

SECTION-5 DETAIL SPECIFICATION

Item No.: - 03.

Construction of granular Sub base (Grading-I) by providing close graded material BTMC using metal 53 mm to 26.5 mm @ 27.5%, aggregate 26.5 mm to 9.5 mm @ 22.5% & 9.5 mm to 4.75 mm @ 10% and stone dust 4.75 mm & below @ 40% including spreading in uniform layers with motor grader on prepared surface mixing by mix in place method with front end loader at OMC and compacting with vibratory roller to achieve the desired density complete as per MORTH specification.

401 GRANULAR SUB-BASE

401.1. Scope

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

401.2. Materials

401.2.1. The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag, or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the gradings given in Table 400-1 and physical requirements given in Table 400-2. Gradings III and IV shall preferably be used in lower sub-base. Gradings V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

401.2.2 If the water absorption of the aggregates determined as per IS: 2386 (Part 3) is greater than 2 percent, the aggregates shall be tested for Wet Aggregate Impact Value (AIV) (IS: 5640). Soft aggregates like Kankar, brick ballast and laterite shall also be tested for Wet AIV (IS: 5640).

Table 400-1: Grading for Granular Sub-base Materials

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	-	-	35-65	55-75
4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	-	-	10-20	10-25
0.85 mm	-	-	-	-	2-10	-
0.425 mm	10-15	10-15	-	-	0-5,	0-8
0.075 mm	<5	<5	<5	<5	-	0-3

Table 400-2: Physical Requirements for Materials for Granular Sub-base

Aggregate Impact Value (AIV)	IS: 2386 (Part 4) or IS: 5640	40 maximum
Liquid Limit	IS: 2720 (Part 5)	Maximum 25
Plasticity Index	IS: 2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS: 2720-Part 8)	IS: 2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

401.3 Construction Operations**401.3.1. Preparation of sub-grade**

Immediately prior to the laying of sub-base, the sub grade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 KN smooth wheeled roller.

401.3.2 Spreading and compacting

The sub-base material of the grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS: 2720 (Part 8). The mix shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer.

Moisture content of the mix shall be checked in accordance with IS: 2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 percent below the optimum moisture content.

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer up to 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall or on super elevation. For carriageway having cross fall on both sides, rolling shall commence at the edges and progress towards the crown.

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

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

401.4 Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

401.5 Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 112.

401.6. Measurements for Payment

Granular sub-base shall be measured as finished work in position in cubic meters.

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

401.7 Rate

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for:

- (i) Making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) Furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
- (iii) All labour, tools, equipment, and incidentals to complete the work to the Specifications;
- (iv) Carrying out the work in pan widths of road where directed; and
- (v) Carrying out the required tests for quality control.

The payment will be made on cubic meter basis of the finished work.

Item No.: - 04.

Providing, laying, spreading and compacting 250 mm thick (2 layer of 125 mm) graded stone aggregate to Wet Mix Macadam (WMM) specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed material by tripper to site, laying in uniform layers with grader in sub base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density etc. complete as per MORT&H Specification.

406 WET MIX MACADAM SUB-BASE/BASE

406.1 Scope: This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub grade / sub-base / base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200 mm upon approval of the Engineer.

406.2 Materials

406.2.1 Aggregates**406.2.1.1 Physical requirements**

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel / shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-12 below.

If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part-5).

Table 400-12: Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-base/Base Courses

	Test	Test Method	Requirements
1)	Los Angeles Abrasion value or Aggregate Impact value	IS: 2386 (PART-4)	40 percent (Max)
		IS: 2386 (PART-4) or IS: 5640	30 percent (Max)
2.	Combined Flakiness and Elongation indices (Total)	IS: 2386 (PART-I)	30 percent (Max)*

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

406.2.1.2 Grading requirements

The aggregates shall conform to the grading given in Table 400-13.

Table 400-13: Grading Requirements of Aggregates for Wet Mix Macadam

IS Sieve Designation	Percent by weight passing the IS Sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	—
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-5

Material finer than 425-micron shall have Plasticity Index (PI) not exceeding 6.

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

406.3 Construction Operations**406.3.1 Preparation of base**

Clause 404.3.1 shall apply.

406.3.2 Provision of Lateral Confinement of Aggregates

While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 404.3.3.

406.3.3 Preparation of mix

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced / positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. The plant shall have following features:

- i) For feeding aggregates- three / four bin feeders with variable speed motor
- ii) Vibrating screen for removal of oversize aggregates
- iii) Conveyor Belt
- iv) Controlled system for addition of water
- v) Forced / positive mixing arrangement like pug-mill or pan type mixer
- vi) Centralized control panel for sequential operation of various devices and precise process control
- vii) Safety devices

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

406.3.4 Spreading of Mix

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

The mix may be spread by a paver finisher. The paver finisher shall be self-propelled of adequate capacity with following features:

- i) Loading hoppers and suitable distribution system, so as to provide a smooth uninterrupted material flow for different layer thicknesses from the tipper to the screed.
- ii) Hydraulically operated telescopic screed for paving width up to 8.5 m and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.
- iii) Automatic levelling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure.

In exceptional cases where it is not possible for the paver to be utilized, mechanical means like motor grader may be used with the prior approval of the Engineer. The motor grader shall be capable of spreading the material uniformly all over the surface.

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

The Engineer may permit manual mixing and /or laying of wet mix macadam where small quantity of wet mix macadam is to be executed. Manual mixing/laying in inaccessible/ remote locations and in situations where use of machinery is not feasible can also be permitted. Where manual mixing / laying is intended to be used, the same shall be done with the approval of the Engineer.

406.3.5 Compaction

After the mix has been laid to the required thickness, grade, and crossfall / camber the same shall be uniformly compacted to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN with an arrangement for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h.

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

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

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerb, walls, or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the sub-grade is soft or yielding or when it causes a wave- like motion in the sub-base/base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case shall the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

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

406.3.6 Setting and Drying

After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

406.4 Opening to Traffic

No vehicular traffic shall be allowed on the finished wet mix macadam surface. Construction equipment may be allowed with the approval of the Engineer.

406.5 Surface Finish and Quality Control of Work

406.5.1 Surface Evenness

The surface finish of construction shall conform to the requirements of Clause 902.

406.5.2 Quality Control

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

406.6 Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, re-shaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompacted in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

406.7 Arrangement for Traffic

During the period of construction, arrangements for traffic shall be done as per Clause 112.

406.8 Measurements for Payment

Wet mix macadam shall be measured as finished work in position in cubic meters.

406.9 Rate

The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.7.

The payment will be made on cubic meter basis of the finished work.

Item No.: - 05.

Providing & laying Priming coat with emulsion SS-1 grade and spraying emulsion with spray set fitted on mechanical bouzer using emulsion at the rate of 7.5 KG / 10 Sqm on WMM surface including cleaning the surface etc. complete.

502 PRIME COAT OVER GRANULAR BASE**502.1 Scope**

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix. The work shall be carried out on a previously prepared granular / stabilized surface to Clause 501.8.

502.2 Materials

502.2.1 The primer shall be cationic bitumen emulsion SS1 grade conforming to IS: 8887 or medium curing cutback bitumen conforming to IS: 217 or as specified in the Contract.

502.2.2 Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as given in Table 500-3.

Table 500-3: Quantity of Bitumen Emulsion for Various Types of Granular Surfaces

Type of Surface	Rate of Spray (Kg / Sqm)
WMM / WBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9-1.2

502.2.3 Cutback for primer shall not be prepared at the site. Type and quantity of cutback bitumen for various types of granular surface shall be as given in Table 500-4.

Table 500-4: Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (Kg / Sqm)
WMM / WBM	MC 30	0.6-0.9
Stabilized soil bases / Crusher Run Macadam	MC 70	0.9-1.2

502.2.4 The correct quantity of primer shall be decided by the Engineer and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10 mm.

502.3 Weather and Seasonal Limitations

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 100 C. Cutback bitumen as primer shall not be applied to a wet surface. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water.

502.4 Construction**502.4.1 Equipment**

The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small areas,

inaccessible to the distributor, or in narrow strips shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

502.4.2 Preparation of road surface

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil / murrum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

502.4.3 Application of bituminous primer

After preparation of the road surface as per Clause 502.4.2, the primer shall be sprayed uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively though the jets of the spray and to cover the surface uniformly.

502.4.4 Curing of primer and opening to traffic

A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

502.5 Quality Control of Work

For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

502.6 Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

502.7 Measurement for Payment

Prime coat shall be measured in terms of surface area of application in square meters.

502.8 Rate

The contract unit rate for prime coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.7 (i) to (v) and as applicable to the work specified in these specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of quantity at 0.6 kg per square meter or at the rate specified in the Contract, with adjustment, plus or minus, for the variation between this quantity and the actual quantity approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.

The payment will be made on square meter basis of the finished work.

Item No.: - 06.

Providing and laying 20 mm thick Mix seal surface with B.T. aggregate as per MORT&H gradation and specification with asphalt of Grade VG-30 at the rate of 5.09% i.e. 50.9 KG / M.T. by weight of total mix of asphalt for tack coat at 2.5 KG / 10 Sqm including heating & mixing in continuous batch mix plant, transporting the mix spreading the same by sensor paver finisher and consolidation by vibratory roller as per MORT&H specification including cost of all materials fuel, labours, tools and plant etc. using contractor's own machineries, batch mix plant and sensor paver finisher etc. complete.

508 CLOSE-GRADED PREMIX SURFACING / MIXED SEAL SURFACING**508.1 Scope**

508.1.1 This work shall consist of the preparation, laying and compaction of a close-graded premix surfacing material of 20 mm thickness composed of graded aggregates premixed with a bituminous binder on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course.

508.1.2 Close graded premix surfacing shall be of Type A or Type B as specified in the Contract documents. Type A grading is recommended for use in areas having rainfall more than 150 cm per year. In other areas Type B grading may be used.

508.2 Materials

508.2.1 Binder The provisions of Clause 510.1.2.1 shall apply.

508.2.2 Coarse aggregates: The provisions of Clause 510.1.2.2 shall apply.

508.2.3 Fine aggregates: The fine aggregates shall consist of crushed rock, or natural sand or a mixture of both. These shall be clean, hard, durable, un-coated, mineral particles, dry; and free from injurious, soft or flaky particles and organic or deleterious substances.

508.2.4 Aggregate gradation

The coarse and fine aggregates shall be so graded or combined as to conform to one or the other gradings given in Table 500-19, as specified in the contract.

Table 500-19: Aggregate Gradation

IS Sieve Designation (mm)	Cumulative percent by weight of total aggregate passing	
	Type A	Type B
13.2 mm	-	100
11.2 mm	100	88 – 100
5.6 mm	52 – 88	31 – 52
2.8 mm	14 – 38	5 – 25
0.090 mm	0 – 5	0 – 5

508.2.5 Proportioning of materials

The total quantity of aggregates used for Type A or B close-graded premix surfacing shall be 0.27 cubic meter per square meter area. The quantity of binder used for premixing shall be 22.0 kg and 19.0 kg per 10 square meter area for Type A and Type B surfacing respectively.

508.3 Construction Operations: The provisions of Clause 510.1.3.1 through 510.1.3.5 shall apply.

508.4 Opening to Traffic: Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. Speed restrictions may be imposed at initial stages.

508.5 Surface Finish and Quality Control of Work: The surface finish of construction shall conform to the requirements of Clause 902. For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

508.6 Arrangements for Traffic: During the period of construction, arrangements for traffic shall be in accordance with the provisions of Clause 112.

508.7 Measurements for Payment: Close-graded premix surfacing, Type A or B shall be measured as finished work, for the area specified to be covered, in square meters at a specified thickness. The area will be the net area covered.

508.8 Rate: The contract unit rate for close-graded premix surfacing, Type A or B shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.8.2.

The payment will be made on M.T. basis of the finished work.

Item No.: - 07.

Providing and laying Glass fibre Geogrid with Non-Woven Geotextile having tensile strength of 50 kN/m, tack coat with bitumen grade VG-40 and spraying with spray set filled on mechanical sprayer using bitumen at the rate of 5.0 kg / 10 Sqm on surface, including cleaning the surface etc. complete as per instruction of Engineer in charge.

1.0 General

This work comprises supply of Glass Fibre Grid conforming to the material specifications stated herein.

This work shall consist of furnishing and placing Glass Fibre Grid as a full width or strip interlayer over existing pavement prior to placement of an asphalt concrete overlay, in accordance with these specifications.

2.0 Materials

2.1 General Requirements

The Glass Fibre Grid shall be processed in to a grid structure through sophisticated machineries like "weft insertion warp knitted" type (woven glass fibre geogrid or any other type of manufacturing the product will not be acceptable) to maintain virgin fibre quality and the designed mesh size and coated online with a specially formulated polymer modified bitumen emulsion for good compatibility with asphalt overlay.

Glass Fibre Grid shall meet all the relevant requirements as per the test procedure given in ASTM. The physical parameters shall confirm to the values given in Table 1.

Indigenously manufactured Glass Fibre Grid shall be having 2.5 / 5.0-meter width

2.2 Transportation & Storage

Material shall be protected from sunlight, mud, dirt, debris, any other harmful substances or mechanical damage during transportation.

Rolls shall be stored in a secured area sufficiently elevated above the ground and adequately covered to protect them from the site construction damage, precipitation, prolonged exposure to ultraviolet

radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, high temperatures, and any other environmental conditions that may damage the physical property values of the material.

Any material, which is damaged during transportation, handling or storage and do not meet the minimum requirements of the specifications is liable for rejection by the Engineer-in-charge.

2.3 Quality Control & testing

The quality management system of the manufacturer shall conform to the requirements of ISO 9001:2008 and In-house Laboratory should have certificate of NABL Accreditation ISO/IEC 17025:2005.

Manufacturer shall issue a test report stating minimum average roll values of material properties, at the time of shipment is made.

CE-certification (BTTG certification) should be required for supply of material.

Manufacturer shall submit the proof of supply and satisfactory performance for the quantity of 10000 Sqm at least, for projects in India.

Contractor shall furnish proof of all above and it is mandatory.

2.4 Properties of Glass Fibre Grid

The properties of Glass Fibre Grid shall conform to Table-1 below:

Table-1

Properties		Test Method	Unit	Glass Fibre Grid		
Mechanical Properties				Type-50	Type-100	Type 100/200
Ultimate Tensile Strength ¹	MD	ASTM D 6637	Kn/m	50	100	100
Ultimate Tensile Strength ¹	CD			50	100	200
Elongation at Break	MD		%	Max. 5	Max. 5	Max. 5
Elongation at Break	CD			Max. 5	Max. 5	Max. 5
Glass Filament Pitch		-	mm	25 x 25	12.5 x 12.5	12.5 x 12.5
Melting Point		ASTM D 276	°C	>218	>218	>218
Mass Per Unit Area		ASTM D 5261	gsm	Min. 185	Min. 370	Min. 550
Form of Supply						
Roll Width		-	Mtr	2.5 / 5	2.5 / 5	2.5 / 5
Roll Length		-	Mtr	50 / 100	50 / 100	50 / 100

Minimum Average Roll value, Minimum Refers to 95 % confidence limit, MD-Machine Direction, CD-Cross Direction

3 Installation:

3.1 Site Preparation

Prior to the placing of the Glass Fibre Grid; Pot-holes shall be repaired properly and all cracks wider than 3 mm shall be filled with suitable crack filler; the pavement surface shall be reasonably clean and dry.

All repair work shall be carried out as per current regulating standards to ensure a uniform level surface.

Existing Rigid pavement shall be leveled by using a fine road miller and or a leveling course shall be applied on it.

Tack coat shall be applied at the rate of minimum 0.5 kg / sqm or as stated in MORTH, which should be sufficient to saturate the fabric and ensure proper bond between existing pavement, Glass Fibre Grid and the overlay.

3.2 Laying of Grid

The Glass Fibre Grid shall be installed smoothly by manual or mechanical means without wrinkles or folds before the tack coat has cooled and lost its tackiness on the prepared leveled surface.

Application of a small pressure through a pneumatic roller to ensure proper adhesion between the Glass Fibre Grid and the leveling course and to keep the Glass Fibre Grid under tension and free of ripples.

Proper contact and bond should be ensured between Glass Fibre Grid and the pavement surface.

Adjacent rolls shall be overlapped as shown on the drawings. Unless otherwise shown on the drawings or directed by the Engineer-in-charge, the minimum overlap shall be 300 mm on longitudinal and transverse directions. All laps must be fixed by manual tack coat.

On curves, the Glass Fibre Grid may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, etc.

Placement of overlay should closely follow immediate after Glass Fibre Grid laydown.

Prior to placing overlay, the installed Glass Fibre Grid shall be inspected and approved by the Engineer in Charge. Any damages shall be repaired by covering the damaged location with a AIC Geo-Composite patch with additional tack coat, which extends an amount equal to the required overlap beyond the damaged area, as directed by the Engineer-in-charge.

