6. Surface Moisture Content	1. At the beginning for approval of each source and change of source 2. At every change of mix design 3. Every time making the concrete	1 1/2A 2A	IS: 383-1970 IS: 2386 (Part III)-1963	Test required to adjust the water content in the mix design before starting any concrete mixing.
7. Alkali Reactivity	1. At the beginning for approval of each source and change of source.	1	IS: 383-1970 IS: 2386 (Part VII)-1963	Innocuous Aggregate
8.Petrographic Examination a) Trade Group b) Petrological name & Description	1. At the beginning for approval of each source and change of source.	1	IS: 383-1970 IS: 2386 (Part VII)-1963	Information required for approval of source

c) Description of Bulk d) Particle shape e) Surface texture.				

2. FINE AGGREGATES

Test	Frequency	Laboratories	Ref. Codes	Acceptance Standard
1.Particle Sizes	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part I)-1963	Table –4 of IS:383-1970
	2. Once in a day	2A		
2. Deleterious Materials	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part I)-1963	Table –1 of IS:383-1970
	2. Once in a week	2A/2B		
3. Silt Content	1. At the beginning for approval of each source and change of source	1		As specified in 5.2.8
	2. Once Daily	2A		
4. Specific Gravity, & Density	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part II)-1963	Test is required for maintaining uniformity of material brought from the source
	2. Once in a month	2A		
5. Water absorption	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part II)-1963	Test is required for adjusting the water content in the mix design before starting any concrete mixing
6. Moisture Content	1. Daily at regular interval	2A		
7. Soundness	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part II)-1963	IS: 383-1970

3. **Water**

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1 Chemical Analysis				
a) pH value	1. Once at beginning for approval of each source and change of source 2. Once in 3 months	1	IS: 456:2000	As specified in 5.2.9
b) Chlorides (as Cl)			IS:3025(Part24)	As specified in 5.2.9
c) Sulphates (as SO_3)			IS:3025(Part32)	As specified in 5.2.9
d) Neutralization with NaOH (with phenolphathalein as indicator)		2B	IS:3025(Part22)	CPWD Specifications
e) Neutralization with H_2SO_4 (with mixed indicator)			IS:3025(Part 23)	CPWD Specifications
2 Physical Analysis				
a) Suspended matter	1. Once at beginning for approval of each source and change of source	1	IS:3025(Part 17)	As specified in 5.2.9
b) Organic matter	Once in 3 months. at the beginning for approval of each source and change of source	2B	IS:3025(Part 18)	As specified in 5.2.9
c) Inorganic matter			IS:3025(Part 18)	As specified in 5.2.9

4. Cement

(a) ORDINARY PORTLAND CEMENT (43/53 GRADE)

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1. Chemical Tests	1. At the beginning for approval of each source and change of source	1		
• Total Chloride content	2. Once for every lot	1		
• Ratio of Alumina to that of Iron Oxide			IS:12269 – 1987 (for 53 Grade) & IS: 8112- 1989 (for 43 Grade)	**As per relevant IS Code for 43 Grade/53 Grade Cement**
• Magnesia % by mass				
• Total sulphate content	3. Once in 3 months	3		
• Loss on Ignition				
• Insoluble Residue				
• Lime saturation factor.				
2. Physical tests				
• Setting Time **i) Initial** **ii) Final**	1. At the beginning for approval of each source and change of source	1		
• Soundness	2. Once for every lot	1	IS:12269 – 1987 (for 53 Grade) & IS: 8112- 1989 (for 43 Grade)	As per relevant IS Code for 43 Grade/53 Grade Cement
• Compressive Strength • At 3 days • At 7 days • At 28 days	3. Once in 3 months	3		
• Fineness				

(b) PORTLAND SLAG CEMENT

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
8.2 1) Chemical Tests **8.3** Magnesium oxide (MgO) **8.4** Sulphur Trioxide (SO_3) **8.5** Sulphide Sulphur (S) **8.6** Loss on Ignition **8.7** Insoluble Residue **8.8** Chloride Content	1. At the beginning for approval of each source and change of source 2. Once for every lot 3. Once in 3 months	1 1 3	IS:455-1989 IS:4032:1985	As per IS:455-1989
2) Physical Tests				
a) Fineness (Blain's Air permeability method)	1. At the beginning for approval of each source and change of source	1	IS : 4031 (Part 2) : 1988	
b) Soundness	2. Once for every lot	1	IS : 4031 (Part 3) : 1988	
c) Setting time				
i) Initial				As per IS:455-1989
ii) Final			IS : 4031 (Part5) : 1988	
d) Compressive Strength	3. Once in 3 months	3		
iii) 72 ± 1h			IS : 4031 (Part 6) : 1988	
iv) 168 ± 2h				
v) 672 ± 4h				

5. PLASTICISER (NORMAL AND RETARDING TYPE SUPERPLASTICISER)

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
• Water content, percent of control sample • Slump • Time of Setting, allowable deviation from control sample a) Initial b) Final • Compressive strength, percent of control sample • 1 day • 3 days • 7 days • 28 days • 6 months • 1 year • Flexural Strength, percent of control sample a) 3 days b) 7 days c) 28 days • Length change percent increase over control sample a) 28 days b) 6 months c) 1 year • Bleeding, percent increase over control sample • Loss of workability • Air content (%) over control specimen	1. At the beginning for approval of each source and change of source (for test at S.No.1 to 10)	1/3	IS:9103-1999	As specified in IS:9103 -1999
• Uniformity Tests Dry Material Content Ash content Relative Density Chlorides ion content pH	For uniformity Test 1. Once for every lot	2A/2B		As specified in IS:9103 -1999

B. ROAD WORKS.

1. AGGREGATES FOR ROAD WORK (NON BITUMINOUS SUB BASE AND BASE) GRANULAR SUB BASE (GSB)

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1. Graduation	1. At the beginning for approval of each source and change of source	1	MORTH Specifications for Road & Bridge Works	Clause 401 of MORTH Specifications for Road & Bridge Works (4th Revision) 2001
	2. One test per 200 m^3	2A		
2. Deleterious Materials	• At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part II)-1963	Clause 401 of MORTH Specifications for Road & Bridge Works (4th Revision) 2001
	• Once in 3 months	2B		
3. Water absorption	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part III)-1963	Clause 401 of MORTH Specifications for Road & Bridge Works (4th Revision) 2001
4. 10 % Fines	1. At the beginning for approval of each source and change of source	1	BS : 812 (Part 111)	Clause 401 of MORTH Specifications for Road & Bridge Works (4th Revision) 2001
	2. Once in 3 months	2B		
5. Soundness (Test is required if water absorption is greater than 2 %)	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part V)-1963	Clause 401 of MORTH Specifications for Road & Bridge Works (4th Revision) 2001
	2. Once in 3 months	2B		
6. Atterberg Limits for material passing 425 µ sieve	• At the beginning for approval of each source and change of source	1	IS : 2720 (Part 5)	Clause 401 of MORTH Specifications for Road & Bridge Works (4th Revision) 2001
a) Liquid Limit b) Plasticity Index	• One test per 200 m^3	2A/B		

2. WET MIX MACADAM (WMM)

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1. Sieve Analysis	• At the beginning for approval of each source and change of source • Once for 100 m^3 of aggregate	1 2A	IS: 383-1970 IS: 2386 (Part I)-1963	Clause 406 of MORTH Specifications for Road & Bridge Works
2. Deleterious Materials	1. At the beginning for approval of each source and change of source 2. Once in a month	1 2B	IS: 383-1970 IS: 2386 (Part II)-1963	Clause 406 of MORTH Specifications for Road & Bridge Works
3. Water absorption	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part III)-1963	Clause 406 of MORTH Specifications for Road & Bridge Works
4. Mechanical Properties a) Aggregate Crushing Value b) Impact Value c) Los Angeles Abrasion Value d) Combined Flakiness and Elongation Value	1. At the beginning for approval of each source and change of source 2. Once for 200 m^3 of aggregate	1 2A/2B	IS: 383-1970 IS: 2386 (Part IV)-1963	Clause 406 of MORTH Specifications for Road & Bridge Works
5. Soundness (test to be conducted if water absorption is more than 2 %)	1. At the beginning for approval of each source and change of source 2. Once in three months, if required	1 2B	IS: 383-1970 IS: 2386 (Part V)-1963	Clause 406 of MORTH Specifications for Road & Bridge Works
6. Plasticity Index of Materials finer than 425 µ sieve	1. At the beginning for approval of each source and change of source 2. Once for 200 m^3 of aggregate	1 2A/2B	IS :2720 (Part 5) & MORTH	Clause 406 of MORTH Specifications for Road & Bridge Works
7. Density of Compacted layer	One test per 500 sqm	2A/2B		

3. AGGREGATES FOR ROAD WORK (BITUMINOUS BASE AND SURFACE COURSES)

(a) Dense Bituminous Macadam (DBM)
(b) Bituminous Concrete (BC)
(c) Mastic Asphalt

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1. Sieve Analysis	• At the beginning for approval of each source and change of source • Once per $25m^3$ of aggregate	1 2A	IS: 383-1970 IS: 2386 (Part I)-1963	Relevant clause of MORTH Specifications for Road & Bridge Works
2. Deleterious Materials	1. At the beginning for approval of each source and change of source 2. Once in a month	1 2B	IS: 383-1970 IS: 2386 (Part II)-1963	Relevant clause of MORTH Specifications for Road & Bridge Works
3. Water absorption	1. At the beginning for approval of each source and change of source	1	IS: 383-1970 IS: 2386 (Part III)-1963	Relevant clause of MORTH Specifications for Road & Bridge Works
4. Mechanical Properties a) Impact Value b) Los Angeles Abrasion Value c) Combined Flakiness and Elongation Value	• At the beginning for approval of each source and change of source Once per $50m^3$ of aggregate	1 2A/2B	IS: 383-1970 IS: 2386 (Part IV)-1963	Relevant clause of MORTH Specifications for Road & Bridge Works
5. Soundness (test to be conducted if water absorption is more than 2 %)	1. At the beginning for approval of each source and change of source 2. Once in three months, if required	1 2B	IS :2720 (Part 5)	Relevant clause of MORTH Specifications for Road & Bridge Works
6. Stripping Test Bitumen Aggregate Mixtures	1. At the beginning for approval of each source and change of source 2. Once a month	1 2B	IS: 6241	Relevant clause of MORTH Specifications for Road & Bridge Works
7. Retained Tensile Strength (test to be conducted if retained coating is less than 95 %)	1. At the beginning for approval of each source and change of source 2. Once a month	1 2B		Relevant clause of MORTH Specifications for Road & Bridge Works

4. Lime

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1. $CaCO_3$ content 2. Sieve Analysis	1. At the beginning for approval of each source and change of source	1	IS: 1195-1978	80% Minimum
	2. One Test for every 5MT of lime consumption.	2B		100% through 75 micron sieve

C. REINFORCING BARS (TMT Bars).

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
1. Chemical Tests	1. At the beginning for approval of each source and change of source	1	IS: 1786-1985	As specified in IS:1786-1985
a) Carbon				
b) Sulphur	2. Once for every lot	1		
c) Phosphorus	3. Once in 3 months	3		
d) Sulphur + phosphorus				
2. Physical test	1. At the beginning for approval of each source and change of source	1		
a) Ultimate Tensile strength				
b) 0.2% Proof stress	2. Once for every lot	2A/2B		
c) Percentage elongation	3. Once in 3 months	3		
d) Bend and rebend test				
e) Mass per meter run (Kg)				

The lot shall be defined as under.

From each source for each dia.

a) For consignment below 100 MT.
   i) Under 10mm – One sample for each 25MT or part thereof.
   ii) 10mm to 16mm dia – One sample for each 35MT or part thereof..
   iii) Over 16mm dia – One sample for each 45MT or part thereof.

b) For consignment over 100 MT.
   - Under 10mm – One sample for each 40MT or part thereof.
   - 10mm to 16mm dia – One sample for each 45MT or part thereof.
   - Over 16mm dia – One sample for each 50MT or part thereof.

D. MILD STEEL

Test	Frequency	Laboratories	Refer Codes	Acceptance Standard
Chemical Composition	1. At the beginning for approval of each source and change of source 2. Once in a project for every source	1 3	IS:2062-1999	As specified in IS:2062-1999

E. THERMOPLASTIC PAINTS

Test	Frequency	Laboratories	Refer Codes
1. Binder content 2. Glass Beads 3. Titanium Dioxide content 4. Calcium Carbonate & Inert fillers 5. Yellow Pigments 6. Luminance (Daylight) 7. Drying Time 8. Skid Resistance 9. Cracking Resistance at low temperature 10. Softening Point 11. Flow resistance 12. Yellowness Index	1. At the beginning for approval of each source and change of source 2. Once in a project for every source	1 2B	BS: 3262 and MORTH Specifications clause 803

F. BENTONITE

Test	Frequency	Laboratories	Refer Codes
• Density • Marsh Cone Viscosity • pH value • Silt content • Liquid limit	1. At the beginning for approval of each source and change of source 2. Once for every day of Piling	1 2A	MORTH Specifications for Road & Bridge works

G. GALVANISING

Test	Frequency	Laboratories	Ref. code
1. Mass of Zinc Coating	One Test per lot	3	IS:6745-1972
2. Visual Test	One Test per lot	3	IS:2629-1985
3. Free Bore Test	One Test per lot	3	IS:2633-1986
4. Uniformity of Galvanised Coating	One Test per lot	3	IS:4736-1986
5. Adhesion Test	One Test per lot	3	IS:2629-1985

H. NON SHRINK GROUT

Test	Frequency	Laboratories	Ref Codes
1. Compressive Strength (50mm cubes)	1. At the beginning for approval of each source and change of source	1	ASTM C109-99
2. Compressive Strength with addition of aggregates.		1	ASTM 469-94
3. Flexural Strength		1	BS 4551, 1998
4. Time for expansion (after mixing)		1	
a) Start			
b) Finish			
5) Pull Out Bond Strength		1	ASTM C109-99
6) Time for expansion		1	
7) Freshwet Density		1	ASTM 469-94
8) Young's Modulus		1	

9) Dynamic Load resistance		1	BS 4551, 1998
10) Coefficient of thermal Expansion		1	
11)Unrestrained Expansion		1	
12) Pressure to restrain Plastic Expansion		1	
13) Flow Characteristics Grout Consistency		1	