Movement of construction equipment directly over the Glass Fibre Grid shall not be permitted.

Sudden breaking and sharp turning of construction equipment shall be avoided over the Glass Fibre Grid.

4.0 Measurements for Payment

Glass Fibre Grid will be measured by the square meter unit.

Payment for the supply of Glass Fibre Grid shall be made at the contract unit price per square meter, which shall be full compensation for the cost of materials, transportation, duties and taxes.

The payment will be made on square meter basis of the finished work.

Item No.: - 08.

Providing and laying 50 mm thick compacted D.B.M. with B.T. stone aggregates as per MORT&H gradation & specification with bitumen VG-30 for mixing at the rate of 45.00 KG / M.T. by weight of total mix i.e. (4.5% by weight of total mix) & for tack coat at 2.5 KG / 10 Sqm including heating the asphalt & aggregates by continuous batch mix plant & spreading the same by sensor paver finisher including rolling & consolidation with 10-12 tones vibratory and power roller & providing all materials, equipments, tools & plants, fire wood, oil, kerosene, labour charges etc. and using contractor's own machineries, batch mix plant and sensor paver finisher etc. complete.

505 DENSE GRADED BITUMINOUS MACADAM**505.1 Scope**

The specification describes the design and construction procedure for Dense Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base / binder and profile corrective courses. The work shall consist of construction in a single or multiple layer of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

505.2 Materials

505.2.1 Bitumen: The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS: 73, modified bitumen complying with Clause 501.2.1 or as otherwise specified in the Contract.

The type and grade of bitumen to be used shall be specified in the Contract.

505.2.2 Coarse aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor's selected source of aggregates has poor affinity for bitumen, the Contractor shall produce test results that with the use of anti-stripping agents, the stripping value is improved to satisfy the specification requirements. The Engineer may approve such a source and as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer's recommendations, at the cost of the Contractor. The aggregates shall satisfy the requirements specified in Table 500-8.

Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

505.2.3 Fine aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm sieve and retained on the 75-micron sieve. These shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand up to 50 percent of the fine aggregate may be allowed in base courses. 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).

505.2.4 Filler

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The filler shall be graded within the limits indicated in Table 500-9.

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly

505.2.5 Aggregate grading and binder content

505.2.5.1 When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 500-10 for grading 1 or 2 as specified in the Contract. To avoid gap grading, the combined aggregate gradation shall not vary from the lower limit on one sieve to higher limit on the adjacent sieve.

Table 500-8: Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS: 2386 Part IV
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS: 2386 Part V
Water Absorption	Water Absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS: 6241
Water Sensitivity	Retained Tensile Strength**	Min 80%	AASHTO 283

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

** If the minimum retained tensile test strength falls below 80 percent, use of anti-stripping agent is recommended to meet the requirement.

Table 500-9: Grading Requirements for Mineral Filler

IS sieve (mm)	Cumulative Percent Passing by Weight of Total Aggregate
0.6	100
0.3	95 – 100
0.075	85 – 100

Table 500-10: Composition of Dense Graded Bituminous Macadam

Grading	1	2
Nominal aggregate size*	37.5 mm	19 mm
Layer thickness	75 - 100 mm	50-75 mm
IS Sieve ¹ (mm)	Cumulative % by weight of total aggregate passing	

45	100	
37.5	95 – 100	100
26.5	63 – 93	90 – 100
19	–	71 – 95
13.2	55 – 75	56 – 80
9.5	–	–
4.75	38 – 54	38 – 54
2.36	28 – 42	28 – 42
1.18	–	–
0.6	–	–
0.3	7 – 21	7 – 21
0.15	–	–
0.075	2 – 8	2 – 8
Bitumen content % by mass of total mix	Min 4.0**	Min 4.5 **

* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30° C or lower and lowest daily air temperature is - 10° C or lower, the bitumen content may be increased by 0.5 percent.

505.2.5.2 Bitumen content indicated in Table 500-10 is the minimum quantity. The quantity shall be determined in accordance with Clause 505.3.

505.3 Mix Design: The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.

The Fines to Bitumen (F/B) ratio by weight of total mix shall range from 0.6 to 1.2.

505.3.1 Requirements for the Mix

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-11.

Table 500-11: Requirements for Dense Graded Bituminous Macadam

Properties	Viscosity Grade Paving Bitumen	Modified bitumen		Test Method
		Hot climate	Cold climate	
Compaction level	75 blows on each face of the specimen			
Minimum stability (kN at 600 C)	9.0	12.0	10.0	AASHTO T 245
Marshall flow (mm)	2 –	2.5 – 4	3.5 – 5	AASHTO T 245
Marshall Quotient (<u>Stability</u> Flow)	2 – 5	2.5 – 5		MS-2 and ASTM 02041
% air voids	3 – 5			

% Voids Filled with Bitumen (VFB)	65 – 75	
Coating of aggregate particle	95% minimum	IS: 6241
Tensile Strength ratio	80% Minimum	AASHTO T 283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA) are set out in Table 500-13	

505.3.2 Binder content

The binder content shall be optimized to achieve the requirements of the mix set out in Table 500-11. The binder content shall be selected to obtain 4 percent air voids in the mix design. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diameter specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in Table 500-12 shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

Table 500-12: Minimum Percent Voids in Mineral Aggregate (VMA)

Nominal Maximum Particle Size ¹ (mm)	Minimum VMA Percent Related to Design Percentage Air voids		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.	11.0	12.0

Note: Interpolate minimum voids in the mineral aggregate (VMA) for designed percentage air voids values between those listed

505.3.3 Job mix formula

The Contractor shall inform the Engineer in writing, at least 21 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details:

- (i) Source and location of all materials;
- (ii) Proportions of all materials expressed as follows:
 - (a) Binder type, and percentage by weight of total mix;
 - (b) Coarse aggregate / Fine aggregate / Mineral filler as percentage by weight of total aggregate including mineral filler;
- (iii) A single definite percentage passing each sieve for the mixed aggregate;
- (iv) The individual gradings of the individual aggregate fractions, and the proportion of each in the combined grading;
- (v) The results of mix design such as maximum specific gravity of loose mix (G_{mm}), compacted specimen densities, Marshall stability, flow, air voids, VMA, VFB and related graphs and test results of AASHTO T 283 Moisture susceptibility test;
- (vi) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch;
- (vii) Test results of physical characteristics of aggregates to be used;
- (viii) Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the Engineer for approval before the placing of the material.

505.3.4 Plant trials - permissible variation in job mix formula

Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500- 13. These variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900.

Table 500-13: Permissible Variations in the Actual Mix from the Job Mix Formula

Description	Base / binder Course
Aggregate passing 19 mm sieve or larger	± 8%
Aggregate passing 13.2 mm, 9.5 mm	± 7%
Aggregate passing 4.75 mm	± 6%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 5%
Aggregate passing 0.3 mm, 0.15 mm	± 4%
Aggregate passing 0.075 mm	± 2%
Binder content	± 0.3%
Mixing temperature	± 10° C

505.3.5 Laying Trials

Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid and compacted all in accordance with Clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works. The area of the laying trials shall be a minimum of 100 sqm of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method. The compacted layers of Dense Graded Bituminous Macadam (DBM) shall have a minimum field density equal to or more than 92% of the density based on theoretical maximum specific gravity (G_{mm}) obtained on the day of compaction in accordance with ASTM D 2041.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

505.4 Construction Operations

505.4.1 Weather and seasonal limitations: The provisions of Clause 501.5.1 shall apply.

505.4.2 Preparation of base

The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer.

505.4.3 Geosynthetics

Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in Clause 703

505.4.4 Stress absorbing layer

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

505.4.5 Prime coat

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502, or as directed by the Engineer.

505.4.6 Tack coat

Where the material on which the dense bituminous macadam is to be placed is bitumen bound surface, a tack coat shall be applied as specified, in accordance with the provisions of Clause 503, or as directed by the Engineer.

505.4.7 Mixing and transportation of the mixture

The provisions as specified in Clauses 501.3 and 501.4 shall apply. Table 500-2 gives the mixing, laying and rolling temperature for dense mixes using viscosity grade bitumen. In case of modified bitumen, the temperature of mixing and compaction shall be higher than the mix with viscosity grade bitumen. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per the recommendations of the manufacturer. In order to have uniform quality, the plant shall be calibrated from time to time.

505.4.8 Spreading: The provisions of Clauses 501.5.3 and 501.5.4 shall apply.

505.4.9 Rolling

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

505.5 Opening to Traffic

It shall be ensured that the traffic is not allowed without the approval of the Engineer in writing, on the surface until the dense bituminous layer has cooled to the ambient temperature.

505.6 Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of this Specification.

505.7 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

505.8 Measurement for Payment

Dense Graded Bituminous Materials shall be measured as finished work either in cubic meters, tonnes or by the square meter at a specified thickness as indicated in the Contract drawings, or documents, or as otherwise directed by the Engineer.

505.9 Rate

The contract unit rate for Dense Graded Bituminous Macadam shall be payment in full for carrying out all the required operations as specified and shall include, to all components listed in Clause 501.8.8.2. The rate shall include the provision of bitumen, at 4 percent and 4.5 percent by weight of the total mixture for grading 1 and grading 2 respectively. The variation in actual percentage of bitumen used shall be assessed and the payment adjusted plus or minus accordingly.

The payment will be made on M.T. basis of the finished work.

Item No.: - 09.

Providing and laying 30 mm thick Bituminous Concrete using B.T. aggregate as per MORT&H specification & Bitumen grade VG-30 for mixing at 55.00 KG / M.T. i.e. 5.5% by weight of total mix & for tack coat at 2.5 KG / 10 Sqm including heating the aggregate and asphalt by continuous batch mix plant and spreading the same by sensor paver finisher and consolidation with Pneumatic Roller and power roller including providing all materials equipment, tools and plants, oil, kerosene, firewood, labour charges etc. complete using contractor's own machineries, batch mix plant and sensor paver finisher etc. complete.

507 BITUMINOUS CONCRETE

507.1 Scope

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 30 mm / 40 mm / 50 mm thick.

507.2 Materials

507.2.1 Bitumen

The bitumen shall conform to Clause 504.2.1.

507.2.2 Coarse Aggregates

The coarse aggregates shall be generally as specified in Clause 504.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-16 and where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table 500-16: Physical Requirements for Coarse Aggregate for Bituminous Concrete

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices	Max 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 30% Max 24%	IS: 2386 Part IV

Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS: 2386 Part V
Polishing	Polished stone value	Min 55	Bs: 812-114
Water Absorption	Water Absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS: 6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

** If the minimum retained tensile test strength falls below 80 percent, use of anti-stripping agent is recommended to meet the requirement.

507.2.3 Fine Aggregates

The fine aggregates shall be all as specified in Clause 505.2.3.

507.2.4 Filler

Filler shall be as specified in Clause 505.2.4.

507.2.5 Aggregate Grading and Binder Content

When tested in accordance with IS: 2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and filler shall fall within the limits shown in Table 500-17. The grading shall be as specified in the Contract.

Table 500-17: Composition of Bituminous Concrete Pavement Layers

Grading	1	2
Nominal aggregate size*	19 mm	13.2 mm
Layer thickness	50 mm	30 – 40 mm
IS Sieve ¹ (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5	100	
19	90 – 100	100
13.2	59 – 79	90 – 100
9.5	52 – 72	70 – 88
4.75	35 – 55	53 – 71
2.36	28 – 44	42 – 58
1.18	20 – 34	34 – 48
0.6	15 – 27	26 – 38
0.3	10 – 20	18 – 28
0.15	5 – 13	12 – 20
0.075	2 – 8	4 – 10
Bitumen content % by mass of total mix	Min 5.2*	Min 5.4 **

Notes:

- * The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

- ** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30° C or lower and lowest daily air temperature is - 10° C or lower, the bitumen content may be increased by 0.5 percent.

507.3 Mix Design

507.3.1 Requirements for the Mix

Clause 505.3.1 shall apply.

507.3.2 Binder Content

Clause 505.3.2 shall apply.

507.3.3 Job Mix Formula

Clause 505.3.3 shall apply.

507.3.4 Plant Trials - Permissible Variation in Job Mix Formula

The requirements for plant trials shall be as specified in Clause 505.3.4, and permissible limits for variation as given in Table 500-18.

Table 500-18: Permissible Variations in Plant Mix from the Job Mix Formula

Description	Permissible Variation
Aggregate passing 19 mm sieve or larger	± 7%
Aggregate passing 13.2 mm, 9.5 mm	± 6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 4%
Aggregate passing 0.3 mm, 0.15 mm	± 3%
Aggregate passing 0.075 mm	± 1.5%
Binder content	± 0.3%
Mixing temperature	± 10° C

507.3.5 Laying Trials

The requirements for laying trials shall be as specified in Clause 505.3.5. The compacted layers of bituminous concrete (BC) shall have a minimum field density equal to or more than 92 percent of the average theoretical maximum specific gravity (G_{mm}) obtained on the day of compaction in accordance with ASTM 02041.

507.4 Construction Operations

507.4.1 Weather and seasonal limitations: The provisions of Clause 501.5.1 shall apply.

507.4.2 Preparation of base

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

507.4.3 Geosynthetics

Where Geosynthetics are specified in the Contract, this shall be in accordance with the requirements stated in Clause 703.

507.4.4 Stress Absorbing Layer

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

507.4.5 Tack Coat

The provisions as specified in Clause 504.4.6 shall apply.

507.4.6 Mixing and Transportation of the Mix

The provisions as specified in Clauses 501.3, 501.4 and 504.4.7 shall apply.

507.4.7 Spreading

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

507.4.8 Rolling

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

507.5 Opening to Traffic

Provisions in Clause 504.5 shall apply.

507.6 Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of these Specifications.

507.7 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

507.8 Measurement for Payment

The measurement shall be as specified in Clause 505.8.

507.9 Rate

The contract unit rate shall be all as specified in Clause 504.9, except that the rate shall include the provision of bitumen at 5.2 percent & 5.4 percent for grading 1 and grading 2 by weight of total mix respectively. The variation in actual percentage of bitumen used will be assessed and the payment adjusted plus and minus accordingly.

The payment will be made on M.T. basis of the finished work.

Item No.: - 11.

Providing, laying, and compacting Quarry spall for Road side shoulders including spreading in uniform thickness, rolling with vibratory roller 80-100 kN static weight to proper grade and camber including watering etc. complete.

- 1.0 The quarry spalls shall be approved quarry as approved by the Executive Engineer prior to collection. Filling of boxes, shall not be allowed till the metal is broken to the specified site.
- 2.0 The quarry spall shall be as uniform in size as possible. The quarry spall shall be hard, tough, solid durable of black trap quarry of close texture, free from decay and weathering. The stone

shall be angular and roughly cubical in shape and round elongated or flaky materials shall be rejected. No sound or long rubble or angular chips smaller than specified size shall be allowed.

Grading for Quarry Spalls

IS Sieve Designation	Per cent by weight passing the IS sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	---	---
53.0 mm	-	100	---
26.5 mm	55-75	50-80	100
9.50 mm	-	-	-
4.75 mm	10-30	15-35	25-45
2.36 mm	-	-	-
0.425 mm	-	-	-
0.075 mm	< 10	< 10	< 10

Material passing through 425 micro sieves for all the three gradings when tested according to I.S. 2720 (Part-5) shall have liquid limit and plastic index not more than 25 and 6 respectively.

- 3.0 All unsound, weathered, or disintegrated stone obtained from the under-surface layer of the quarry or other layers of boulders shall be rejected.
- 4.0 Wherever any doubt as to whether above requirement is satisfied in whole or part of the collection it shall be got screened by the Contractor if so, ordered by the Executive Engineer, and for which no extra payment shall be claimed by the contractor
- 5.0 Any collection which does not fully satisfy the above requirements is liable to be rejected all together.
- 6.0 Regular stacks shall be made by the contractor on a fairly level ground. All the stack shall be marked by white wash immediately on being measured and recorded by the Engineer-in-charge.
- 7.0 The rate includes blasting the rock, if any, breaking the quarry spalls, stacking measuring in pharas etc. complete.
- 8.0 Stacks shall as per actual requirements and any materials in excess shall have to be transported by the contractor at the places directed by the Executive Engineer at the risk and cost of the contractor.
- 9.0 While stacking materials the depositing should commence at one end of the KM and carried continuously towards the other end unless the Executive Engineer shall direct otherwise and as a rule measurement shall be taken after metal for half kilometer or Km. has been fully collected. Any fraction of these distance shall not be measured up.
- 10.0 The measurements shall be recorded in on Cum. basis on level computing method after rolling and consolidation and shall be paid accordingly.

Spreading Quarry Spalls in Grade & Camber Complete.

1. The quarry spalls shall be only allowed to be spread after the written permission of the Executive Engineer is obtained.
2. The permission for spreading the metal shall be given by the Executive Engineer if
 - (i) The full quantity of a particular mile (kilometer) is completely collected.
 - (ii) The collection of metal-is also completed in the adjoining two miles (Kilometers)
 - (iii) The measurements are recorded in the Measurement book.

3. Quarry Spall shall if required, be screened, if containing rubbish dust, grass etc. it shall than be filled in basket & conveyed where required and spread evenly on the prepared surface be given twisting motion to the basket at the time of spreading. The surface shall then (15 m) by means of templates and strings as well as with camber boards and spirit level.
4. Between the straight length and curves and at the meeting points of the convex and concave portions of the reverse curves, the change in camber of the road, due to super elevations shall be made as well as with camber boards and spirit level.
5. At the time of spreading Quarry Spall a small quantity (about 4 to 5 percent) of metal as directed, shall be retained at the first instance. It shall be spread later 0:1 after partial consolidated as required to rectify the camber and to fill up the hollows if any. No extra amount shall be paid for this.
6. Measurements shall be paid as per the measurements of collection less the quantity remained to be spread and on cubic meter basis.
7. The rate includes the cost of screening the Quarry Spall if any spreading, sectioning, with template and adding reserved quota of metal, while / oiling is in progress for making good hollows and camber.
8. The surface shall be brought to the required camber which shall be checked at every 50 ft. (15 M) by means off templates of while the necessary of the in between shall tested by strings and corrected as required.
9. The centre line shall first be marked in the subgrade which is properly consolidated and has uniform camber and grade as required
10. The Quarry Spall shall be laid for a small length on 25 ft. (8 M.) and then the edge stones shall be laid.
11. Pegs shall be driven on either side of the road and joined with strings true and parallel with a distance between they equal to the width be laid with over metal Similarly.
12. The Q. S. shall be laid as close as possible to leave minimum possible interstices and voids.
13. Before roiling is allowed on soling the side berms shall be filled up to the top of the soling and at least 3'-0" (1 m.) on either side to prevent metal layer getting disturbed at times during rolling. The rate is inclusive of all the operations as stated above.
14. Immediately following the spreading of the coarse aggregates rolling shall be started with three wheeled power roller of 8 to 10 tone capacity or tandem roller or equivalent vibratory roller. The weight of the roller shall depend upon the type of the aggregate and be indicated by Engineer-in-charge.
15. Except on super elevated portions where the roiling shall proceed from inner edge to outer, rolling shall from the edges gradually progressing towards the centre. First the edge / edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half the width.
16. Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate a head of the roller is no longer visible. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub grade is soft or yielding or when it causes a wave like motion in the sub grade or sub base course.
17. The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding, or removing necessary amounts of

aggregate and re-rolling until the entire surface conform to desired camber and grade. In no case shall the base of screening be permitted to make up depression.

18. The blindage material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied the wheels of the rollers, if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids forms a wave ahead of the wheels of the moving roller.
19. After the final compaction of water bound macadam course, the road shall be allowed to any overnight Next morning hungry spots shall be filled with screenings of binding materials as directed lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer-in-charge shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion, it would cause excessive damage to the surface.

Mode of Measurements for Payment:

Measurements shall be paid as per the measurements of collection less the quantity remained to be spread and on cubic meter basis.

The rate includes the cost of screening the quarry spall if any spreading, sectioning, with template and adding reserved quota of metal, while/oiling is in progress for making good hollows and camber.

The payment will be made on cubic meter basis of the finished work.

Item No.: - 17.

Providing and fixing Direction (Junction) sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 244 x 122 cms rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 4.0 mtr long (2 Nos) stand post of 75 x 75 x 6 mm / 65NB Circular MS pipe as required and frame fabricated from suitable size iron angle of 50 x 50 x 5 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per the instruction of Engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cms for each leg, including excavation, curing etc. complete under the supervision of Engineer in charge. A warranty for 10-years for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

Detailed Technical Specifications for Sign Board

1. Material & Manufacturing:

1.1 Scope

The work shall consist of fabrication, supply, and installation of ground mounted traffic signs on roads. The details of the signs shall be as shown in the drawings and in conformity with the code of practice for Road signs, IRC 67-2012.

1.2 Materials

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

1.2.1 Concrete:

Concrete for the foundation shall be of M-15 Grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.2 Reinforcing Steel: Reinforcing steel shall conform to the requirements of IS: 1786 unless otherwise shown on the drawings

1.2.3 Bolts, Nuts and Washers: High strength Bolts shall conform to IS: 1367 whereas precision bolts, nuts, etc. shall conform to IS: 1364

1.2.4 Plates and Supports

Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2052 or any other relevant IS specifications.

1.2.5 Substrate

Sign panel shall be fabricated on Aluminum sheet, aluminum composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistance aluminum alloy conforming to IS: 735 Material Designation 24345 or 1900. Aluminum composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low-Density Polyethylene (LDPE) between two thick skins/sheets of aluminum with overall thickness of 3 mm or 4 mm (as specified in the contract), and aluminum skin thickness 0.5 mm and 0.3 mm respectively on both the sides.

The mechanical proportion of ACM and that of aluminum skin shall conform to the requirements given in the table 800-1, when tested in accordance with the test methods mentioned against each of them.

Sl. No.	Description	Specification for 4 mm		Specification for 3mm
		Standard test	Acceptable value	Acceptable value
A	Mechanical Properties of ACM			
1	Peel off strength with retro reflective sheeting. (Drum Peel Test)	ASTM D903	Min. 4 N/mm	Min. 4 N/mm
2	Tensile strength	ASTM E8	Min. 40 N/mm ²	Min. 30 N/mm ²
3	0.20% Proof Stress	ASTM E8	Min. 34 N/mm ²	Min. 34 N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5 %
5	Flexural strength	ASTM C393	Min. 130 N/mm ²	Min. 120 N/mm ²
6	Shear strength with Punch shear test	ASTM D732	Min. 18 N/mm ²	Min. 18 N/mm ²
B	Properties of Aluminium Skin			
1	Tensile strength (Rm)	ASTM E8	Min. 150 N/mm ²	Min. 130 N/mm ²
2	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm ²	Min. 70,000 N/mm ²
3	Elongation	ASTM E8	A ₅₀ Min. 2 %	A ₅₀ Min. 2 %
4	0.2 % Proof Stress	ASTM E8	Min. 110 N/mm ²	Min. 110 N/mm ²

1.2.6 Plate Thickness

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminum and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2 mm thick Aluminum and 4 mm thick with Aluminium Composite Material. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under prevailing wind and other loads.

1.2.7 In respect of sign sizes not covered by IRC-67, the structural details (thickness etc.) shall be as per the approved drawings or as directed by the Engineer.

1.3.1. General Requirements: The retro reflective sheeting used on the signs shall consist of white or coloured sheeting having a smooth outer surface, which has the property of retro reflection over its entire surface. It shall

be weather resistant and exhibit colour fastness. It shall be new and unused and show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having the sheeting tested for coefficient of retro reflection, daytime colour and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance, 3 years outdoor weathering and its having passed these tests shall be obtained from International / Government laboratory / Institute by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-Prismatic Grade retro reflective element material as given in Clauses 801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC-67,

1.3.2 High Intensity Grade sheeting

1.3.2.1 High Intensity Grade (Type III): This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface or as an unmetallized micro prismatic reflective material elements, The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined with ASTM D: 4956-09) as indicated in Table 800-2.

Table 800-2 Acceptable Minimum Coefficient of Retro-reflection for Type III High Intensity Grade Sheetting A (Encapsulated Lens Type)
(Candelas Per Lux Per Square Meter)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1 ^{OB}	-4 ⁰	300	200	120	54	54	24	14
0.1 ^{OB}	+30 ⁰	180	120	72	32	32	14	10
0.2 ⁰	-4 ⁰	250	170	100	45	45	20	12
0.2 ⁰	+30 ⁰	150	100	60	25	25	11	8.5
0.5 ⁰	-4 ⁰	95	62	30	15	15	7.5	5.0
0.5 ⁰	+30 ⁰	65	45	25	10	10	5.0	3.5

^A Minimum Coefficient of Retro reflection (R_A) ($\text{cd.lx}^{-1}.\text{m}^{-2}$).

^B Values for 0.1⁰ observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.2.2 High intensity Micro Prismatic Grade Sheetting (HIP) (Type IV):

This sheeting shall be of high intensity retro-reflective sheeting made of micro-prismatic retroreflective element material coated with pressure sensitive adhesive. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retroreflection (determined in accordance with ASTM D 4956-09) as indicated in Table 800-3.

Table 800-3 Acceptable Minimum Coefficient of Retro-Reflection for Type IV High Intensity Micro-Prismatic Grade Sheetting^A
(Candelas Per Lux Per Square Meter)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1 ^{OB}	-4 ⁰	500	380	200	70	90	42	25	400	300	150
0.1 ^{OB}	+30 ⁰	240	175	94	32	42	20	12	185	140	70
0.2 ⁰	-4 ⁰	360	270	145	50	65	30	18	290	220	105

0.2°	+30°	170	135	68	25	30	14	8.5	135	100	50
0.5°	-4°	150	110	60	21	27	13	7.5	120	90	45
0.5°	+30°	72	54	28	10	13	6	3.5	55	40	22

^A Minimum Coefficient of Retro reflection (R_A) ($\text{cd} \cdot \text{lx}^{-1} \cdot \text{m}^{-2}$).

^B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4 Prismatic Grade Sheeting

1.3.4.1 Prismatic Grade Sheeting (Type VIII)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. The retro reflective surface, after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro reflection (determined in accordance with ASTM D: 4956-09) as indicated in Table 800-4

**Table 800-4 Acceptable Minimum Coefficient of Retro-Reflection for Type VIII
Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Meter)**

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	1000	750	375	100	150	45	30	800	600	300
0.1° ^B	+30°	460	345	175	46	69	21	14	370	280	135
0.2°	-4°	700	525	265	70	105	32	21	560	420	210
0.2°	+30°	325	245	120	33	49	15	10	260	200	95
0.5°	-4°	250	190	94	25	38	11	7.5	200	150	75
0.5°	+30°	115	86	43	12	17	5	3.5	92	69	35

^A Minimum Coefficient of Retro reflection (R_A) ($\text{cd} \cdot \text{lx}^{-1} \cdot \text{m}^{-2}$).

^B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.2 Prismatic Grade Sheeting (Type IX)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. The retro reflective surface, after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro reflection (determined in accordance with ASTM D: 4956-09) as indicated in Table 800-5

**Table 800-5 Acceptable Minimum Coefficient of Retro-Reflection for Type IX
Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Meter)**

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	660	500	250	66	130	30	530	400	200
0.1° ^B	+30°	370	280	140	37	74	17	300	220	110

0.2°	-4°	380	285	145	38	76	17	300	230	115
0.2°	+30°	215	162	82	22	43	10	170	130	65
0.5°	-4°	240	180	90	24	48	11	190	145	72
0.5°	+30°	135	100	50	14	27	6	110	81	41
1.0°	-4°	80	60	30	8	16	3.6	64	48	24
1.0°	+30°	45	34	17	4.5	9.0	2	36	27	17

^A Minimum Coefficient of Retro reflection (R_A) ($\text{cd.lx}^{-1}.\text{m}^{-2}$).

^B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3 Prismatic Grade Sheeting (Type XI)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. The retro reflective surface, after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro reflection (determined in accordance with ASTM D: 4956-09) as indicated in Table 800-6

**Table 800-6 Acceptable Minimum Coefficient of Retro-Reflection for Type XI
Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Meter)**

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	830	620	290	83	125	37	25	660	500	250
0.1° ^B	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4°	580	435	200	58	87	26	17	460	350	175
0.2°	+30°	220	165	77	22	33	10	7	180	130	66
0.5°	-4°	420	315	150	42	63	19	13	340	250	125
0.5°	+30°	150	110	53	15	23	7	5	120	90	45
1.0°	-4°	120	90	42	12	18	5	4	96	72	36
1.0°	+30°	45	34	16	5	7	2	1	36	27	14

^A Minimum Coefficient of Retro reflection (R_A) ($\text{cd.lx}^{-1}.\text{m}^{-2}$).

^B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.5 Adhesive

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

1.3.5 Fabrication

Surface to be reflectorized shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scale / dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting / primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joint shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer,

1.3.7 Message / Border

The messages (legends, letters, numerals, etc.) and borders shall either be screen-printed or of cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary / mandatory sign boards. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informatory and other sign boards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut-outs shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50 per cent of the corresponding values in Tables 800-2 to 800-6 as applicable. Cut-out messages and borders, wherever used, shall be either made out of retro-reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

1.3.8 Color for Signs

1.3.8.1 Signs shall be provided with retro-reflective sheeting and / or overlay film / screening ink as shown on the detailed drawings. The reverse side of all signs shall be painted grey.

1.3.8.2 Except in the case of railway level crossing signs (for which the colour scheme is given later) the sign posts shall be painted in 250 mm wide bands, alternately black and white. The lowest band next to the ground shall be in black.

1.3.8.3 The colour of the material shall be located within the area defined by the chromaticity coordinates in Table 8.1 and comply with the luminance factor given in Table 800-7 when measured as per ASTM D: 4956-09

Table 8.1 Specification Limits (Daytime) ^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.116	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

The colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

1.3.8.4 The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black.

1.3.8.5 The colours chosen for informatory or guide signs shall be distinct for different categories of roads. For National Highways and State Highways, these signs shall be of green background with white borders, legends and word messages. For Expressways these signs shall be of blue back ground with white border, legends and word messages.

1.3.9 Refurbishments

Where existing signs are specified for refurbishments, the sheeting shall have semi-rigid aluminum backing or materials as per clause 1.2.5; pre-coated with aggressive tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the signs and should thoroughly bond with that material.

1.3.10 Sizes of Letters

1.3.10.1 Letter size should be chosen with due regard to the speed, classification and location of the road, so that the sign is of adequate size for legibility but without being too large or obtrusive. The size of the letter, in terms of x-height, to be chosen as per the design speed is given in Table 800-8.

Table 800-8 Acceptable Limits for Size of Letters and Visibility Distance

Design Speed (kmph)	Minimum 'x' Height of the Letters (mm)	Minimum Sight Distance / Clear visibility distance (m)	Maximum Distance from Centre Line (m)
40	100	45	12
50	125	50	14
65	150	60	16
80	250	80	21
100	300	90	24
120	400	115	32

The thickness of the letters and their relation to the x-height, the width and the heights are indicated in Table IV (a) of the Annexure-IV to facilitate the design of the informatory signs and definition plates"

1.3.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highways and 100 mm for other roads. In case of overhead signs, the size ('X' height) of letters may be minimum 300 mm. Thickness of the letter could be varied from 1/6 to 1/5 of the letter 'x' size. The size of the initial uppercase letter shall be 1-1/3 times x-height. In urban areas, letter size shall be 100 mm on all directional signs. For easy and better comprehension, the word messages shall be written in initial upper-case letter followed by lower case letters.

1.3.10.3 Letter size on definition plates attached with normal sized signs should be 100 mm or 150 mm. In the case of small signs, it should be 100 mm. Where the message is long, as for instance in "NO PARKING" and "NO STOPPING" signs, the message may be broken with two lines and the size of letters may be varied in the lines so that the definition plate is not too large. The lettering on definition plates will be all-in upper-case letters.

1.3.11 Warranty and Durability

The Contractor shall obtain from the original manufacturer of the Retro Reflective sheeting for period of ten (10) years warranty for satisfactory field performance including stipulated retro reflectance of Micro-Prismatic sheeting and a Seven years warranty for High Intensity Grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters / legends and their bonding to the retro reflective sheeting. The contractor shall also furnish LOT numbers and certificate that the signs and material supplied

against the assigned work meet all the stipulated requirements and carry the stipulated warranty and the contractor / supplier is the authorized converter of the particular sheeting.

All the signs shall be dated during the fabrication with indelible marking to indicate the start of the warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement / repair / restoration of the retro reflective efficiency,

A certificate in original shall be given by the manufacturer of the sheeting that its offered retroreflective sheeting has been tested for various parameters such as co-efficient of retro reflection, day / night time color and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance; the tests shall be carried out by a Government laboratory in accordance with the various ASTM procedures and the results must show that the sheeting has passed the requirements for all the above mentioned parameters. A copy of the test reports shall be attached with the certificate.

1.4 installation

1.4.1 The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS: 1239, Rectangular Hollow Section conforming to IS: 4923 or square hollow Section conforming to IS: 3589. Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 square metre shall be mounted on a single post, and for greater area, two or more supports shall be provided. Post End(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

1.4.2 All components of signs and supports, other than the reflective portion of GI posts shall be thoroughly de-sealed, cleaned, primed and painted with two coats of epoxy paint. Any part of post below ground shall be painted with protective paint,

1.4.3 The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced concrete or GI posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

1.5 Measurement for Payment

The measurements of standard cautionary, mandatory and information signs shall be in number of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by per Number.