I. WATER PROOFING COMPOUND

Test	Frequency	Laboratories	Ref Codes
1. Permeability	1. At the beginning for approval of each source and change of source 2. Once in a project for every source	1 2B	IS:2645-1975
2. Setting Time.	1. At the beginning for approval of each source and change of source 2. Once in a project for every source	2B	
3.Compressive Strength	1. At the beginning for approval of each source and change of source 2. Once in a project for every source	2B	
4. Chloride Content	1. At the beginning for approval of each source and change of source 2. Once in a project for every source	2B	
5. Sulphate Content	1.At the beginning for approval of each source and change of source 2. Once in a project for every source	2B	

G. ASSEMBLED ACCESSORIES

1. STAINLESS STEEL

Test	Frequency	Check Level	Ref. Codes
Chemical Tests.			IS-6911:1992
Carbon			
Silicon			
Manganese			
Nickel			
Chromium			
Molybdenum	1. At the beginning for approval of each source and change of source	1	
Sulphur			
Phosphorus	2. Once in a project for every source	3	
Mechanical Tests			
Tensile Test			IS:1663:1972
Yield Strength			IS:1608:1972
Hardness Test			IS:1500:1983
Elongation			IS:1501:1984
			IS:1586:1988

2. CHLOROPRENE ELASTOMER

Test	Frequency	Check Level	Ref. Codes
Hardness	As per the requirement of the respective item	3	MORTH specification for Road & Bridge works.
Minimum Tensile Strengths		3	
Minimum Elongation at Break		3	
Maximum Compression set		3	
Accelerated Ageing		3	
Maximum Change in Hardness		3	
Maximum Change in Tensile strength		3	
Maximum change in elongation		3	
Shear Modulus		3	

Ash Content		3	

3. POLY TETRA FLOURO ETHYLENE (PTFE)

Test	Frequency	Check Level	Ref. Codes
Form	As per the requirement of the respective item	3	BS:3784 BS:6564 Part 2 – 1991
Density at 23 ± 2^0C.		3	
Tensile Strength at break		3	
Elongation at Break		3	
Resistance to heat		3	
Dimensional stability		3	

4. CAST STEEL (FOR BEARING GRADE 280-250W)

Test	Frequency	Check Level	Ref. Codes
1. Chemical Test	1. Once in the beginning for source	1	IS:1030-1989
	2. During execution depending upon the nature of use	3	
	3. Once in a project for every source	3	
2. Physical Tests			
Ultrasonic Tests	1.Once in the beginning for source	1	
Magnetic Particle Examination	2. During execution depending upon the nature of use	3	
Liquid Penetration Examination			
Radiographic Examination	3. Once in a project for every source	3	

5. TESTS ON NEOPRENE SEAL (FOR STRIP SEAL EXPANSION JOINTS)

Test	Frequency	Check Level	Ref. Codes
1) Hardness	1. At the beginning for approval of each source and change of source	1	MORTHspecification for Road & Bridge works
2) Tensile Strengths	2. Once for every Lot	3	
Elongation at Break			
Tar Propagation Strength	1.At the beginning for approval of each source and change of source	1	
a) Longitudinal	2. Once for every Lot	3	
b) Transverse			
Shock Elasticity	1.At the beginning for approval of each source and change of source	1	
Abrasion	2. Once for every Lot	3	
Residual Compressive strain (22h/70 °C /30 % strain)	1.At the beginning for approval of each source and change of source	1	
Ageing in hot air	2. Once for every Lot	3	
Maximum Change in Hardness			
Maximum Change in Tensile strength			
Maximum change in elongation			

Ageing in Ozone (24h/50 pphm/ 25°C/ 20 % strain) Swelling behaviour in oil Volume Change Change in Hardness	1.At the beginning for approval of each source and change of source 2. Once for every Lot	1 3	
ASTM oil No. 3 Volume Change Change in Hardness	1.At the beginning for approval of each source and change of source 2. Once for every Lot	1 3	
Cold Hardening Point	1.At the beginning for approval of each source and change of source 2. Once for every Lot	1 3	

6. POT-PTFE BEARINGS

Test	Frequency	Check Level	Ref. Codes
Dimensional Tolerance			MORTH specification for Road & Bridge works
Plan dimensions			
Overall Height			IRC: 83 Part-III
Height of any steel component	All bearing to be tested for overall dimension	3	
Machined			
Unmachined			
Height of Elastomer			
Stainless steel sliding surface			
Flatness	All bearing to be tested for overall dimension	3	
Surface finish			
Load Test	All bearing	3	
Friction Test	Two bearings per lot	3	
Ultrasonic Test	All castings	3	
Dye Penetration Test	All welding	3	
Raw Material Testing	All raw material	3	

7. STRIP SEAL EXPANSION JOINTS

Test	Frequency	Check Level	Ref. Codes
Tests on Neoprene seal	1. Once for all joints	3	MORTH specification for Road & Bridge Works
Test on Edge Beams	2. Once for each lot		IRC:SP:69-2005
Fatigue Strength		2B	
Test on Anchorage system			
Dynamic Loading characteristics	1. Once for all joints	3	
Water Tightness test	2. Once for each lot	2B	
Satisfactory Past Performance			

Annexure - D

List Of Equipment In Site Testing Laboratory

Coarse Aggregates

1. Trays
2. Thickness Gauge
3. Length Gauge
4. Balance (more than 3 Kg capacity) with 0.1 % accuracy
5. Oven (100 to 110 °C Capacity)
6. Wire Basket of lesser than 6.3 mm mesh,
7. A stout water container
8. Two dry soft absorbent cloths each not less than 75 x 45 cm.
9. A shallow trey not less than 650 cm^2
10. An airtight container
11. Cylindrical metal measure of 11.5 cm ϕ, 18 cm height
12. 15 cm ϕ open-ended steel cylinder, with plunger and base plate
13. Cylindrical Tamping Rod of 16mm ϕ, 60 cm length and rounded at one end
14. Compressive Testing Machine capable of applying a load of 40 T
15. Seive Shaker

Fine Aggregates

1. Trays
2. Fine mesh, wire cloth sieves of size 3.35 mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ, 75µ
3. Balance (more than 3 Kg capacity) with 0.1 % accuracy
4. Oven (100 to 110 °C Capacity)
5. Soft Brush
6. Wire Basket of lesser than 6.3 mm mesh,
7. A stout water container
8. Two dry soft absorbent cloths each not less than 75 x 45 cm.

9. A shallow trey not less than 650 cm^2

10. An airtight container

11. Pycnometer

12. Means of warm air

13. Filter Papers

14. Funnel

15. Cylindrical metal measure of 3, 15 and 30 l capacity

16. Cylindrical Tamping Rod of 16mm ϕ, 60 cm length and rounded at one end

17. Flask of glass or non corrosive metal

18. 1000 ml measuring cylinder

19. Sieve Shaker

20. Moisture meter

Water

- Specialised Testing Kits for testing Chlorides and Sulphates
- pH testing Strips
- Titration Equipment with Pipette

Cement

1. Vicat Apparatus
2. Le Chatelier Test Apparatus
3. Vibrating Machine
4. Cube Moulds of 50 mm/75mm size
5. Standard Weights
6. Balance (for a load of 1000g $\pm$1g)
7. Water Bath
8. Gauging Trowel
9. Planetary Mixer
10. Flow Table

11. Tamping Rod

12. Pocking Rod

13. Graduated Glass Cylinder (150 to 200 ml capacity)

14. Standard Sand

Concrete

1. Cube Testing Machine
2. 150-mm size Cube moulds
3. Water Bath
4. Vernier Caliper
5. Micrometer
6. Weighing Balance
7. Tamping steel Bar 16mm in diameter, 0.6 m length and bullet pointed at the lower end.
8. Slump Cone
9. Calibrating Pneumatic hammer

Plasticiser

1. Cube Testing Machine
2. 150 mm size Cube moulds
3. Water Bath
4. Vernier Caliper
5. Micrometer
6. Weighing Balance
7. Tamping steel Bar 16mm in diameter, 0.6 m length and bullet pointed at the lower end
8. Slump Cone
9. Container with mixing arrangement

Bentonite

1. 75 micron sieve

2. Cassagranda Apparatus

Bentonite Slurry

1. pH strips

Earth Work/Embankment Construction:

1. Small sand Pouring Cylinder
2. Tools for excavating Earth
3. Cylindrical Calibrating container with an internal dia. 100mm and depth of 150mm
4. Balance
5. Plane surfaces: Glass or Perspex Plate
6. Metal containers (150mm dia. and 200mm deep)
7. Cylindrical Steel Core Cutter
8. Metal Tray (300mm square and 40mm deep) with 100mm Hole
9. Moisture meter
10. Bituminous works.
11. Core cutting machine

Any other instrument/equipment as desired by the Engineer-in-charge for site testing of materials

Annexure – D1

List Of Approved External Laboratories

Any of the following laboratories in and around Delhi shall be made use for external / independent testing of materials and products:

AES Testing & research Laboratories (AES)

Central Road & Research Institute (CRRI)

Indian Institute of Technology, Delhi (IITD)

National Council for Cement & Building Materials (NCCBM)

Regional Testing Centre (RTC)

Sunbeam Casting (SBC)

Shriram Institute of Industrial Research (SIIR)

DDA lab.

All laboratories approved by CE(QC) / DDA vide letter no. F73(36)/2003/QA/Parts/75dated 13/03/08 and time to time approved by DDA..

Annexure - E

FORM OF BANK GUARANTEE TO SECURE A LUMPSUM ADVANCE

To

The DDA _____

1. In consideration of the DDA of the state of (hereinafter called " the Government " which expression shall unless repugnant to the subject or context include his successors and assigns) having agreed under the terms and conditions of Contract No.,----------dated ---------- made between * ---------- and the DDA in connection with ---------- (hereinafter called " the said Contract") to make at the request of the Contractor a lump sum advance of Rs ---------- (Rupees _____) for utilising it for the purpose of the Contract on his furnishing a guarantee acceptable to the DDA, we the ** ---------- Bank Ltd. (hereinafter referred to as " the said Bank") a company under the Companies Act, 1956 and having our registered office at ---------- do hereby guarantee the due recovery by the DDA of the said advance with interest thereon as provided according to the terms and conditions of the Contract. We** ---------- do hereby undertake to pay the amount due and payable under this Guarantee without any demur, merely on a demand from the DDA stating that the amount claimed is due to the DDA under the said Agreement. Any such demand made on the ---------- shall be conclusive as regards the amount due and payable by the ---------- under this guarantee and the ---------- agree that the liability of the ---------- to pay the DDA the amount so demanded shall be absolute and unconditional notwithstanding any dispute or disputes raised by the Contractor and notwithstanding any legal proceeding pending in any Court or Tribunal relating thereto. However, our liability under this Guarantee shall be restricted to an amount not exceeding Rs---------- (Rupees _____).

We** ---------- Bank Ltd. further agree that the DDA shall be the sole judge of and as to whether the said Contractor has not utilized the said advance or any part thereof for the purpose of the Contract and the extent of loss or damage caused to or suffered by the DDA on account of the said advance together with interest now being recovered in full and the decision of the DDA that the said Contractor has not utilized the said advance or any part thereof for the purpose of the Contract and as to the amount or amounts of loss or damages caused to or suffered by the DDA shall be final and binding on us.

3. We, the said Bank further agree that the Guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and till the said advance with interest has been fully recovered and its claims satisfied or discharged and till _____ certify that the said advance with interest has been fully recovered from the said Contractor, and accordingly discharges this Guarantee subject, however, that the DDA shall have no claims under this Guarantee after ---------- years from the date of completion

of the said Contract, as the case may be, unless a notice of the claim under this Guarantee has been served on the Bank before the expiry of the said period of ---------- years in which case the same shall be enforceable against the Bank notwithstanding the fact that the same is enforced after the expiry of the said period of ..... years.

4. The DDA shall have the fullest liberty without affecting in any way the liability of the Bank under this Guarantee or indemnity, from time to time to vary any of the terms and conditions of the said contract or the advance or to extend time of performance by the said Contractor or to postpone for any time and from time to time any of the powers exercisable by it against the said Contractor and either to enforce or forbear from enforcing any of the terms and conditions governing the said Contract or the advance or securities available to the DDA and the said Bank shall not be released from its liability under these presents by any exercise by the DDA of the liberty with reference to the matters aforesaid or by reasons of time being given to the said Contractor or any other forbearance, act or omission on the part of the DDA or any indulgence by the DDA to the said Contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of so releasing the Bank from its such liability.

5. It shall not be necessary for the DDA to proceed against the Contractor before proceeding against the Bank and the Guarantee herein contained shall be enforceable against the Bank notwithstanding any security which the DDA may have obtained or obtain from the Contractor shall at the time when proceedings are taken against the Bank hereunder be outstanding or unrealized.

6. We, the said Bank lastly undertake not to revoke this Guarantee during its currency except with the previous consent of the DDA in writing and agree that any change in the constitution of the said Contractor or the said Bank shall not discharge our liability hereunder.

Dated this ..... day of 20

For and on behalf of the Bank_____ (Name and Designation).

The above Guarantee is accepted by the DDA of the state of _____.

For and on behalf of the DDA _____ Dated_____ (Name and Designation).

Note :

*For Proprietary Concerns

Shri ---------- son of ---------- resident of ---------- carrying on business under the name and style of ---------- at ---------- (hereinafter called the said Contractor which expression shall, unless the context requires or otherwise include his heirs, executors, administrators and legal representatives).

*For partnership Concerns

1) Shri ---------- son of---------- resident of----------

2) Shri ----------son of ----------resident of---------- and carrying on business in co-partnership under the name and style of ---------- at ---------- (hereinafter collectively called "the said Contractors" which expression shall unless the context requires otherwise include each of them and their respective heirs, executors, administrators, and legal representatives).

*For Companies

S/Shri---------- a Company under the Companies Act, 1956 and having its registered office at ---------- in the State of ---------- (hereinafter called" the said Contractor" which expression shall unless the context requires otherwise include its successors and assigns).