1.6 Rate

The Contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the Specifications.

The payment will be made on number basis of the finished work.

Item No.: - 18.

Providing and fixing Cautionary Warning sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 90 x 90 x 90 cm equilateral triangle as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest MOST specifications; 3.6 Mtr long stand post of 75 x 75 x 6 mm / 65NB circular MS pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of Engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cm for each leg, including excavation, curing etc. complete under the supervision of Engineer in charge. A warranty for 10-year for the retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Cautionary Warning sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 90 x 90 x 90 cm equilateral triangle as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade etc. complete as directed by the Engineer in charge.

The payment will be made on number basis of the finished work.

Item No.: - 19.

Providing and fixing Village name / Bump Ahead Sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 90 x 60 cms rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest MOST Specifications; 3.3 Mtr long stand post of 75 x 75 x 6 mm / 65NB circular MS pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol or inscription / letters / numerals for each board shall be as per the instruction of Engineer-in-charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cms for each leg, including excavation, curing etc. complete under the supervision of Engineer-in-charge. A warranty for 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Village name / Bump Ahead Sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 90 x 60 cms rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade etc. complete as directed by the Engineer-in-charge.

The payment will be made on number basis of the finished work.

Item No.: - 20.

Providing and fixing Facility Informatory sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 80 x 60 cm rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest MOST Specifications; 3.6 Mtr long stand post of 75 x 75 x 6 mm / 65NB Circular MS pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per the instruction of Engineer-in-charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cm for each leg, including excavation, curing etc. complete under the supervision of Engineer-in-charge. A warranty for 10-years for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Facility Informatory sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 80 x 60 cm rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade etc. complete as directed by the Engineer-in-charge.

The payment will be made on number basis of the finished work.

Item No.: - 21.

Providing and fixing Hazard Marker Sign boards made out of 1.5 mm aluminium sheet / 3 mm ACP (Aluminium composite Panel); size 90 x 30 cms rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest MOST Specifications; 1.8 Mtr long stand post of 75 x 75 x 6 mm / 65NB circular MS pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per the instruction of Engineer-in-charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cms for each leg, including excavation, curing etc. complete under the supervision of Engineer-in-charge. A warranty for 10-years for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Hazard Marker Sign boards made out of 1.5 mm aluminium sheet / 3 mm ACP (Aluminium composite Panel); size 90 x 30 cms rectangular as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade etc. complete as directed by the Engineer-in-charge.

The payment will be made on number basis of the finished work.

Item No.: - 22.

Providing and fixing Regulatory / Mandatory sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 60 cm dia circle as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest MOST Specifications; 3.6 Mtr long stand post of 75 x 75 x 6 mm / 65NB circular MS pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of Engineer-in-charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cm for each leg, including excavation, curing etc. complete under the supervision of Engineer-in-charge. A warranty for 10-years for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Regulatory / Mandatory sign boards made out of 2 mm aluminium sheet / 4 mm ACP (Aluminium composite Panel); size 60 cm dia circle as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade etc. complete as directed by the Engineer-in-charge.

The payment will be made on number basis of the finished work.

Item No.: - 23.

Providing and fixing Chevron sign boards made out of 1.5 mm aluminium sheet / 3 mm ACP (Aluminium composite Panel); size 60 x 50 cm as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest MOST Specifications; 3.3 Mtr long stand post of 75 x 75 x 6 mm / 65NB circular MS pipe as required and frame fabricated from suitable size iron angle of 50 x 50 x 5 mm; painted with best quality epoxy coatings in black and white bends. The details of symbol or inscription / numerals for each board shall be as per the instruction of Engineer-in-charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 cms for each leg, including excavation, curing etc. complete under the supervision of Engineer-in-charge. A warranty for 10-year for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Chevron sign boards made out of 1.5 mm aluminium sheet / 3 mm ACP (Aluminium composite Panel); size 60 x 50 cm as per design of IRC-67-2012. Pre-treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with Micro Prismatic Grade etc. complete as directed by the Engineer-in-charge.

The payment will be made on number basis of the finished work.

Item No.: - 24.

Cat Eye / Road Stud / RPM: Supplying of Molded Twin Shanks Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panels with Micro prismatic lens (No Glass bead lens) capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 Kgs tested in accordance to ASTM D 4280 Type H and complying to specifications of category-A of MORTH Circular No RW / NH / 33023 / 10-97 - DO III Dt 11.06. 1997. The height, width and length shall not exceed 20 mm, 130 mm and 130 mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35 +/- 5 degree. The strength of detachment of the integrated cylindrical shanks, (of diameter not less than 19 +/- 2 mm and height not less than 30 +/- 2 mm) from the body is to be a minimum value of 500 Kgf. Fixing will be by drilling holes on the road for the shanks to go inside, without nails and using epoxy resin-based adhesive as per manufacturer's recommendation and the colour of the marker should be as per the IRC 35-2015 and as directed by Engineer in charge.

1.0 General:

The colour, configuration, size and location of Molded Twin Shanks Raised Pavement Markers for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC: 35-2015 or as shown on the drawings or as directed by the Engineer.

The Molded Twin Shanks Raised Pavement Markers shall be reflectorized as shown on the drawings or as directed by the Engineer. It shall be of retro-reflectorized type and made of polycarbonate and ABS moulded body and reflective panels with micro prismatic lens capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 kgs. tested in accordance to ASTM D 4280 Type H and complying to Specifications of Category A of MORT&H Circular No: RW / NH / 33023 / 10-97 - DO III Dt. 11.06.1997.

In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions, either the message could be printed over the reflective sheeting or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

1.2 Materials:

The various materials and fabrication of the Molded Twin Shanks Raised Pavement Markers shall conform to the following requirements.

The adhesive materials shall be of standard quality and it shall be high resistance quality against heavy moving vehicles.

The materials shall be used for the body of the Molded Twin Shanks Raised Pavement Markers is of high-density PVC materials.

The dimensions and size of the Molded Twin Shanks Raised Pavement Markers shall be as per IS standard. The retro-reflective sheeting used on the Molded Twin Shanks Raised Pavement Markers shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro reflection over its entire surface. It shall be weather resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having

passed these tests shall be obtained from a reputed laboratory, by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or of High Intensity Grade with encapsulated lens. The type of the sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

High intensity grade sheetings: This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM D 4280 Type H).

TABLE 800.1: ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING [CANDEL AS PER LUX PER SQUARE METRE]

Observation (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green/ Red	Blue
0.2	-4	250	170	100	45	20
0.2	+ 30	150	100	60	25	11
0.5	- 4	95	62	30	15	7.5
0.5	+ 30	65	45	25	10	5.0

When totally wet, the sheeting shall not show less than 90 percent of the values of retro reflective indicated in Table 800-1. At the end of 7 years, the sheeting shall retain at least 75 percent of its original retro-reflectance.

Engineer grade sheetings: This sheeting shall be of enclosed lens type consisting of micro prismatic lens elements embedded beneath the surface of a smooth, flexible, transparent, water proof plastic, resulting in a non-exposed lens optical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM D 4280 Type H) as indicated in Table 800.2.

TABLE 800.2: ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING [CANDEL AS PER LUX PER SQUARE METRE]

Observation (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+ 30	30	22	7.0	3.5	6.0	1.7
0.5	-4	30	25	13.5	4.5	7.5	2.0
0.5	+ 30	15	13	4.0	2.2	3.0	0.8

When totally wet, the sheeting shall not show less than 90 percent of the values of retro reflective indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50 percent of its original retro-reflectance.

1.3 Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, show no appreciable discoloration, cracking,

blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values (Table 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH Weatherometer (AASHTO Designation M 268).

1.4 Installation:

The Molded Twin Shanks Raised Pavement Markers shall be installed directly on road surface, after cleaning completely by removing all dust and other foreign materials from the surface of the road.

1.5 Measurement for Payment:

The measurement of Molded Twin Shanks Raised Pavement Markers shall be in numbers, these shall be measured in No.

1.6 RATE:

The Contract unit rate shall be payment in full for the cost of making Molded Twin Shanks Raised Pavement Markers including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.

The payment will be made on number basis of the finished work.

Item No.: - 27.

Providing and fixing Tree Guard sign board made out of 2 mm aluminium sheet / 3 mm ACP (Aluminium composite Panel), size 30 cms diameter circle, pre-treated with phosphating process and acid etching, painted with one coat of epoxy primer and two coats of best quality epoxy paint reflectorized with retro reflective sheeting as per latest MOST specifications. A warranty for 10-years for the Retro reflective sheeting from original manufacturer & a certified copy of 3-year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

The relevant specifications of this Tender **Item No. 17** shall be followed as directed.

The item shall be providing and fixing Tree Guard sign board made out of 2 mm aluminium sheet / 3 mm ACP (Aluminium composite Panel), size 30 cms diameter circle, pre-treated with phosphating process and acid etching, painted with one coat of epoxy primer and two coats of best quality epoxy paint reflectorized with retro reflective sheeting and it shall be fixed on site as directed by the Engineer-in-charge.

The payment will be made on number basis of the finished work.

Item No.: - 28.

Type - A, "W": Metal Beam Crash Barrier

Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road / ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2 m centre to centre, 1.8 m high, 1.1 m below ground / road level, all steel parts and fitments to be galvanized by hot dip process, all fittings to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical post with a spacer of channel section 150 x 75 x 5 mm, 330 mm long complete as per clause 811) etc. complete as per instruction of Engineer in charge.

811.3 Metal Beam Crash Barrier

811.3.1 Materials

811.3.1.1 Metal beam rail shall be corrugated sheet steel beams of the class, type, section and thickness indicated on the drawings. Railing posts shall be made of steel of the section, weight and length as shown on the drawings. All complete steel rail elements, terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanized. All elements of the railing shall be free from abrasions, rough or sharp edges and shall not be kinked, twisted or bent.

811.3.1.2 The "W" beam type safety barrier shall consist of a steel post and a 3 mm thick "W" beam rail element. The steel post and the blocking out spacer shall both be channel section of 75 mm x 150 mm & size 5 mm thick. The rail shall be 70 cm above the ground level and posts shall be spaced 2 m center-to-center. Double "W" beam barrier shall be as indicated in IRC: 5-1998.

The thrie beam safety barrier shall have posts and spacers similar to the ones mentioned above for "W" beam type. The rail shall be placed at 85 cm above the ground level. The "W" beam, the thrie beam, the posts, spacers and fasteners for steel barriers shall be galvanized by hot dip process (zinc coated, 0.55 kg per square meter; minimum single spot) unless otherwise specified. The galvanizing on all other steel parts shall conform to the relevant IS Specifications. All fittings (bolts, nuts, washers) shall conform to the IS: 1367 and IS: 1364. All galvanizing shall be done after fabrication.

811.3.1.3 Concrete for bedding and anchor assembly shall conform to Section 1700 of these Specifications.

811.3.2 Construction Operations

811.3.2.1 The line and grade of railing shall be true to that shown on the plans. The railing shall be carefully adjusted prior to fixing in place, to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

811.3.2.2 Unless otherwise specified on the drawing, railing steel posts shall be given one shop coat of paint (primer) and three coats of paint on structural steel after erection, if the sections are not galvanized. Any part of assembly below ground shall be painted with three coats of red lead paint.

811.3.2.3 Splices and end connections shall be of the type and designs specified or shown on the plans and shall be of such strength as to develop full design strength of the rail elements.

811.3.3 Installation of Posts

811.3.3.1 Holes shall be dug or drilled to the depth indicated on the plans or posts may be driven by approved methods and equipment, provided these are erected in proper position and are free from distortion and burring or any other damage.

811.3.3.2 All post holes that are dug or drilled shall of such size as will permit proper setting of the posts and allow sufficient room for backfilling and tapping.

811.3.3.3 Holes shall be backfilled with selected earth or stable materials in layers not exceeding 100 mm thickness and each layer shall be thoroughly tamped and rammed. When backfilling and tamping are completed, the posts or anchors shall be held securely in place.

811.3.3.4 Post holes that are drilled in rock and holes for anchor posts shall be backfilled with concrete.

811.3.3.5 Posts for metal beam guardrail on bridges shall be bolted to the structure as detailed on the plans. The anchor bolts shall be set to proper location and elevation with templates and carefully checked.

811.3.4 Erection

811.3.4.1 All guard rail anchors shall be set and attachments made and placed as indicated on the plans or as directed by the Engineer.

811.3.4.2 All bolts or clips used for fastening the guardrail or fittings to the posts shall be drawn up tightly. Each bolt shall have sufficient length to extend at least 6 mm through and beyond the full nut, except where such extensions might interfere with or endanger traffic in which case the bolts shall be cut off flush with the nut.

811.3.4.3 All railings shall be erected, drawn and adjusted so that the longitudinal tension will be uniform throughout the entire length of the rail.

811.3.5 End Treatment for Steel Barrier

811.3.5.1 End treatments shall form an integral part of safety barriers which should not spear, vault or roll a vehicle for head-on or angled impacts. The two end treatments recommended for steel barriers are "Turned-down-guardrail" and "Anchored in back slope", as shown on the drawings or as directed by the Engineer.

811.3.6 Tolerance

The posts shall be vertical with a tolerance not exceeding 6 mm in a length of 3 m. The railing barrier shall be erected true to line and grade.

The relevant specification as per M.O.R.T. & H. Clause-801, 802 of Section 800 & Section 1900 for fixing and fabrication and other for completed satisfactory work as directed.

811.3.7 Measurements for Payment

811.3.7.1 Metal beam railing barriers will be measured by linear meter of completed length as per plans and accepted in place. Terminals/anchors of various types shall be paid for by numbers.

811.3.7.2 Furnishing and placing anchor bolts and/or devices for guard rail posts on bridges shall be considered incidental to the construction and the costs thereof shall be included in the price for other items of construction.

811.3.7.3 No measurement for payment will be made for excavation or backfilling performed in connection with this construction.

811.3.8 Rate

The Contract unit rate shall include full compensation for furnishing of labour, materials, tools, equipments and incidental costs necessary for doing all the work involved in constructing the metal beam railing barrier complete in place in all respects as per these Specifications.

The payment will be made on running meter basis of the finished work.

Item No.: - 29.

Providing, laying, spreading and compacting stone aggregates of specific sizes to water bound macadam (Grade-I) (B.T. Metal of size 63 to 45 mm) specification including spreading in uniform thickness, hand packing, rolling with vibratory roller in stages to proper grade and camber, applying and brooming requisite type of screening / binding materials to fill-up the interstices of coarse aggregate, watering and compacting to the required density etc. complete as per MORT&H Specification.

404. WATER BOUND MACADAM SUB-BASE / BASE**404.1. Scope**

This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening binding material where necessary and water laid on a properly prepared sub-grade / sub-base / base or existing pavement, as the case may be and finished in accordance with the requirements of these Specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

404.2. Materials**404.2.1. Coarse aggregates:**

Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quality. Materials other than crushed or broken stone and crushed slag shall be used in sub-base courses only. If crushed gravel / shingle is used, not less than 90 percent by weight of the gravel / shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in **Table 400-8**. The type and size range of the aggregate shall be specified in the Contract or shall be as specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part 5).

TABLE 400-8: Physical Requirements of Coarse Aggregates for Water Bound Macadam for Sub-base/Base Courses

S. No.	Test	Test Method	Requirements
1) ***	Los Angeles Abrasion value or Aggregate Impact Value	IS: 2386 (Part-4)	40 percent (Max)
		IS: 2386 (Part-4) or IS: 5640 *	30 percent (Max)
2)	Combined Flakiness and Elongation Indices (Total) **	IS: 2386 (Part-1)	35 percent (Max)

* Aggregates which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS:5640.

** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

*** In case water bound macadam is used for sub-base, the requirements in respect of Los Angeles Value and Aggregate Impact Value shall be relaxed to 50 percent and 40 percent maximum respectively

404.2.2 Crushed or Broken Stone

The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

404.2.3. Crushed slag

Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than 11.2 kN per M³ and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements:

- (i) Chemical stability : To comply with requirements of appendix of BS:1047
- (ii) Sulphur content : Maximum 2 percent
- (iii) Water absorption : Maximum 10 percent

404.2.4. Overburnt (Jhama) Brick aggregates

Jhama brick aggregates shall be made from overburnt bricks or brick bats and be free from dust and other objectionable and deleterious materials. This shall be used only for road stretch when traffic is low.

404.2.5. Grading Requirement of Coarse aggregates

The coarse aggregates shall conform to one of the Gradings given in Table 400-9 as specified.