** Fill in name of the Bank

Annexure - F

GUARANTEE BOND FOR EXPANSION JOINT

The agreement made this----------day of----------Two Thousand eight between M/s ----------(hereinafter called the Guarantor of the one part) and the DDA (hereinafter called the Government of other part)

WHEREAS THIS agreement is supplementary to a contract (hereinafter called the Contract) dated----------and made between the GUARANTOR OF THE ONE part and the government of the other part, whereby the Contractor _____in the said contract recited quality of single strip seal Modular strip seal expansive joints , Material , Manufacture and workmanship as per revised interim specification for expansion joint issued by MORTH upto the date of receipt of tenders.

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the said strip seal expansion joint will remain satisfactorily functional for fifteen years to be reckoned from the date after the maintenance period, prescribed in the contract, expires.

During this period of guarantee, the guarantor shall make good all defects and for that matter, shall replace at his risk and cost such elements of the joints i/c cost of installation and fixing of the expansion joint to the satisfaction of the Engineer-in-Charge, at his cost and he shall commence the work for such rectification within seven days from the date of issue of the notice from the Engineer-in-charge calling upon him to rectify the defects, failing which the work shall be got done by the Department through some other contractor at the GUARANTOR's cost and risk. The decision of the Engineer-in-Charge as to the cost payable by the Guarantor shall be final and binding.

That if the Guarantor fails to execute the replacement/rectification or commits breach thereunder, then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the Guarantor in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the DDA, the decision of the Engineer-in-Charge will be final and binding on the parties.

IN WITNESS WHEREOF these presents have been executed by the Obligor ----------and by----------for and on behalf of the DDA on the day, month and year first above written.

Signed, sealed and delivered by Obligor in the presence of:

1 _____

2 _____

Signed for and on behalf of DDA by Executive Engineer, DDA, (F.O.D-2) in the presence of:

1

2

To be filled by the Executive Engineer

Annexure - G

GUARANTEE BOND FOR BEARINGS

The agreement made this ----------day of ----------Two thousand eight between M/s ----------son of----------of----------(hereinafter called the Guarantor of the one part) and the DDA (hereinafter called the Government of the part)

WHEREAS THIS agreement is supplementary to a contract (hereinafter called the Contract) dated---------- and made between the GUARANTOR OF THE ONE part and the government of the other part, whereby the Contractor, _____ in the said contract recited quality of POT cum PTFE bearings, Material, Manufacture and workmanship as per revised interim specification for POT cum PTFE bearings issued by MORTH upto the date of receipt of tenders.

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the said POT cum PTFE bearings will remain satisfactorily functional for fifteen years to be reckoned from the date after the maintenance period prescribed in the contract expires.

During , this period of guarantee, the guarantor shall make good all defects and for that matter, shall replace at his risk and cost such elements of the POT cum PTFE bearings i/c cost of installation and fixing of the POT cum PTFE bearings to the satisfaction of the Engineer-in-Charge, at his cost and he shall commence the work for such rectification within seven days from the date of issue of the notice from the Engineer-in-Charge calling upon him to rectify the defects, failing which the work shall be got done by the Department through some other contractor at the GUARANTOR's cost and risk. The decision of the Engineer-in-Charge as to the cost payable by the Guarantor shall be final and binding.

That if the Guarantor fails to execute the replacement/rectification or commits breach thereunder, then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the Guarantor in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the DDA , the decision of the Engineer-in-Charge will be final and binding on the parties.

IN WITNESS WHEREOF these presents have been executed by the obligor ---------- and by ----------for and on behalf of the DDA on the day, month and year first above written.

Signed, sealed and delivered by Obligor in the presence of:

1

2

Signed for and on behalf of DDA by Executive Engineer, DDA, Flyover Div-2 in the presence of:

1

2

To be filled by the Executive Engineer.

Annexure - H

FORM OF PERFORMANCE SECURITY/

BANK GUARANTEE BOND

In consideration of the DDA (hereinafter called " The Government") having agreed to accept the tender of M/s …… (herein after called "the said contractors") for the work …….. which on its acceptance shall be deemed as "Agreement" between ……on behalf of the Government and the said contractors (herein after referred to as the said agreement) and having further agreed under the terms and conditions of the said tender/agreement to production of a irrevocable Bank Guarantee for Rs……..(Rupees……) as a security/guarantee from the contractor(s) for compliance of his obligations in accordance with the terms & conditions in the said agreement , We …….. (hereinafter referred to as "the Bank") (indicate the name of the Bank) hereby undertake to pay to the Government an amount not exceeding Rs. ……. (Rupees …… only) on demand by the Government.

2) We …….. Do hereby undertake to pay the amounts due and payable

(indicate the name of the Bank)

under this Guarantee without any demure, merely on a demand from the DDA stating that the amount claimed is required to meet the recoveries due or likely to be due from the said contractor(s). Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the bank under this Guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. ……..(Rupees……only).

We, the said bank further undertake to pay to the DDA any money so demanded notwithstanding any dispute or disputes raised by the contractor(s) in any suit or proceeding pending before any court or Tribunal relating thereto, our liability under this present being absolute and unequivocal.

The payment so made by us under this bond shall be a valid discharge of our liability for payment thereunder and the contractor(s) shall have no claim against us for making such payment.

4). We …… further agree that the guarantee herein contained

(indicate the name of the Bank)

shall remain in full force and effect during the period that would be taken for the performance of the said agreement and that it shall continue to be enforceable till all the dues of the DDA under or by virtue of the said agreement have been fully paid and its claims satisfied or discharged or till Engineer-in-Charge on behalf of the DDA certifies that the terms and conditions of the said agreement have been fully and properly carried out by the said contractor(s) and accordingly discharges this guarantee.

5) We ……. further agree with the DDA that

(indicate the name of the Bank)

The DDA shall have the fullest liberty without our consent and without effecting in any manner our obligations hereunder to vary any of the terms and conditions of the said agreement or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the DDA against the said contractor (s) and to for bear or enforce any of the terms and conditions relating to the said agreement and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said contractor(s) or fore any forbearance, act of omission on the part of the DDA or any indulgence by the DDA to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would, but for this provision, have effect of so relieving us.

6) This guarantee will not be discharged due to the change in the constitution of the Bank or the contractor(s).

We ……. lastly undertake not to revoke this

(indicate the name of the Bank)

guarantee except with the previous consent of the DDA in writing.

This guarantee shall be valid upto _____ . Unless extended on demand by DDA. Notwithstanding anything mentioned above, our liability against this guarantee is restricted to Rs. _____ (Rs. _____only) and unless a claim in writing is lodged with us within six months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharged.

Dated the _____ day of _____for _____ (indicate the name of bank)

Annexure - I

CUSTOMER NAME :

NAME OF WORK :

TENDER DUE ON :

PREQUALIFICATION WARRANTY

This is to certify that _____ High Intensity Retro Reflective

(Brand name of the sheet)

Sheeting, supplied by M/s _____to M/s_____

(Name of the supplier) (Name of the authorized converter)

for retro Reflective signboards as mentioned above will conform to ASTM D-4956-01 Type-IV performance specifications. M/s _____

(Name of the manufacture or their subsidiary in India)

and M/s _____ the sign fabricators,

(Name of the authorised converter)

jointly and severally agree to repair or replace, warranted retro Reflective Sign Board fabricated by M/s _____.