404.2.6. Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as murrum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75-micron sieve does not exceed 10 percent.

TABLE 400-9: Grading Requirements of Coarse Aggregates

Grading No.	Size Range	IS Sieve Designation	Percent by weight Passing
1)	63 mm to 45 mm	75 mm	100
		63 mm	90 - 100
		53 mm	25 - 75
		45 mm	0 - 15
		22.4 mm	0 - 5
2)	53 mm to 22.4 mm	63 mm	100
		53 mm	95 - 100
		45 mm	65 - 90
		22.4 mm	0 - 10
		11.2 mm	0 - 5

Note: The compacted thickness for a layer shall be 75 mm.

Screenings shall conform to the grading set forth in Table 400-10. The quantity of screenings required for various grades of stone aggregates are given in Table 400-11. The Table also gives the quantities of materials (loose) required for 10 m² for sub-base/base compacted thickness of 75 mm.

The use of screenings shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites, etc. as they are likely to get crushed to a certain extent under rollers.

404.2.7 Binding Material: Binding material to be used for water bound macadam as a filler material meant for preventing raveling shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS:2720 (Part-5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m³ per 10 m².

TABLE 400-10: Grading for Screening

Grading Classification	Size of Screenings	IS Sieve Designation	Percent by Weight Passing the Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95 - 100
		5.6mm	15 - 35
		180 micron	0 - 10
B	11.2 mm	11.2 mm	100
		9.5mm	80 - 100
		5.6 mm	50 - 70
		180 micron	5 - 25

Table 400-11: Approximate Quantities of Coarse Aggregates and Screenings Required for 75 mm Compacted Thickness of Water Bound Macadam (WBM) Sub-Base/Base Course for 10m² Area

Classification	Size Range	Compacted Thickness	Loose Qty.	Screenings			
				Stone Screening		Crushable Type Such as Murrum or Gravel	
				Grading Classification & Size	For WBM Sub-base/ Base Course (Loose Quantity)	Grading Classification & Size	Loose Qty.
Grading 1	63 mm to 45	75 mm	0.91 to 1.07 M ³	Type A 13.2 mm	0.12 to 0.15 M ³	Not uniform	0.22 to 0.24 m ³
-do-	-do-	-do-	-do-	Type B 11.2 mm	0.20 to 0.22 M ³	-do-	-do-
Grading 2	53 mm to 22.4 mm	75 mm	-do-	-do-	0.18 to 0.21 M ³	-do-	-do-

The above-mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as murrum or gravel.

404.3. Construction Operations

404.3.1. Preparation of base

The surface of the sub-grade/sub-base/base to receive the water bound macadam course shall be prepared to the specified grade and camber and cleaned of dust, dirt and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained.

Where the WBM is to be laid on an existing metalled road, damaged area including depressions and potholes shall be repaired and made good with the suitable material. The existing surface shall be scarified and re-shaped to the required grade and camber before spreading the coarse aggregate for WBM.

As far as possible, laying water bound macadam course over existing bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it.

404.3.2 Inverted Choke/Sub-surface Drainage Layer

If water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) or coarse sand shall be spread on the prepared sub-grade before application of the aggregates is taken up. In case of a fine sand or silty or clayey sub-grade, it is advisable to lay 100 mm insulating layer of screening or coarse sand on top of fine grained soil, the gradation of which will depend upon whether it is intended to act as a drainage layer as well. As a preferred alternative to inverted choke, appropriate geosynthetics performing functions of separation and drainage may be used over the prepared sub-grade as directed by the Engineer. Section 700 shall be applicable for use of geosynthetics.

404.3.3 Lateral Confinement of Aggregates

For construction of WBM, arrangement shall be made for the lateral confinement of aggregates. This shall be done by building adjoining shoulders along with WBM layers. The practice of constructing WBM in a trench section excavated in the finished formation must be completely avoided.

Where the WBM course is to be constructed in narrow widths for widening of an existing pavement, the existing shoulders should be excavated to their full depth and width up to the sub-grade level except where widening specifications envisages laying of a stabilized sub-base using in-situ operations in which case the same should be removed only up to the sub-base level.

404.3.4 Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-grade / sub-base in the required quantities from the stockpiles to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than

75 mm. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards.

No segregation of coarse aggregates shall be allowed and the coarse aggregates, as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved drawings.

The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

404.3.5 Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of 80 to 100 kN static weight. The type of roller to be used shall be approved by the Engineer based on trial run.

Except on super elevated portions and carriageway with unidirectional cross-fall where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the center line of the road, in successive passes uniformly overlapping preceding tracks by at least one-half width.

Rolling shall be carried out on courses where coarse aggregates of crushed / broken stone are used, till the road metal is partially compacted. This will be followed by application of screenings and binding material where required in Clauses 404.3.6 and 404.3.7.

However, where screenings are not to be applied as in the case of aggregates like brick metal, laterite and Kankar for sub-base construction, the compaction shall be continued until the aggregates are thoroughly keyed. Rolling shall be continued and light sprinkling of water shall be done till the surface is well compacted. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely with templates and longitudinally with 3 m straight edge. Any irregularities, exceeding 12 mm, shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to the desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

Material, which gets crushed excessively during compaction or becomes segregated, shall be removed and replaced with suitable aggregates.

404.3.6 Application of Screenings

After the coarse aggregates have been rolled to Clause 404.3.5, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped

in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be equipped with pneumatic tyres and operated so as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregates. These operations shall continue until no more screenings can be forced into voids of the coarse aggregates. The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

404.3.7 Sprinkling of Water and Grouting

After application of screenings, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregates have been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the sub-base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

In case of lime treated soil sub-base, construction of water bound macadam on top of it shall be taken up after curing as per Clause 402.3.9 and as directed by the Engineer.

Application of binding material: After the application of screenings in accordance with Clauses 404.3.6 and 404.3.7, the binding material where it is required to be used (Clause 404.2.7) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

404.3.8 Setting and Drying

After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course shall be allowed to completely dry and set before the next pavement course is laid over it.

404.4 Surface Finish and Quality Control of Work

404.4.1 The surface finish of construction shall conform to the requirements of Clause 902.

404.4.2 Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

404.4.3 The water bound macadam work shall not be carried out when the atmospheric temperature is less than 10°C in the shade.

404.4.4 Reconstruction of Defective Macadam

The finished surface of water bound macadam shall conform to the tolerances of surface regularity as prescribed in Clause 902. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to sub-grade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re-compacted. The area treated shall not be less than 10 Sqm. In no case shall depressions be filled up with screenings or binding material.

404.5 Arrangements for Traffic

During the period of construction, the arrangements for traffic shall be done as per Clause 11 2.

404.6 Measurements for Payment

Water bound macadam shall be measured as finished work in position in cubic meters.

404.7 Rate

The Contract unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations including full compensation for all components listed in Clause 401.7 (i) to (v), including arrangement of water used in the work as approved by the Engineer.

The payment will be made on cubic meter basis of the finished work.

Item No.: - 30.

Construction of dry lean cement concrete Sub-base over a prepared sub-grade with coarse and fine aggregate conforming to IS: 383, the size of coarse aggregate not exceeding 25 mm aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per table 600-1, cement content not to be less than 150 KG / Cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, laid with a concrete sensor paver method, compacting with 8-10 tonne vibratory roller, finishing and curing etc. complete.

601 DRY LEAN CEMENT CONCRETE SUB-BASE

601.1 Scope

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

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

601.2 Materials:

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

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

Sr. No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade	IS:8112
ii)	Portland Slag Cement	IS:455
iii)	Portland Pozzolana Cement	IS:1489-Part I

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

Cement to be used may preferably be obtained in bulk form. It shall be stored in accordance with stipulations contained in Clause 1014 and shall be subjected to acceptance test prior to its immediate use.

601.2.3 Fly-ash: Fly-ash up to 20 percent by weight of cementitious material (cement + fly ash) may be used along with 43/53 grade cement may be used to replace OPC cement grade 43 up to 30 percent by weight of cement. Fly-ash shall conform to IS:3812 (Part 1) and its use shall be permitted only after ensuring that facilities exist for uniform blending through a proper mechanical facility with automated process control like batch mix plant conforming to IS:4925 and IS:4926.

601.2.4 Aggregates

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

601.2.4.2 Coarse Aggregates: Coarse aggregates shall comply with Clause-602.2.6.2, except that the maximum size of the coarse aggregate shall be 26.5 mm and aggregate gradation shall comply with Table 600-1.

601.2.4.3 Fine Aggregates: The fine aggregate shall comply with Clause 602.2.6.3.

601.2.4.4 The material after blending shall conform to the grading as indicated in Table 600-1.

Table 600-1: Aggregate Gradation for Dry Lean Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
26.50 mm	100
19.0 mm	75-95
9.50 mm	50-70
4.75 mm	30-55
2.36 mm	1-42
600 micron	8-22
300 micron	7-17
150 micron	2-12
75 micron	0-10

601.2.5 Water: Water used for mixing and curing of concrete shall comply with Clause 602.2.7.

601.2.6 Storage of Materials: All materials shall be stored in accordance with the provisions of Clauses 602.2.12 of these Specifications and other relevant IS Specifications.

601.3 Proportioning of Materials for the Mix

601.3.1 The mix shall be proportioned with a maximum aggregate cementitious material ratio of 15:1. The water content shall be adjusted to the optimum as per Clause 601.3.2 for facilitating compaction by rolling. The strength and density requirements of concrete shall be determined in accordance with Clauses 601.7 and, 601.8 by making trial mixes. Care should be taken to prevent one size of aggregate falling into the other-size of the hopper of the feeding bin while loading the individual size of aggregates into the bins.

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

601.3.3 Cement Content: The cement content in the dry lean concrete shall be such that the strength specified in Clause 601.3.4 is achieved. The minimum cement content shall be 220 kg / cum of concrete. In case fly-ash is blended at site as part replacement of cement, the quantity of fly-ash shall not be more than 20 percent by weight of cementitious material and the content of OPC shall not be less than 120 kg / cum. If this minimum is not sufficient to produce dry lean concrete of the specified strength, it shall be increased as necessary by the Contractor at his own cost.

601.3.4 Concrete Strength: The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 903.5.1.1 shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

601.4 Sub-grade: The sub-grade shall conform to the grades and cross-sections shown on the drawings and shall be laid and compacted in accordance with Clause 305. The subgrade strength shall correspond to the design strength specified in the Contract. As far as possible, the construction traffic shall be avoided on the prepared sub-grade.

601.5 Drainage Layer: A drainage layer conforming to Clause 401 shall be laid above the subgrade before laying the Dry Lean Concrete sub-base, as specified in the drawings and the Contract.

601.6 Construction:

601.6.1 General: The Dry Lean Concrete shall be laid on the prepared granular drainage layer. The pace and programme of the Dry Lean Concrete sub-base construction shall be matching suitably with the programme of construction of the cement concrete pavement over it. The Dry Lean Concrete sub-base shall be overlaid with concrete pavement only after 7 days of sub-base construction.

601.6.2 Batching and Mixing:

The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clauses 602.9.2, 602.9.3.1 and 602.9.3.2. The design features of Batching Plant should be such that the plant can be shifted quickly.

601.6.3 Transporting: Plant mix lean concrete shall be discharged immediately from the mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tipping trucks with tarpaulin during transit. The concrete shall be transported by tipping trucks, sufficient in number to ensure a continuous supply of material to feed the laying equipment to work at a uniform speed and in an uninterrupted manner. The lead of the batching plant to paving site shall be such that the travel time available from mixing to paving as specified in Clause 601.6.5.2 will be adhered to. Tipping truck shall not have old concrete sticking to it. Each tipping truck shall be washed with water jet before next loading as and when required after inspection.

601.6.4 Placing: Lean concrete shall be placed by a paver with electronic sensor on the drainage layer or as specified in the Contract. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. The paving machine shall have high amplitude tamping bars to give good initial compaction to the sub-base. One day before placing of the dry lean cement concrete subbase, the surface of the granular sub-base / drainage layer shall be given a fine spray of water and rolled with a smooth wheeled roller.

Preferably the lean concrete shall be placed and compacted across the full width of the two-lane carriageway, by constructing it in one go. In roads with carriageway more than 2 lanes a longitudinal joint shall be provided. Transverse butt type joint shall be provided at the end of the construction in a day. Transverse joints in the concrete pavement shall not be coterminous with the transverse construction joint of the Dry Lean Concrete.

The Dry Lean Concrete shall be laid in such a way that it is at least 750 mm wider on each side than the proposed width including paved shoulders of the concrete pavement. The actual widening shall be decided based on the specifications of the paver, such that the crawler moves on the Dry Lean Concrete, and the cost of extra width shall be borne by the Contractor.

601.6.5 Compaction

601.6.5.1 The compaction shall be carried out immediately after the material is laid and levelled. In order to ensure thorough compaction, rolling shall, be continued on the full width till there is no further visible movement under the roller and the surface is well closed.

The minimum dry density obtained shall not be less than 98 percent of that achieved during the trial length construction in accordance with Clause 601.7. The densities achieved at the edges i.e. 0.5 m from the edge shall not be less than 96 percent of that achieved during the trial construction.

601.6.5.2 The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possible and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the layer and the final finishing of the same shall not exceed 90 minutes when the temperature of concrete is between 25°C and 30°C, and 120 minutes if less than 25°C. This period may be reviewed by the Engineer in the light of the results of the trial run but in no case shall it exceed 120 minutes.

Work shall not proceed when the temperature of the concrete exceeds 30°C. If necessary, chilled water or addition of ice may be resorted to for bringing down the temperature. It is desirable to stop concreting when the ambient temperature is above 35°C. After compaction has been completed, roller shall not stand on the compacted surface for the duration of the curing period except during commencement of next day's work near the location where work was terminated the previous day.

601.6.5.3 Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 KN static weight are suitable for rolling dry lean concrete. In case any other roller is proposed, the same shall be got approved from the Engineer, after demonstrating its performance. The number of passes required to obtain maximum compaction depends on the thickness of the dry lean concrete, the compatibility of the mix and the weight and type of the roller and the same as well as the total requirement of rollers for the jobs shall be determined during trial run by measuring in-situ density and the scale of the work to be undertaken.

Except on super elevated portions where rolling shall proceed from the inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First, the edge/edges shall be compacted with a roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one-half width.

601.6.5.4 A preliminary pass without vibration to bed the Dry Lean Concrete down shall be given followed by the required number of passes to achieve the desired density and, a final pass without vibration to remove roller with vibration marks and to smoothen the surface.

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

601.6.5.5 The final lean concrete surface on completion of compaction shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects. The final surface shall be inspected immediately on completion and all loose, segregated or defective areas shall be corrected by using fresh lean concrete material, laid and compacted. For repairing honeycombed / hungry surface, concrete with aggregates of size 10 mm and below shall be spread and compacted as per Specifications. It is necessary to check the level of the rolled surface for compliance. Any level/thickness deficiency shall be corrected after applying concrete with aggregates of size 10 mm and below after roughening the surface. Surface regularity also shall be checked with 3 m straight edge. Strength tests shall be carried out, and if deficiency in strength is noticed, at least three (evenly spread) cores of minimum 100 mm dia per km shall be cut to check deficiency in

strength. The holes resulting from cores shall be restored by filling with concrete of the specified strength and compacted by adequate rodding.

601.6.5.6 Segregation of concrete in the tipping trucks shall be controlled by moving the dumper back and forth while discharging the mix into the same or by any appropriate means. Paving operation shall be such that the mix does not segregate.

601.6.6 Joints: Construction and longitudinal joints shall be provided as per the drawings.

Transverse butt type joint shall be provided at the end of the construction in a day. Longitudinal construction joint shall be provided only when full width paving is not possible. Transverse joints in Dry Lean concrete shall be staggered from the construction butt type joint in Concrete pavement by 800-1000 mm.

Longitudinal joint in Dry Lean Concrete shall be staggered by 300-400 mm from the longitudinal joint of concrete pavement.

At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical plane where the correct thickness of the properly compacted material has been obtained.

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

- a) Curing may be done by covering the surface by gunny bags / hessian, which shall be kept wet continuously for 7 days by sprinkling water.
- b) The curing shall be done by spraying with approved resin based aluminized reflective curing compound conforming to ASTM-C 309-81 in accordance with Clause 602.9.12. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days. The rate of application shall be as recommended by the supplier.
- c) Wax-based white pigmented curing compound with water retention index of not less than 90 percent shall be used to cure the dry lean concrete. The curing compound shall conform to BS:7542. The compound shall be applied uniformly with a mechanical sprayer and with a hood to protect the spray from the wind. The curing compound shall be applied over the entire exposed surface of the Dry Lean Concrete, including sides and edges, at the rate of 0.2 litres / sqm, or as recommended by the supplier.

The first application, referred to as curing application shall be applied immediately after the final rolling of Dry Lean Concrete is completed.