(Name of the manufacture or their subsidiary in India)

If _____ High Intensity retro reflective Sheeting which

(Brand name of the sheet)

has been processed and applied in accordance with the recommended procedure deteriorates within three and seven years as per test results, from the date of fabrication due to natural causes to the extent that:

The sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day night driving conditions by a driver with a normal vision, and

The co-efficient of Retro reflection is less than as specified in the following table:

(Candelas per Lux per Square Metre)

Observation angle	Entrance angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1^0	-4^0	400	270	160	56	56	32	12
0.1^0	$+30^0$	120	75	48	13	13	7	3.0
0.2^0	-4^0	250	170	100	35	35	20	7.0
0.2^0	$+30^0$	80	54	34	9	9	5	2.0
0.5^0	-4^0	135	100	64	17	17	10	4.0
0.5^0	$+30^0$	55	37	22	6.5	6.5	3.5	1.4

The co-efficient of retro-reflection at the end of 3 years and 7 years will be at least 80% and 75% respectively of the values mentioned above.

All measurements shall be made after cleaning the retro reflective surface with soap and water in dry condition. For Screen printed transparent areas on white sheeting, the coefficients of retro-reflection shall not be less than 50% of the values for coloured sheeting as given in the above table.

Such failure must be solely the result of defects in the _____ High

(Brand name of the Sheet)

Intensity Retro Reflective sheeting or/and in the fabrication of the sign and not of outside causes such as improper handling, vandalism or malicious mischief. Cause of the failure shall be decided by the Engineer-in0Charge and shall be binding upon the parties.

(Sheet Manufacture (Authorised Converter)

Or their subsidiary in India)

AUTHORISED SIGNATORY AUTHORISED SIGNATORY

Annexure - J

Elastic Recovery Test For Bitumen

Scope: The elastic recovery of modified bitumen is evaluated by comparing recovery of thread after conditioning for 1 hour at Specified Temperature and the specimen is elongated upto 10 cm deformation in a ductility machine. This is intended to assess degree of bitumen modification and the quality of modified bitumen.

Significance & Use: This test is intended to optimise dose of polymeric or and rubber additive in bitumen and help in assessing quality of PMB.

Apparatus:

Ductility Machine – AS per IS 1208:1978.

Thermometer – An ASTM 63^0C thermometer or any other standard thermometer of equivalent range shall be used.

Scissors – Any type of conventional scissors capable of cutting modified bitumen at the test temperature.

Scale – Any transparent scale capable of measuring upto 25 cm with $\pm$ 1 mm accuracy.

Procedure:

Prepare the test specimens for one sample and condition as prescribed in Test Method IS 1208 at specified temperature. Elongate the test specimen at the specified rate to a deformation 10 cm at a rate of 5 $\pm$ 0.25 cm/minute at specified temperature. Immediately cut the test specimen into two halves at the midpoint using the scissors. Keep the test specimen in the water bath in an undisturbed condition for 1 hour at specified temperature.

After the 1hour time period, move the elongated half of the test specimen back into position near the fixed half of the test specimen so that the two pieces of modified bitumen just touch. Record the length of the recombined specimen as X.

Report – Calculate the percent/ elastic recovery by the following procedure.

Elastic Recovery (%) = $10\text{-}X_{\ X\ 100}$

Annexure - K

Separation Test For Bitumen

Scope: The separation of modifier and bitumen during hot storage is evaluated by comparing the ring and ball softening point of the top and bottom portion samples taken from conditioned, polymer or rubber-modified bitumen in a sealed tube. The conditioning consists of placing a sealed tube of modified bitumen in a vertical position at 163 $\pm$ 5^0C in an oven for a period of 48 hours.

Apparatus:

Aluminium Tubes – 25.4 mm (1 in.) diameter and 136.7 mm long blind aluminium tubes,

Oven, capable of maintaining 163 $\pm$ 5^0C.

Freezer, capable of maintaining 6.7 $\pm$ 5^0C.

Rack, capable of supporting the aluminium tubes in a vertical position in the oven and freezer.

Spatula and Hammer: - The spatula must be rigid and sharp to allow cutting of the tube containing the sample when at a low temperature.

Procedure: Place the empty tube, with sealed end down in the rack. Heat the sample carefully untill sufficiently fluid to pour. Care should be taken to prevent localized over-heating. Pass the molten sample through IS 600 micron sieve. After thorough stirring, pour 50.0g into the vertically held tube. Fold the excess tube over two times, and crimp and seal.

Place the rack containing the sealed tubes in a 163 $\pm$ 5^0C oven. Allow the tubes to stand undisturbed in the oven for a period of 48 $\pm$ 4 hour. At the end of the period, remove the rack from the oven, and place immediately in the freezer at 6.7 $\pm$ 5^0C, taking care to keep the tubes in a vertical position at all times. Leave the tubes in the freezer for a minimum of 4 hours to solidify the sample completely.

Upon removing the tube from the freezer, place it on a flat surface. Cut the tube into three equal length portions with the spatula and hammer. Discard the centre section, and place the top and bottom portions of the tube into separate beakers. Place the beakers into a 163 $\pm$ 5^0C oven until the bitumen is sufficiently fluid to remove the pieces of aluminium tube.

After thoroughly stirring, pour the top and bottom samples into appropriately marked rings for the ring-and-ball softening point test. Prepare the rings and ball apparatus according to Test Method IS 1205. The top and bottom samples from the same tube should be tested at the same time.

Report – Report the difference, in ^{0}C, between the softening points of the respective top and bottom samples as average of three specimens.

Annexure - L

GUARANTEE TO BE EXECUTED BY CONTRACTOR FOR REMOVAL OF DEFECTS AFTER COMPLETION IN REPSECT OF BITUMINOUS WORKS.

The Agreement made this ……**……. day of ……**…….. Two Thousand eight between ……**……. son of ……**……. of M/S.……**……. (hereinafter called the Guarantor of the one part) and the DDA (hereinafter called the Government of the other part).

WHEREAS THIS agreement is supplementary to a contract (hereinafter called the Contract), dated ……..** and made between the GUARANTOR OF THE ONE part and the Government of the other part, whereby the Contractor, M/s _____, undertook to provide the Dense Bituminous Macadam and Dense Bituminous Concrete surfaces in the said contract recited completely crack-proof and impermeable without showing separation of construction joints and losing desired hardness.

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the said road surface will remain sound as per above noted undertaking for two years from the date of record of completion certificate for the work.

NOW THE GUARANTOR hereby guarantees that Dense Bituminous Macadam and Dense Bituminous Concrete work carried out by him will render the road surface completely crack proof and impermeable wearing course and shall be defect free for two years to be reckoned from the date of record of completion certificate for the work.

The decision of the Engineer-in-Charge with regard to cause of crack formation, permeability, loss of hardness, separation of construction joints shall be final.

During this period of guarantee, the guarantor shall make good all defects mentioned above by Re-Executing the Dense Bituminous Macadam and Dense Bituminous Concrete work after removing the defective layer over the affected area, as per specifications of agreement. Repairing of the existing defective surface shall not be allowed. In case of any defect being found, render the rectification as described above, to the satisfaction of the Engineer-in-Charge, at GUARANTER'S cost and he shall commence the work for such rectification within seven days from the date of issue of notice by the Engineer-in-Charge calling upon him to rectify the defects, failing which the work shall be got done by the DEPARTMENT through some other contractor at the GUARANTOR'S cost and risk. The decision of the Engineer-in-Charge as to the cost payable by the Guarantor shall be final and binding.