As soon as the curing compound loses tackiness, the surface shall be covered with wet hessian for three days. The second application of curing compound also referred to as the debonding application, shall be applied 24 to 48 hours prior to the placement of the concrete pavement. Any damaged Dry Lean Concrete shall be corrected prior to the second application. Normally, the manufacturer's instructions shall be followed for its application.

601.7 Trial Mixes: The Contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 percent using specified cement content, specified aggregate grading and aggregate-cement ratio specified in Clause 601.3.1. Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix shall be done

in three layers with vibratory hammer fitted with a square or rectangular foot as described in Clause 903.5.1.1. After establishing the optimum moisture, a set of six cubes shall be cast at optimum moisture for the determination of compressive strength on the third and the seventh day. Trial mixes shall be repeated if the strength is not satisfactory by increasing cement content. After the mix design is approved, the Contractor shall construct a trial section in accordance with Clause 601.8.

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

601.8 Trial Length

601.8.1 The trial length shall be constructed at least 14 days in advance of the proposed date of commencement of work. At least 30 days prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a "Method Statement" giving detailed description of the proposed materials, plant, equipment, mix proportions, and procedure for, batching, mixing, laying, compaction and other construction procedures. The Engineer shall also approve the location and length of trial construction which shall be a minimum of 100 m length laid in two days and for full width of the pavement. The trial length shall be outside the main works. The trial length shall contain the construction of at least one transverse construction joint involving hardened concrete and freshly laid Dry Lean Concrete sub-base. The construction of trial length shall be repeated till the Contractor proves his ability to satisfactorily construct the Dry Lean Concrete sub-base.

601.8.2 After the construction of the trial length, the in-situ density of the freshly laid material shall be determined by sand replacement method. Three density holes shall be made at locations equally spaced along a diagonal that bisects the trial length and average of these densities shall be determined. The density holes shall not be made in the strip 500 mm from the edges. The average density obtained from the three samples collected shall be the reference density and is considered as 100 percent. The field density of regular work will be compared with this reference density in accordance with Clauses 601.6.5.1 and 903.5.1.2.

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

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

601.9 Tolerances for Surface Regularity, Level, Thickness, Density and Strength

Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900 as stated below

903.5 Quality Control Tests for Concrete Road Construction

903.5.1 Dry Lean Concrete Sub-base

903.5.1.1 Sampling and Testing of Cubes Samples of dry lean concrete for making cubes shall be taken from the uncompacted material from different locations immediately before compaction at the rate of 3 samples for each 1000 sqm or part thereof laid each day. The sampling of mix shall be done from the paving site.

Test cubes of 150 mm size shall be made immediately from each mix sample.

Cubes shall be made in accordance with the methods described in IS:516 except that the cubes shall be compacted by means of a vibratory hammer with the moulds placed on a level and rigid base. The vibrating hammer shall be electric or pneumatic type fitted with a square or rectangular foot having an area of between 7500 to 14000 sq.mm. The compaction shall be uniformly applied for 60 ± 5 seconds with a downward force of between 300 N and 400 N on to each of the three layers of the lean concrete material placed into the mould. The surface of each compacted layer shall be scarified before the next layer is added to give key for the next layer. The final layer shall be finished flush with the top of the cube mould.

The dry lean concrete shall be cured in accordance with IS:516.

903.5.1.2 In-situ Density: The dry density of the laid material shall be determined from three density holes at locations equally spaced along a diagonal that bisects each 2000 sqm or part thereof laid each day and shall comply with the requirements as per Clause 601.6.5.1. This rate of testing may be increased at the discretion of the Engineer in case of doubt or to determine the extent of defective area in the event of non-compliance. Density holes at random may be made to check the density at edges.

903.5.1.3 Thickness: The average thickness of the subbase layer as computed by the level data of sub-base and subgrade or lower sub-base shall be as per the thickness specified in the contract drawings. The thickness at any single location shall not be 8 mm less than the specified thickness. Such areas shall be corrected as stated in Clause 601.6.5.5. Areas which cannot be repaired should be replaced over full width. The extent of deficient area should be decided based on cores.

903.5.1.4 Frequency of Quality Control Tests: The frequency of quality control tests for levels, alignment and materials shall be as given in Table 900-6

601.10 Traffic: No heavy commercial vehicles like trucks and buses shall be permitted on the dry lean concrete sub-base. Construction vehicles at slow speed may be permitted after 7 days of its construction with the prior approval of the Engineer.

601.11 Measurement for Payment: The unit of measurement for dry lean concrete pavement shall be in cubic metre of concrete placed, based on the net plan area for the accepted thickness shown on the drawings or as directed by the Engineer.

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

The payment will be made on cubic meter basis of the finished work.

Item No.: - 31.

Construction of 250 mm thick un-reinforced, dowel jointed, plain cement concrete pavement over a prepared sub base with concrete grade M-300 and with cement @ 410 kg per cum, coarse and fine aggregate conforming to IS 383, maximum size of coarse aggregate not exceeding 25 mm, mixed in a batching and mixing plant as per approved mix design, transported to site, laid with a fixed form paver, spread, compacted and finished in a continuous operation including provision of contraction, expansion, construction and longitudinal joints, joint filler, Separation Membrane of impermeable plastic sheeting 125 micron thick, sealant primer, joint sealant, debonding strip, dowel bar, tie rod, admixtures as approved, curing compound, Plastic sheath, 1.25 mm thick for dowel bars, finishing to lines and grades as per drawing etc. complete as per instruction of Engineer in charge.

602. CEMENT CONCRETE PAVEMENT**602.1. Scope**

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

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

602.2 Materials:

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

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

Sr. No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade.	IS:8112
ii)	Ordinary Portland Cement 53 Grade	IS:12269
iii)	Portland slag cement	IS:455
iv)	Portland Pozzolana Cement	IS:1489-Part I

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

Cement to be used may preferably be obtained in bulk form. If cement in paper bags is proposed to be used, there shall be bag-splitters with the facility to separate pieces of paper bags and. dispose

them off suitably. No paper pieces shall enter the concrete mix. Bulk cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test.

Fly-ash up to 20 percent by weight of cementitious material may be used in Ordinary Portland-Cement 43 and 53 Grade as part replacement of cement provided uniform blending with cement is ensured. The fly ash shall conform to IS:3812 (Part I).

Site mixing of fly ash shall be permitted only after ensuring availability of the equipments at site for uniform blending through a specific mechanized facility with automated process control like batch mix plants conforming to IS:4925 and IS-4926. Site mixing will not be allowed otherwise.

The Portland Pozzolana Cement produced in factory as per IS:1489-Part I shall not have fly-ash content more than 20 percent by weight of cementitious material. Certificate from the manufacturer to this effect shall be produced before use.

602.2.3 Chemical Admixtures: Admixtures conforming to IS:9103 and IS:6925 shall be permitted to improve workability of the concrete and/or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious effect on steel bars. The particulars of the admixture and the quantity to be used, must be furnished to the Engineer in advance to obtain his approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in the trial length paving. If air entraining admixture is used, the total quantity of air shall be 5 ± 1.5 percent for 31.5 mm maximum nominal size aggregate (in air-entrained concrete as a percentage of the volume of the mix).

602.2.4 Silica Fumes: Silica fume conforming to a standard approved by the Engineer may be used as an admixture in the proportion of 3 to 10 percent of cement. Silica fume shall comply with the requirements given in IS:15388-2003, IS:456-2000, IRC: SP:76 and IRC:44-2008.

602.2.5 Fibers: Fibers may be used subject to the provision in the design/approval by the Engineer to reduce the shrinkage cracking and post-cracking. The fibers may be steel fiber as per IRC: SP:46 or polymeric Synthetic fibers within the following range of specifications:

Effective Diameter	10 micron - 100 micron
Length	6-48 mm
Specific gravity	more than 1.0
Suggested dosage	0.6-2.0 kg / cum (0.2-0.6% by weight of cement in mix). Usage will be regulated as stipulated in IRC:44 / IS:456
Water absorption	less than 0.45 percent
Melting point of this fiber shall not be less than 160°C.	
The aspect ratio generally varies from 200 to 2000	
These synthetic fibers will have good alkali and UV light resistance	

When fibers are used, the mix shall be so designed that the slump of concrete at paving site is 25 ± 15 mm.

602.2.6. Aggregates

602.2.6.1 Aggregates for pavement concrete shall be natural material complying with IS:383 but with a Los Angeles Abrasion Test value not exceeding 35 percent. The limits of deleterious materials shall not exceed the requirements set out in Table 600-2.

Table 600-2: Permissible Limits of Deleterious Substances in Fine and Coarse Aggregates

S No	Deleterious substances	Method of tests	Fine aggregate percentage by Weight (Max.)		Coarse Aggregate Percentage by Weight (Max)	
			Uncrushed	Crushed	Uncrushed	Crushed
1	Coal and lignite	IS :2386 (Part II)-1963	1.0	1.0	1.0	1.0
2	Clay Lumps	Do	1.0	1.0	1.0	1.0
3	Material finer than 75 IS Sieve	IS :2386 (Part II)	3.0	8.0	3.0	3.0
4	Soft fragments	IS :2386 (Part II)	-	-	3.0	-
5	Shale	IS :2386 (Part II)	1.0	-	-	-
6	Total percentages of all deleterious materials (except mica) including SI No. (i) to (V) for col 4,6 and 7 SI No (i) and (II) for Col 5 Only		5.0	2.0	5.0	5.0

* Crushed aggregate at least one face fractured

Note: The presence of mica in the fine aggregate has been found to reduce considerably the durability and compressive strength of concrete and further investigations are underway to determine the extent of the deleterious effect of mica. It is advisable, therefore, to investigate the mica content of fine aggregate and make suitable allowances for the possible reduction in the strength of concrete or mortar; in cases where the stretch of the project road passes through micaceous belt.

The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalis in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 percent by weight and the total sulphate content expressed as sulphuric anhydride (SO₃) shall not exceed 0.25 percent by weight. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer.

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

used. The Los Angeles Abrasion value shall not exceed 35. The combined flakiness and elongation index of aggregate shall not be more than 35 percent.

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

602.2.6.4 Combined Gradation of Fine and Coarse Aggregates:

The combined gradation of fine and coarse aggregates shall be as per Table 600-3.

Table 600-3: Aggregate Gradation for Pavement Quality Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
31.5 mm	100
26.5 mm	85-95
19.0 mm	68-88
9.5 mm	45-65
4.75 mm	30-55
600 micron	8-30
150 micron	5-15
75 micron	0-5

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

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

602.2.9 Joint Filler Board: Synthetic Joint filler board for expansion joints shall be used only at abutting structures like bridges and shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirements of IS: 1838, with a compressibility more than 25 percent. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. If two pieces are joined to make up full width, the joint shall be taped such that no slurry escapes through the joint. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

602.2.10 Joint Sealing Compound: The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide / polyurethane / silicone type having flexibility, resistance to age hardening and durability as per IRC:57. Manufacturer's certificate shall be produced by the Contractor for establishing that the sealant is not more than six months old and stating that the sealant complies

with the relevant standard mentioned below. The samples shall meet the requirements as mentioned in IRC:57.

If sealant is of hot poured type, it shall conform to

Hot applied sealant: IS:1834 or ASTM: 3406-95, as applicable Cold poured sealants shall be one of the following:

- | | | |
|------|--------------|--------------------------------------|
| i) | polysulphide | IS:11433 (Part I), BS:5212 (Part II) |
| ii) | polyurethane | BS:5212 |
| iii) | silicone | ASTM 5893-04 |

602.2.11 Preformed Seals: The pre-formed joint sealing material shall be a vulcanized elastomeric compound using poly chloroprene (Neoprene) as the base polymer.

The joint seal shall conform to requirements of ASTM D 2628 as given in Table 600-4.

Table 600-4: Requirement of Preformed Seals as per ASTM D 2628

Sr. No	Description	Requirements	ASTM Test methods
1	Tensile strength, min	13.8 MPa	D 412
2	Elongation at break	Min.250 %	D 412
3	Hardness, Type A durometer	55+/- points	D 2240
4	Oven aging, 70 h at 100°C Tensile strength loss	20 % max	D 573
5	Elongation loss	20 % max	
6	Hardness Change Type A durometer	0 to +10 points	D 471
7	Oil Swell, ASTM Oil 3,70 h at 100°C Weight Change	45% max	D 1149
8	Ozone resistance 20 percent strain,300 pphm in air, 70 h at 40°C	No cracks	D 2240
9	Low temperature stiffening, 7days at -10°C Hardness Change type A durometer	0 to +15 points	
10	Low temperature recovery, 22h at -10°C deflection	88 % min	D 2628
11	Low temperature recovery, 22h at -29°C deflection	83 % min	D 2628
12	Low temperature recovery, 70h at -100°C, 50% deflection	85 % min	D 2628
13	Compression, deflection, at 80% of normal width min	613 N/m	D 2628

602.2.12 Storage of Materials: All materials shall be stored in accordance with the provisions of Clause 1014 of the Specifications. All efforts shall be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for the work. The platform where aggregates are stock piled shall be paved and elevated from: the ground at least by 150 mm. The area shall have slope to drain off rain water. The storage space must also permit easy inspection, removal and storage of the materials. Aggregates of different sizes shall be stored in partitioned stack-yards. All such materials even though stored in approved godowns must be subjected to acceptance test as per Clause 903 of these Specifications prior to their use.

602.3 Proportioning of Concrete

602.3.1 After approval by the Engineer of all the materials to be used in the concrete, the Contractor shall submit the mix design based on weighed proportions of all ingredients for the approval of the Engineer vide Clause 602.3.4. The mix design shall be submitted at least 30 days prior to the paving of trial length and the design shall be based on laboratory trial mixes using the approved materials and methods as per IRC:44 or IS:10262. The target mean strength for the design mix shall be determined as indicated in Clause 602.3.3.1. The mix design shall be based on the flexural strength of concrete.

602.3.2 Cement Content: When Ordinary Portland Cement (OPC) is used the quantity of cement shall not be less than 450 kg / cum. In case fly ash Grade-I (as per IS:3812) is blended at site as part replacement of cement, the quantity of fly ash shall be up to 20 percent by weight of cementitious material and the quantity of OPC in such a blend shall not be less than 360 kg / cum. The minimum of OPC content, in case ground granulated blast furnace slag cement blended, shall also not be less than 310 kg/m³. If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary by the contractor at his own cost.

602.3.3 Concrete Strength:

602.3.3.1 The characteristic flexural strength of concrete shall not be less than 4.5 MPa unless specified otherwise. Target mean flexural strength for mix design shall be more than $4.5 \text{ MPa} + 1.65s$, where s is standard deviation of flexural strength derived by conducting test on minimum 30 beams. 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 specimens. 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 as approved by the Engineer and the maximum free water cement ratio shall be 0.45 when only OPC is used and 0.50 when blended cement (Portland Pozzolana Cement or Portland Slag Cement or OPC blended with fly ash or Ground Granulated Blast Furnace Slag, at site) is used.

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

If during the construction of the trial length or during some normal working, the average value of any four consecutive 7-day test results falls below the required 7-day strength as derived from the value of 'R' then the cement content of the concrete shall, without extra payment, be increased by 5 percent by weight or by an amount agreed by the Engineer. The increased cement content shall be maintained at least until the four corresponding 28-day strengths have been assessed for in conformity with the requirements as per Clause 602.3.3.1. Whenever the cement content is increased, the concrete mix shall be adjusted to maintain the required workability.

602.3.4 Workability

602.3.4.1 The workability of the concrete at the point of placing shall be adequate for the concrete to be fully compacted and finished without undue flow. The optimum workability for the mix to suit the

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

602.3.4.2 The workability requirement at the batching and mixing plant and paving site shall be established by slump tests carried during trial paving. These requirements shall be established from season to season and also when the lead from batching and mixing plant site to the paving site changes. The workability shall be established for the type of paving equipment available. A slump value in the range of 25 ± 15 mm is reasonable for paving works but this may be modified depending upon the site requirement and got approved by the Engineer. These tests shall be carried out on every tipping truck/dumper at hatching and mixing plant site and paving site initially when the work commences but subsequently the frequency can be reduced to alternate tipping trucks or as per the instructions of the Engineer.

602.3.5 Design Mix

602.3.5.1 The Contractor shall carry out laboratory trials of design mix with the materials from the approved sources to be used as per IRC:44. Trial mixes shall be made in presence of the Engineer or his representative and the design mix shall be subject to the approval of the Engineer. They shall be repeated, if necessary, until the proportions, that will produce a concrete which complies in all respects with these Specifications and conform to the requirements of the design / drawings.

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

602.3.5.3 Any change in the source of materials or mix proportions proposed by the Contractor, during the course of work shall be assessed by making laboratory trial mixes and the construction of a further trial length of length not less than 50 m unless approval is given by the Engineer for minor adjustments like compensation for moisture content in aggregates or minor fluctuations in the grading of aggregate.

602.4 Sub-base: The cement concrete pavement shall be laid over the sub-base constructed in accordance with the relevant drawings and Specifications. It shall be ensured that the sub-base is not damaged before laying the concrete pavement. If the dry lean concrete sub-base is found damaged at some places or it has cracks wider than 10 mm, it shall be repaired with fine cement concrete (aggregate size 10 mm and down) or bituminous concrete before laying separation membrane layer.

602.5 Separation Membrane: A separation membrane shall be used between the concrete slab and the sub-base. Separation membrane shall be impermeable PVC sheet 125 micron thick transparent or white in colour laid flat with minimum creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheathing shall be replaced at the Contractor's cost. The separation membrane may be nailed to the lower layer with concrete nails. The separation membrane shall be omitted when two layers of wax-based curing compound is used.

602.6 Joints

602.6.1 The locations and type of joints shall be as shown in the drawing. Joints shall be constructed depending upon their functional requirement. The location of the joints should be transferred

accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It shall be ensured that the required depth of cut is made from edge-to-edge of the pavement. Transverse and longitudinal joints in the pavement and Dry Lean Concrete sub-base shall be staggered so that they are not coincident vertically and are at least 800 to 1000 mm and 300 to 400 mm apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and crew members without damaging the texture of the pavement.

Sawing operation could start as early as 4-8 hours after laying of concrete pavement but not later than 8 to 12 hours depending upon the ambient temperature, wind velocity, relative humidity and required maturity of concrete achieved for this purpose.

When the kerb is cast integrally with the main pavement, slab, the joint cutting shall also be extended to the kerb.

Where the use of maturity meter is specified, sawing should not be initiated when the compressive strength of the concrete is less than 2 MPa and should be completed before it attains the compressive strength of 7 MPa.

602.6.2 Transverse Joints

602.6.2.1 Transverse joints shall be contraction, construction and expansion joints constructed at the spacing described in the drawings. Transverse joints shall be straight within the following tolerances along the intended line of joints.

- i) Deviations of the performed filler board (IS:1838) in the case of expansion joints from the intended line of the joint shall not be greater than ± 10 mm.
- ii) The best fit straight line through the joint grooves as constructed shall be not more than 25 mm from the intended line of the joint.
- iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.
- iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 602.10.

602.6.2.2 Contraction Joints: The contraction joints shall be placed transversely at pre-specified locations as per drawings/ design using dowel bars. These joints shall be cut as soon as the concrete has undergone initial hardening and is hard enough to take the load of joint sawing machine without causing damage to the slab.

Contraction joints shall consist of a mechanical sawn joint groove, 3 to 5 mm wide and one fourth to one-third depth of the slab ± 5 mm or as stipulated in the drawings and dowel bars complying with Clause 602.6.5.

Contraction joint shall be widened subsequently to accommodate the sealant as per Clause 602.10, to dimensions shown on drawings or as per IRC:57.

602.6.2.3 Expansion Joints: The expansion joint shall consist of a joint filler board complying with Clause 602.2.9 and dowel bars complying with Clause 602.6.5 and as detailed in the drawings. The

filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within the tolerances given in Clause 602.6.2.1. The adjacent slabs shall be completely separated from each other by the joint filler board.

602.6.3 Transverse Construction Joint: Transverse construction joint shall be placed whenever concreting is completed after a day's work or is suspended for more than 30 minutes. These joints shall be provided at location of contraction joints using dowel bars. If sufficient concrete has not been mixed to form a slab extending up to a contraction joint, and if an interruption occurs, the concrete placed shall be removed up to the last preceding joint and disposed of. At all construction joints, steel bulk heads shall be used to retain the concrete. The surface of the concrete laid subsequently shall conform to the grade and cross sections of the previously laid pavement. When positioning of bulk head/stop-end is not possible, concreting to an additional 1 or 2 m length may be carried out to enable the movement of joint cutting machine so that joint grooves may be cut and the extra 1 or 2 m length is cut out and removed subsequently after concrete has hardened.

After minimum 14 days of curing, in case OPC cement is used and 16 days of curing when fly ash or blended cement is used, the construction joint shall be widened to accommodate the sealant as per Clause 602.10 to dimensions shown on drawing or as per IRC:57.

602.6.4 Longitudinal Joint

602.6.4.1 The longitudinal joints shall be constructed by forming or by sawing as per details of the joints shown in the drawing. Sawed longitudinal joints shall be constructed when the concrete pavement placement width exceeds 4.5 m. The groove may be cut after the final set of the concrete. Joints should be sawn to at least one-third the depth of the slab ± 5 mm as indicated in the drawing. The joint shall be widened subsequently to dimensions shown on the drawings.

Where adjacent lanes of pavement are constructed separately using slip form pavers or side forms, the tie bars may be bent at right angles against the vertical face/ side of the first lane constructed and straightened before placing concrete in the adjacent lane. Broken or damaged tie bars shall be repaired or replaced as required.

The groove for sealant shall be cut in the pavement lane placed later.

602.6.4.2 Tie Bars: Tie bars shall be provided at the longitudinal joints as per dimensions and spacing shown in the drawing and in accordance with Clause 602.6.6. The direction of the tie bars at curves shall be radial in the direction of the radius.

602.6.5 Dowel Bars

602.6.5.1 Dowel bars shall be mild steel rounds in accordance with Clause 602.2.8 with details/dimensions as indicated in the drawings and free from oil, dirt, loose rust or scale. They shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. Any protrusions shall be removed by grinding the ends of the dowel bars. The dowel bar shall be supported on cradles/dowel chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full re-compaction of the concrete around the dowel bars.

602.6.5.2 Unless shown otherwise on the drawings, dowel bars shall be positioned at mid depth of the slab within a tolerance of ± 20 mm, and centered equally about intended lines of the joint within a tolerance of ± 25 mm. They shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given here-in-under, the compliance of which shall be checked as per Clause 602.11.7.

- i) For bars supported on cradles prior to the laying of the slab:
 - a) All bars in a joint shall be within ± 2 mm per 300 mm length of bar
 - b) 2/3rd of the number of bars shall be within ± 3 mm per 500 mm length of bar
 - c) No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical plane
 - d) Cradles supporting dowel bar shall not extend across the line of joint i.e. no steel bar of the cradle assembly shall be continuous across the joint.
- ii) For all bars inserted after laying of the slab except those inserted by a Dowel Bar Inserter the tolerance for alignment may be twice as indicated in (i) above.

The transverse joints at curves shall be radial in the direction of the radius.

602.6.5.3 Dowel bars; supported on cradles in assemblies, when subject to a load of 110 N applied at either end and in either the vertical or horizontal direction (upwards and downwards and in both directions horizontally) shall conform to be within the limits given in Clause 602.6.5.2.

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

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

602.6.5.5 Dowel bars in the contraction joints, construction joints and expansion joints shall be covered by a thin plastic sheath. The thickness of the sheath shall not exceed 0.5 mm and shall be tightly fitted on the bar for at least two-thirds of the length from one end for dowel bars in contraction/construction joints and half toe; length plus 50 mm for expansion joints. The sheathed bar shall comply with the following pull-out tests:

Four bars shall be taken at random from stock and without any special preparation shall be covered by sheaths as required in this Clause. The ends, if the dowel bars which have been sheathed shall be

cast centrally into concrete specimens' 150 mm x 150 mm x 600 mm, made of the same mix proportions to be used in the pavement, but with a maximum nominal aggregate size of 20 mm and cured in accordance with IS:516. At 7 days a tensile load shall be applied, to achieve a movement of the bar of at least 0.25 mm. The average bond stress to achieve this movement shall not be greater than 0.14 MPa.

602.6.5.6 For expansion joints, a closely fitting cap 100 mm long consisting of water proofed cardboard or an approved synthetic material like PVC or GI pipe shall be placed over the sheathed end of each dowel bar. An expansion space (about 25 mm) at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of cement slurry into the annular space between the sheathing and, dowel bar shall be taped around its mouth

602.6.6 Tie Bars

602.6.6.1 Tie bars in longitudinal joints shall be deformed steel bars of strength 500 MPa complying with IS:1786 and in accordance with the requirements given in this Clause. The bars shall be free from oil, dirt, loose rust and scale.

602.6.6.2 Tie bars projecting across the longitudinal joint shall be protected from corrosion for 75 mm on each side of the joint by a protective coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used. In the case of coastal region and high rainfall areas, tie bars shall be epoxy coated in their full length as per IS:13620.

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

602.6.6.4 Tie bars shall be positioned to remain in the middle from the top or within the upper middle third of the slab depth as indicated in the drawings and approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30 mm below the joint groove. Spacing of tie bars on curves of radius less than 360 m shall not be less than 350 mm.

602.6.6.5 To check the position of the tie bars, one-meter length, 0.5 m on either side of the longitudinal joint shall be opened when the concrete is green (within 20 to 30 minutes). The pit shall be refilled with the fresh concrete of same mix after checking.

602.7 Weather and Seasonal Limitations

602.7.1 Concreting during Monsoon Months: Concreting should be avoided during rainy season. However, when concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulin or other waterproof cloth shall be provided along the line of the work. Any time when it rains, all freshly laid concrete which had not been covered for curing purposes shall be adequately protected. Any concrete damaged by rain shall be removed and replaced. If the damage is limited to texture, it shall be retextured in accordance with the directions of the Engineer.

602.7.2 Temperature Limitation: No concreting shall be done when the temperature of the concrete reaching the paving site is above 30°C. Besides, in adverse conditions like high temperature, low relative humidity, excessive wind velocity, imminence of rains etc., tents on mobile trusses may be provided over the freshly laid concrete for a minimum period of 3 hours as directed by the Engineer. To bring down the temperature, if necessary, chilled water or ice flakes should be made use of. When the ambient temperature is more than 35°C, no concreting shall be permitted. The ice flakes should not be manufactured from chlorinated water. Generally, the rate of evaporation of water shall not exceed 1 kg / sqm / hour as per IRC:15.

No concreting shall be done when the concrete temperature is below 5°C and the temperature is further falling.

602.8 Fixed Form Paving

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

602.8.2 At all times sufficient forms shall be used and set to the required alignment for at least 300 m length of pavement immediately in advance of the paving operations, or the anticipated length of pavement to be laid within the next 24 hours whichever is more.

602.8.3 Slip Form Paving

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

602.8.3.2 The guide wires shall be supported on stakes 5-6 m apart by connectors capable of fine horizontal and vertical adjustment. The guide wire shall be tensioned on the stakes so that a 500-gm weight shall produce a deflection of not more than 20 mm when suspended at the mid-point between any pair of stakes. The ends of the guide wires shall be anchored to fixing point or winch and not on the stakes. On the curves, the stakes shall be fixed at not more than 3 m centre-to-centre.

602.8.3.3 The stakes shall be positioned and hammered into the ground and the connectors will be maintained at their correct height and alignment from 12 hours on the day before concreting takes place till after finishing of texturing and spraying of curing compound on the concrete.

However, the guide wire shall be erected and tensioned on the connectors at any section for at least 2 hours before concreting that section.

602.8.3.4 The Contractor shall submit to the Engineer for his approval of line and level, the stakes and connectors which are ready for use in the length of road to be constructed next day. Such approval shall be obtained at least 12 hours before commencement of paving operation. Any deficiencies noted by the Engineer shall be rectified by the Contractor who shall then re-apply for approval of the affected stakes. Work shall not proceed until the Engineer has given his approval. It shall be ensured that the stakes and guide wires are not affected by the construction equipment when concreting is in progress.

602.9 Construction

602.9.1 General: A systems approach may be adopted for construction of the pavement, and the Method Statement for carrying out the work, detailing all the activities, indication of time-cycle, equipment, personnel etc., shall be got approved from the Engineer before the commencement of the work. This shall include the type, capacity and make of the batching and mixing plant besides the hauling arrangement and paving equipment. The capacity of paving equipment, batching plant as well as all the ancillary equipment shall be adequate for a paving rate of at least 500 m in one day. The paving speed of slip-form paver shall not be less than 1.0 m per minute. The concreting should proceed continuously without stops and starts.

602.9.2 Batching and Mixing:

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

602.9.3 Equipment for Proportioning of Materials and Paving

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

602.9.3.2 Batching Plant and Equipment:

1) General: The batching plant shall include minimum four bins, weighing hoppers, and scales for the fine aggregates and for each size of coarse aggregate. If cement is used in bulk, a separate scale for cement shall be included. There shall be a separate bin for fly ash, if this additive is specified. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant

operation, inspection and testing. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned. A continuous type of mixing plant can also be used provided the ingredients are weighed through electronic sensors before feeding.

2) Automatic weighing devices: Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells. The weighing devices shall have an accuracy within $\pm 1\%$ in respect of quantity of cement, admixtures and water and $\pm 2\%$ in respect of aggregates and the accuracy shall be checked at least once a month.

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

The mixer shall be cleaned at suitable intervals. The pick-up and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 20 mm or more. The Contractor shall (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or (2) provide permanent marks on blade to show points of 20 mm wear from new conditions. Drilled holes of 5 mm diameter near each end and at midpoint of each blade are recommended. Batching Plant shall be, calibrated in the beginning and thereafter at suitable interval not exceeding 1 month.

4) Control cabin: An air-conditioned centralized computer control cabin shall be provided for automatic operation of the equipment.

5) The design features of the batching plant should be such that it can be shifted quickly.

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

Vibrators shall operate at a frequency of 8000-10000 impulses per minute under load at a maximum spacing of 600 mm. The variable vibration setting shall be provided in the machine.

602.9.3.4 Concrete Saw: The Contractor shall provide adequate number of concrete saws with sufficient number of diamond-edge saw blades. The saw machine shall be either electric or petrol/diesel driven type. A water tank with flexible hose and pump shall be made available for this activity on priority basis. The Contractor shall have at least one standby saw in good working condition. The concreting work shall not commence if the saws are not in working condition.

602.9.4 Hauling and Placing of Concrete

602.9.4.1 Freshly mixed concrete from the central batching and mixing plant shall be transported to the paver site by means of tipping trucks or transit mixers of sufficient capacity and approved design in sufficient numbers to ensure a constant supply of concrete. Covers shall be used for protection of concrete against the weather. While loading the concrete truck shall be moved back and forth under the discharge chute to prevent segregation. The tipping trucks shall be capable of maintaining the mixed concrete in a homogeneous state and discharging the same without segregation and loss of cement slurry. The feeding to the paver is to be regulated in such a way that the paving is done in an uninterrupted manner with a uniform speed throughout the day's work. Tipping-trucks shall be washed at a regular frequency as prescribed by the Engineer to ensure that no left-over mix of previous loading remains stuck.

602.9.4.2 Placing of Concrete

The total time taken from the addition of the water to the mix, until the completion of the surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when the concrete temperature is between 25°C and 30°C. When the time between mixing and laying exceed these values, the concrete shall be rejected and removed from the site. Tipping trucks delivering concrete shall normally not run on plastic sheathing nor shall they run on completed slabs until after 28 days of placing the concrete.

The placing of concrete in front of the PQC paver should preferably be from the side placer to avoid damage to DLC by concrete tipping trucks. In case of unavoidable situation, truck supplying concrete to the paver may be allowed to ply on the DLC with the approval of the Engineer. The paver shall be capable of paving the carriageway as shown in the drawings, in a single pass and lift.

602.9.4.3 Where fixed form pavers are to be used, forms shall be fixed in advance as per Clause 602.8. Before any paving is done, the site shall be shown to the Engineer, in order to verify the arrangement for paving besides placing of dowels, tie-bars etc., as per the relevant Clauses of these Specifications. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the concrete in the pavement.

602.9.4.4 In areas inaccessible to paving equipment, the pavement shall be constructed using, side forms, as per Clause 602.9.7.

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

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

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

602.9.4.8 While the concrete is still plastic, its surface shall be textured by brush or tines as per the instructions of the engineer in compliance with Clause 602.9.11. The surface and edges of the slab shall be cured by the application of a sprayed liquid curing membrane in compliance with Clause

602.9.12. After the surface texturing, but before the curing compound is applied, the concrete slab shall be marked with the chainage at every 100 m interval by embossing.

602.9.4.9 As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of 1:1:2, cement: sand: coarse aggregate (10 mm down) with water cement ratio not more than 0.4 under the supervision of the Engineer.

602.9.4.10 If the requirement of Clause 902.4. for surface regularity fails to be achieved on two consecutive working days, then normal working shall cease until the, cause of the excessive irregularity has been identified and remedied.

602.9.5 Construction by Slip Form Paver

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

602.9.5.2 The level of the conforming plate and finishing beams shall be controlled automatically from the guide wires installed as per Clause 602.8 by sensors attached at the four corners of the slip form paving machine. The alignment of the paver shall be controlled automatically from the guide wire by at least one set of sensors attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of the slab.