That if the Guarantor fails to execute Dense Bituminous Macadam and Dense Bituminous Concrete wearing course or commits breach there under, then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and / or damage and / or cost incurred by the DDA, the decision of the Engineer-in-Charge will be final and binding on the parties.

** *To be filled in by the Executive Engineer*.

IN WITNESS WHEREOF these presents have been executed by the Obligor ……** and ……** for and on behalf of the PRESIDENT OF INDIA on the day, month and year first above written.

Signed, sealed and delivered by Obligor in the presence of :

1.

2.

GUARANTOR

Signed for and on behalf of DDA by Executive Engineer (C) , Flyover Division-2/DDA, Seed Bed Park, Shakarpur, Delhi-110092.

1.

2.

EXECUTIVE ENGINEER

** *To be filled by the Executive Engineer*.

Annexure - M

GUARANTEE TO BE EXECUTED BY CONTRACTOR FOR REMOVAL OF DEFECTS AFTER COMPLETION IN RESPECT OF THERMOPLASTIC PAINT

The Agreement made this ……** day of …… **two thousand eight between ……** son of ……**of M/S……**(hereinafter called the Guarantor of the one part) and the DDA (hereinafter called the Government of the other part).

WHEREAS THIS agreement is supplementary to a contract (hereinafter called the contract), dated …….. **and made between the GUARANTOR OF THE ONE part and the DDA of the other part, whereby the contractor, M/s_____ undertook to render the road markings in the said contract recited completely conforming to quality specified in particular specifications of document .

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the said markings will remain intact for two years from the date of record of completion certificate for the work.

NOW THE GUARANTOR hereby guarantees that quality control and assurance at every step during the manufacturing of thermoplastic compound & its application on the road surface, stand guaranteed for a period of two years against any defect in the material or its application. Guarantee period of two years shall be reckoned from the date of record of completion certificate for the work. If any defect is found during the above-mentioned period, the same shall be redone by the contractor including the cost of material and labour without any extra cost to the department.

Provided that the Guarantor will not be responsible for damage caused by earthquake or structural defects or misuse of road or alteration and for such purpose:

Misuse of road shall mean any operation that will damage thermoplastic treatment, like chopping of firewood and things of the same nature that might cause damage to the paint.

The decision of the Engineer-in-Charge with regard to cause of damage shall be final.

During this period of guarantee, the guarantor shall make good all defects and in case of any defect being found render the road markings to the satisfaction of the Engineer-in-Charge at his cost and shall commence the work for such rectification within seven days from the date of issue of the notice from the Engineer-in-Charge calling upon him to rectify the defects failing which the work shall be got done by the department by some other contractor at the GUARANTOR'S cost and risk. The decision of the Engineer-in-Charge as to the cost, payable by the Guarantor shall be final and binding.

***** To be filled in by the Executive Engineer.***

That if the Guarantor fails to execute the thermoplastic road marking or commits breach thereunder, then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the Government the decision of the Engineer-in-Charge will be final and binding on the parties.

IN WITNESS WHEREOF these presents have been executed by the Obligor ……..**. and ……** for and on behalf of the DDA on the day, month and year first above written.

Signed, sealed and delivered by Obligor in the presence of --

1.

2.

GUARANTOR

Signed for and on behalf of the DDA by Executive Engineer (C), Flyover Division-2/DDA, Seed Bed Park, Shakarpur, Delhi-110092.

1.

2.

EXECUTIVE ENGINEER

** *To be filled in by the Executive Engineer*

Annexure - N

PROFORMA FOR CEMENT REGISTER

Particulars of receipt			Particulars of issue								Remarks	
Date of receipt	Quantity received	Progressive Total	Date of issue	Quantity issued	Item of work for which issued	Quantity returned at the end of the day	Total issued	Daily balance in hand	Contractor's initials	J.E'S initials	Astt. Engr's	E.E.'s
1	2	3	4	5	6	7	8	9	10	11	12	13

Annexure - P

Abbreviations

S.No.	Abbreviations	Full Form
1	%	Percentage
2	@	At the rate of
3	µ	Micron
4	AASHTO	American Association of State Highway and Transportation Officials.
5	AM	Ante Meridian
6	ASTM	American Society of Testing and Materials
7	BC	Bituminous Concrete
8	BH	Bore Hole
9	BIS	Bureau of Indian Standard
10	BM	Bituminous Macadam
11	BOQ	Bill of Quantities
12	BS	British Standard
13	C/o	Construction of
14	$CaCo_3$	Calcium Carbonate
15	CBR	California Bearing Ratio
16	cc	Cubic Centimeter
17	CC	Cement Concrete
18	CD	Compact Disk
19	CI	Cast Iron
20	cm	Centimeter
21	cm^3	Centimeter Cube
22	CPM	Critical Path Method
23	CPWD	Central Public Work Department

24	CRCA	Cold Rolled Closed Annealed
25	CRRI	Central Road Research Institute
26	cum	Cubic Meter
27	DBM	Dense Bituminous Macadam
28	DDA	Delhi Development Authority
29	DG	Diesel Generator
30	Dia	Diameter
31	DJB	Delhi Jal Board
32	DMRC	Delhi Metro Rail Corporation
33	DS	Drained Direct shear
34	DTH	Delhi Test House
35	DVB	Delhi Vidyut Board
36	eg.	For example
37	etc.	Etcetera
38	FIP	Federation International de la Pre-contrainte
39	FRC	Fiber Reinforced Concrete
40	Ft	Foot
41	GA	Ground Anchor
42	GAD	General Arrangement Drawing
43	GI	Galvanized Iron
44	gm	Gram
45	Govt.	Government
46	GSB	Granular Sub Base
47	HDPE	High Density Poly Ethylene
48	IITD	Indian Institute of Technology Delhi
49	IRC	Indian Roads Congress

50	IS	Indian Standard
51	km	Kilometer
52	kN	Kilo Newton
53	Lab	Laboratory
54	lb	Pound
55	M, m	Metre
56	MC	Medium Curing
57	MD&CE	Managing Director & Chief Executive
58	MDD	Maximum Dry Density
59	MgO	Magnesium Oxide
60	Min	Minimum
61	ml	Milliliter
62	mm	Millimetre
63	MN	Mega Newton
64	MORTH	Ministry of Road Transport & Highway
65	MOST	Ministry of Surface Transport
66	MPa	Mega Pascal
67	MS	Mild Steel
68	MT	Metric Tonne
69	N.A.	Not Applicable
70	NCCBM	National Council for Cement and Building Materials
71	NCT	National Capital Territory
72	NCTD	National Capital Territory of Delhi
73	No.	Number
74	O.M.	Office Memorandum
75	ºC	Degree Centigrade

76	OMC	Optimum Moisture Contend
77	OPC	Ordinary Portland Cement
78	PCC	Plain Cement Concrete
79	PERT	Program Evaluation and Review Technique
80	PI	Plasticity Index
81	PM	Post Meridian
82	Ps	Paisa
83	PSC	Portland Slag Cement, Pre-stressed Concrete
84	PVC	Poly Vinyl Chloride
85	PWD	Public Work Department
86	QA	Quality Assurance
87	QAM	Quality Assurance Manual
88	QAP	Quality Assurance Plan
89	Qty	Quantity
90	RA	Running Account
91	RCC	Reinforced Cement Concrete
92	Rebar	Reinforcement Bar
93	Rev	Revolution
94	RL	Reduced Level
95	RMC	Ready Mix Concrete, Reverse Mud Circulation
96	Rs.	Rupees
97	RTC	Regional Testing Centre
98	S	Sulphur
99	SH	Sub Head
100	SO_3	Sulphur Trioxide
101	SP	Special Publication

102	SPT	Standard Penetration Test
103	Sqm	Square Meter
104	SRI	Shri Ram Institute for Industrial Research
105	SS	Stainless Steel
106	SSI	Sub Surface Investigation
107	SW	Storm Water
108	SWG	Standard Wire Gauge
109	T&P	Tools and Plants
110	T, t	Tonne
111	TMT	Thermo Mechanically Treated
112	UC	Unconfined Compression
113	UP	Bridge
114	UUT	Unconsolidated Undrained Triaxial
115	VFB	Voids filled with Bitumen
116	VMA	Voids in Mineral Aggregates
117	WC	Wearing Course
118	WMM	Wet Mix Macadam

Annexure - R

FORM OF EARNEST MONEY/ BANK GUARANTEE BOND

In consideration of the DDA (hereinafter called " the Government") having agreed under the terms and conditions of agreement No _____ dated _____ made between _____ and _____{ hereinafter called " the said contractor (s)"} for the _____

_____

(hereinafter called " the said agreement") having agreed to production of an irrevocable Bank Guarantee for Rs. _____ (Rupees _____ only) as a security / guarantee from the contractors (s) for compliance of his accordance with the terms and conditions in the said agreement.

We _____

(indicate the name of the bank)

hereinafter referred to as "the Bank") hereby undertake to pay to the government an amount not exceeding Rs. _____ /- (Rupees _____ only) on demand by the government.

We _____ do hereby undertake to

(indicate the name of the Bank

pay the amounts due and payable under this Guarantee without any demure, merely on a demand from the DDA stating that the amount claimed is required to meet the recoveries due or likely to be due from the said contractor (s). Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the bank under this Guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____ /- (Rupees _____ only).

We, the said bank further undertake to pay to the DDA any money so demanded notwithstanding any dispute or disputes raised by the contractor(s) in any suit or proceeding pending before any court or Tribunal relating thereto, our liability under this present being absolute and unequivocal.

The payment so made by us under this bond shall be a valid discharge of our liability for payment thereunder and the contractor(s) shall have no claim against us for making such payment.

We _____ _____ further agree that the guarantee

(indicate the name of the Bank)

herein contained shall remain in full force and effect during the period that would be taken for the performance of the said agreement and that it shall continue to be enforceable till all the dues of the DDA under or by virtue of the said agreement have been fully paid and its claims satisfied or discharged or till Engineer-in-Charge, on behalf of the DDA, certifies that the terms and conditions of the said agreement have been fully and properly carried our by the said contractor(s) accordingly discharges this guarantee.

We_____ _____ further agree with the DDA

(indicate the name of the Bank)

that the DDA shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to very any of the terms and conditions of the said agreement or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the DDA against the said contractor(s) and to forbear or enforce any of the terms and conditions relating to the said agreement and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said contractor(s) or for any forbearance, act of omission on the part of the DDA or any indulgence by the DDA to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would, but for this provision, have effect of so relieving us.

6. This guarantee will not be discharged due to the change in the constitution of the Bank or

the contractor(s).

We _____ lastly undertake not to

(indicate the name of bank)

revoke this guarantee except with the previous consent of the DDA in writing.

This guarantee shall be valid upto _____ unless extended on demand by DDA. Notwithstanding anything mentioned above, our liability against this Guarantee is restricted to Rs. _____/-(Rupees _____ only) and unless a claim in writing is lodges with us within six months of the date of expiry or the extended date of this guarantee, all our liabilities under this guarantee shall stand discharged.

Dated the _____ day of _____

For _____

(indicate the name of the Bank)

Annexure - S

CUSTOMER NAME :

ADDRESS :

NAME OF WORK :

EFFECTIVE DATE :

WARRANTY

This warranty is in effect on _____ High Intensity Retro Reflective Sheeting for the Agreement number stated above.

M/s _____warrants to Executive Engineer, DDA, Delhi,

(Name of Sheeting manufacture)

an agency engaged in purchasing signs from a 'Qualified Sign Converter' that

_____High Intensity Retro Reflective Sheeting

(Brand name of Sheet)

used in the fabrication of signs will remain effective for its intended used and meet the stated minimum 80% & 75% of the original retro-reflective values (given below) at the end of 3 and 7 years respectively.

Table for Minimum co-efficient of Retro-reflection.

(Candelas per Lux per Square Metre)

Observation angle	Entrance angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1^0	-4^0	400	270	160	56	56	32	12
0.1^0	$+30^0$	120	75	48	13	13	7	3.0
0.2^0	-4^0	250	170	100	35	35	20	7.0

0.2^0	$+30^0$	80	54	34	9	9	5	2.0
0.5^0	-4^0	135	100	64	17	17	10	4.0
0.5^0	$+30^0$	55	37	22	6.5	6.5	3.5	1.4

All measurements shall be made after cleaning the retro reflective surface with soap and water in dry condition.

For Screen printed transparent areas on white sheeting, the coefficients of retro-reflection shall not be less than 50% of the values for coloured sheeting as given in the above table.

If_____High Intensity Retro-reflective Sheeting.

(Brand name of Sheet)

Which has been processed and applied in accordance with the recommended procedures deteriorates within 7 years from the date of fabrication due to natural causes to the extent that:

The sign is ineffective for its intended purpose when viewed from moving vehicle under normal day and night driving conditions by a driver with normal vision, or

The coefficient of retro reflection is less than the minimum herein specified,

M/s_____ will furnish the necessary amount of

(Name of sheeting manufacture)

_____ High Intensity Retro Reflective Sheeting

(Brand name of Sheet)

to restore the surface to its original effectiveness. Such failure must be solely the result of defects in the _____ High Intensity Retro

(Brand name of Sheet)

Reflective Sheeting and not of outside causes such as improper fabrication, handling, maintenance or installation, failure of sign substrate, vandalism or malicious mischief. M/s _____ reserves the right to determine the method of replacement.

(Name of sheeting manufacture)

(Sheet Manufacture)

AUTHORISED SIGNATORY

Annexure - T

CUSTOMER NAME :

NAME OF WORK :

TENDER DUE ON :

CERTIFICATE FROM SHEET MANUFACTURE

This is to certify that _____High Intensity Retro Reflective Sheet

(Brand name of Sheet)

is to be supplied by M/s _____ to

(Name of sheeting manufacture)

M/s _____

for Retro Reflective Sign Boards as mentioned above

(Name of Indian Subsidiary)

conform to the provisions of ASTM-D-4956-01 Type-IV performance specifications. It is further certified that the Sheeting has been tested from the reputed laboratory in an unprotected outdoor exposure for three years and no significant change in the manufacturing process and in any ingredient after the initial development and obtaining the outdoor exposure test reports, have been made. I/We indemnify the Government against any losses arising out of inferior material so supplied and agree to replace the defective sheeting within seven years with no cost to the department.

(Sheet Manufacture)

AUTHORISED SIGNATORY