602.9.5.3 Slip-form paving machines shall have vibrators of variable output, with a maximum energy output of not less than 2.5 KW per meter width of slab per 300 mm depth of slab for a laying speed up to 1.5 m per minute. The machines shall be of sufficient mass to provide adequate reaction during spreading and paving operations on the traction units to maintain forward movements during the placing of concrete in all situations. Normal paving speed shall be maintained as per Clause 602.9.1.

602.9.5.4 If the edges of the slip formed slab slump to the extent that the surface of the top edge of the slab does not comply with the requirements of Clause 902.3, the work shall be stopped until such time as the Contractor can demonstrate his ability to slip form the edges to the required levels. The deficient edge shall be temporarily supported by a side form and the thickness deficiency shall be made good by adding fresh concrete to the newly formed edge and compacting.

602.9.5.5 Slip-form pavers with adequate width to pave the entire carriageway width in one go shall be employed unless specified in the Contract. In situations where full-width paving is not possible, paving in part widths may be permitted by the Engineer. Paving in part will be avoided, except in unavoidable circumstances. In case of part width paving, care shall be taken to ensure that while laying the next lane, bond between the remaining half length of the bar or subsequently inserted tie bars

and the newly laid concrete is adequately developed. Care shall be taken to avoid damage to the previous lane.

602.9.5.6 In case paving in separate lanes is allowed, work on the adjacent lane shall be permitted when the previously paved lane is cured for at least 14 days and is in a position to bear the weight of paving machine. When the wheels or crawler tracks are to ply on the already paved surface, necessary precautions shall be taken by placing protective pads of rubber or similar material so that texture is not damaged. The wheel or track shall be reasonably away from the edge to avoid damage to the previously laid slab.

602.9.5.7 Tube Floating

Upon the instructions of the Engineer, Contractor shall scrape the concrete surface when in plastic state with a 3 m long tube float fixed with a long and stable handle before texturing. Tube float shall be of an alloy steel tube of 50 to 60 mm diameter with a long and stable handle. The length of tube float shall preferably be longer than half the length of slab i.e., half the distance between two transverse contraction joints. This operation shall be done to minimize surface irregularity caused due to varied causes like frequent stoppages of work, surface deformation due to plastic flow etc. The tube, float shall be placed at the centre of the slab parallel to longitudinal joint and pulled slowly and uniformly towards the edges. After the use of float tube, it shall be frequently cleaned before further use. The slurry removed shall be discarded. This activity shall be advanced laterally by providing an overlap of half the length of tube float. The removal of the cement slurry from the surface shall be sufficient enough such that the texture is formed on a firm surface and is more durable. This operation, however, shall be carried out after removing bleeding water.

602.9.6 Construction by Fixed Form Paver

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

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

Tremix Process: Surplus water from the concrete is removed immediately after placing and vibration, reducing the water: cement ratio to an optimum level. This is done using the Vacuum Equipment comprising of Suction Mat Top Cover, Filter pads and Vacuum Pump. The process starts immediately after surface vibration.

Filter pads are placed on the fresh concrete leaving about 4 inches of fresh concrete exposed on all sides. The Top Cover is then placed on the filter pads and rolled out till it covers the strips of exposed

concrete on all sides. The Top Cover is then connected to the vacuum pump through a suction hose and the pump is started. Vacuum is immediately created between the filter pads and the top cover. Atmospheric pressure compresses the concrete and the surplus water is squeezed out. This process lowers the water content in the concrete by 15-25 %. The dewatering operation takes approx. 1.5 - 2 minutes per centimeter thickness of the floor. The dewatered concrete is compacted and dried to such an extent that it is possible to walk on it without leaving any foot prints. This is the indication of concrete being properly dewatered and ready for finishing. The finishing operations - Floating & Troweling take place right after dewatering. Floating operation is done with Floating disc. This ensures after mixing of sand & cement particles, further compaction and closing the pores on the surface. Floating operation generates skid-free finish. Troweling is done with Troweling blades in order to further improve the wear resistance, minimize dusting and obtain smoother finish. Repeated passes with disc and blades improve the wear resistance substantially.

602.9.7 Semi-mechanized Construction: Areas in which hand-guided methods of construction become indispensable shall be got approved by the Engineer in writing in advance. Such work may be permitted only in restricted areas in small lengths. Work shall be carried out by skilled personnel as per methods approved by the Engineer. The acceptance criteria regarding level, thickness, surface regularity, texture, finish, strength, of concrete and all other quality control measures shall be the same as in the case of machine laid work. Guidelines on the use of plants, equipment, tools, hauling of mix, compaction floating, straight edging, texturing, edging etc. shall be as per IRC:15.

602.9.8 Transition Slabs: At the interface of rigid and flexible pavement, at least 3 m long reinforced buried slab shall be provided to give a long-lasting joint at the interface. The details shall be as given in IRC:15.

602.9.9 Anchor Beam and Terminal Slab Beam Adjoining Bridge Structures

RCC anchor beams shall be provided in the terminal slab adjoining bridge structures as per drawings and IRC:15.

602.9.10 The Treatment of Concrete Pavement on Culverts: The concrete pavement shall be taken over the culverts. At both ends of the culvert slab, a contraction joint shall be provided in the concrete pavement. Nominal reinforcement of 10 mm dia bars at 150 mm spacing in both directions shall be provided at 50 mm below the top of the slab. The reinforcement shall be stopped 50 mm short of the contraction joint. Such reinforcement shall also be provided in the next slab panel on either side.

602.9.11 Surface Texture

602.9.11.1 Tinning: After final floating and finishing of the slab and before application of the liquid curing membrane, the surface of concrete slabs shall be textured either in the transverse direction (i.e., at right angles to the longitudinal axis of the road) or in longitudinal direction (i.e., parallel to the centerline of the roadway). The texturing shall be done by tinning the finished concrete surface by using rectangular steel tines. A beam or a bridge mounted with steel tines shall be equipped and operated with automatic sensing and control devices from main paver or auxiliary unit. The timing unit shall have facility for adjustment of the download pressure on the tines as necessary to produce the desired finish. The timing rakes shall be cleaned often to remove snots of slurry. The tines shall be inspected daily and all the damaged and bent tines shall be replaced before commencing texturing. Tined grooves shall be 3 mm wide and 3 to 4 mm deep. Before commencing texturing, the bleeding

water, if any, shall be removed and texturing shall be done on a firm surface. The measurement of texture depth shall be done as per Clause 602.12.

- a) Transverse tinning: When the texturing is specified in transverse direction, a beam of at least 3 m length mounted with tines shall be moved in transverse direction to produce the texture. The grooves produced shall be at random spacing of grooves but uniform in width and depth. The spacing shall conform to a pattern shown below:

Random spacing in mm

10	14	16	11	10	13	15	16	11	10	21	13	10
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The above pattern shall be repeated. Texturing shall be done at the right time such that the grooves after forming shall not close and they shall not get roughened. Swerving of groove patterns will not be permitted. The completed textured surface shall be uniform in appearance.

- b) Longitudinal tinning: Longitudinal tinning shall be done, if specified in the Contract. The texturing bridge shall be wide enough to cover the entire width of the carriageway but within 75 mm from the pavement edge. The centre to centre spacing between the tines shall be 18 to 21 mm. The width of tine texture shall be 3 mm and depth shall be 3 to 4 mm.

602.9.11.2 Brush Texturing: Alternatively, on the instructions of the Engineer, the brush texturing shall be applied. The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450 mm wide but wider brushes normally of 3 m length are preferred. The brush shall be made of 32-gauge tape wires grouped together in tufts placed at 10 mm centers. The tufts shall contain an average of 14 wires and initially be 100 mm long. The brush shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in one row shall be opposite the centre of the gap between tufts in the other row. The brush shall be replaced when the shortest tuft wears down to 90 mm long.

The texture depth shall be determined by the Sand Patch Test as described in the Clause 602.12. This test shall be performed at least once for each day's paving and wherever the Engineer considers it necessary at times after construction as under:

Five individual measurements of the texture depth shall be taken at least 2 m apart anywhere along a diagonal line across a lane width between points 50 m apart along the pavement. No measurement shall be taken within 300 mm of the longitudinal edges of a concrete slab constructed in one pass.

Texture depths shall not be less than the minimum required depth when measurements are taken as given in Table 600-5 nor greater than an average of 1.25 mm.

Table 600-5: Texture Depth

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

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

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

602.9.12 Curing

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

602.9.12.2 The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks of application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying. The curing compound shall be sprayed in two applications to ensure uniform spread.

Curing compounds shall contain sufficient flake aluminum in finely divided dispersion to produce a complete coverage of the sprayed surface with a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have a water retention efficiency index not less than 90 percent in accordance with BS Specification No. 7542 or as per ASTM C-309-81 Type 2.

602.9.12.3 In addition to spraying of curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavement with tents mounted on mobile trusses as described in Clause 602.7.2, during adverse weather conditions as directed by the Engineer. After three hours, the pavement shall be covered by moist hessian laid in two layers and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. The hessian shall be kept continuously moist. All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

602.9.12.4 The Contractor shall be liable at his cost to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint as per procedure in IRC: SP:83.

602.10 Preparation and Sealing of Joint Grooves

602.10.1 General

All joints shall be sealed using sealants described in Clause 602.2.10.

602.10.2 Preparation of Joint Grooves for Sealing

602.10.2.1 Grooves are saw cut in the first instance just to provide minimum width (3-5 mm) to facilitate development of crack at joint locations, as shown in the drawing.

Subsequently before sealing, grooves are widened by sawing as per the dimensions in the drawing. Dimension of the grooves shall be controlled by depth/width gauge.

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

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

602.10.2.4 The groove shall be cleaned and dried at the time of priming and sealing. If sand blasting is recommended by the supplier, the same shall be carried out.

602.10.2.5 Before sealing the temporary seal provided for blocking the ingress of dirt, soil etc., shall be removed. A highly compressible heat resistant paper-backed debonding strip as per drawing shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove so that the sealant may not leak through the cracks. The width of debonding strip shall be more than the joint groove width so that it is held tightly in the groove. In the case of longitudinal joints, heat resistant tapes may be inserted to block the leakage through bottom of the joint where hot poured sealant is used. When cold poured sealant is used a debonding tape of 1.0-2.0 mm thickness and 6 to 8 mm width shall be inserted to plug the groove so that the sealant does not enter in the initially cut groove.

602.10.3 Sealing with Sealants

602.10.3.1 When sealants are applied, an appropriate primer shall also be used if recommended by the manufacturer and it shall be applied in accordance with his instructions.

The sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed, is below 7°C.

602.10.3.2 If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculating pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturer's recommendations and reheated material shall not be used. The Movement Accommodation Factor of the sealant shall be more than 10 percent.

602.10.3.3 Cold applied sealants with chemical formulation like poly sulphide / polyurethane / silicone as per IRC:57 shall be used. These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended, they shall be applied neatly with an appropriate brush. The Movement Accommodation Factor shall be more than 25 percent.

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

602.10.3.5 Sealant shall be applied, slightly to a lower level than the slab with a tolerance of $3 \pm 1\text{mm}$.

602.10.3.6 During sealing operation, it shall be seen that no air bubbles are introduced in the sealant either by vapors or by the sealing process. The sealant after pouring, shall be allowed to cure for 7 days or for a period as per instructions of manufacturers.

602.11 Trial Length

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

602.11.2 The Contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, at least 100 m long for mechanized construction and at least 50 m long for hand guided methods. The width of the trial section shall be the full carriageway width as shown in the drawings. If the first trial is unsatisfactory, the Contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

602.11.3 The trial length shall be constructed in two parts over a period comprising at least part of two separate working days, with a minimum of 50 m constructed each day for mechanized construction and a minimum of 25 m on each day for hand guided construction. The trial length shall be constructed at a paving rate which is proposed for the main work.

602.11.4 Transverse joints including expansion joint and longitudinal joint that are proposed in the main work shall be constructed and assessed in the trial length.

602.11.5 The trial length shall comply with the Specifications in all respects including the test requirement of Table 900-6 with the following additions.

602.11.5.1 Surface Levels and Regularity

- a) In checking for compliance with Clause 902.3 the levels shall be taken at intervals at the locations specified in this Clause along any line or lines parallel to the longitudinal centre line of the trial length.
- b) The maximum number of permitted irregularities of pavement surface shall comply with the requirements of Clause 902.4. Shorter trial lengths shall be assessed pro-rata based on values for a 300 m length

602.11.5.2 Joints

a) Alignment of dowel bars shall be inspected in any two consecutive transverse joints in a trial length construction by removing the fresh concrete in a width of 0.5 m on either side of the joint. The joint pit shall be refilled with freshly prepared concrete, after inspection. Alternatively, it can be tested by suitable device like MIT SCAN with the permission of the Engineer. If the position or alignment of the dowel bars at one of these joints does not comply with the requirements and if that joint remains the only one that does not comply after the next 3 consecutive joints of the same type have been inspected, then the method of placing dowels shall be deemed to be satisfactory. In order to check sufficient joints for dowel bar alignment without extending the trial length unduly joints may be constructed at more frequent joint intervals than the normal spacing required in trial slabs.

b) If there are deficiencies in the first expansion joint that is constructed as a trial, the next expansion joint shall be a trial joint. Should this also be deficient, further trial of expansion joints shall be made as part of the trial length which shall not form part of the permanent works, unless agreed by the Engineer.

602.11.5.3 Density

In-situ density in trial length shall be assessed as described in Clause 903.5.2.2 from at least 3 cores drilled from each part of the trial length 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 the construction in the main carriageway shall not be permitted until further trials have shown that modification has been made which would result in adequate compaction.

602.11.5.4 Strength

Minimum of thirty (30) beams for flexural strength and thirty (30) cubes for compressive strength shall be prepared from the concrete delivered in front of the paving plant. Each pair of beams and cubes shall be from the same location / batch but different sets of beams and cubes shall be from different locations / batches. Compressive and flexural strength shall be tested after 28 days water curing in the laboratory.

At the age of 28 days, thirty (30) cores with diameter 150 mm shall be cut from the pavement slab when the thickness of concrete pavement is more than 300 mm. In case the concrete pavement thickness is less than 300 mm, the dia of core shall be 100 mm. The cores shall be suitably cut at both ends to provide a specimen of plain surface on both ends. The dia to height ratio of core shall be 1 to 2. For cylindrical specimen of PQC of dia 150 mm, the variation in dia shall be ± 0.5 mm, a tolerance on height shall be ± 1 mm for a specimen of height 300 mm or more. For cylindrical specimen of dia 100 mm, the variation in dia shall be ± 0.3 mm, and a tolerance on height shall be ± 1 mm for a specimen height of 200 mm. The compressive strength test shall be conducted as per IS:516. Concrete in the member represented by a core test shall be considered acceptable, if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength (characteristic strength) of the grade of the concrete specified for the corresponding age of 28 days and no individual core has a strength less than 75 percent.

602.11.6 Approval and Acceptance

602.11.6.1 Approval of the materials, plant, equipment and construction methods shall be given when the trial length complies with the Specifications. The Contractor shall not proceed with normal working until the trial length has been approved. If the Engineer does not notify the Contractor of any

deficiencies in any trial length within 7 days after the completion of that trial length, the Contractor may assume that the trial length, and the materials, plant, equipment and construction methods adopted are acceptable, provided that the 28 days strength of cubes and cores extracted from trial length meet the requirement of the Specified strength.

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

602.11.6.3 Trial lengths which do not comply with the Specifications, with the exception of areas which are deficient only in surface texture and which can be remedied in accordance with Clause 602.9.11.6 shall be removed immediately upon notification of deficiencies by the Engineer and the Contractor shall construct a further trial length.

602.11.7 Inspection of Dowel Bars

602.11.7.1 Compliance with Clause 602.6.5. for the position and alignment of dowel bars at contraction and expansion joints shall be checked by measurements relative to the side forms or guide wires.

602.11.7.2 When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them in the plastic concrete across the whole width of the slab. When the joint is an expansion joint, the top of the filler board shall be exposed sufficiently in the plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working, these measurements shall be carried out in the pavement section at the end of days' work by extending slab length by 2 m. After sawing the transverse joint groove, the extended 2 m slab shall be removed carefully soon after concrete has set to expose dowels over half the length. These dowels can be tested for tolerances. This joint shall be treated as construction joint. The position of dowel bars in any type of transverse joint i.e., contraction, construction or expansion can alternatively be tested by suitable device like MIT SCAN with the permission of the Engineer.

602.11.7.3 If the position and alignment of the bars in a single joint in the slab is unsatisfactory then the next two joints shall be inspected. If only one joint of the three is defective, the rate of checking shall be increased to one joint per day until the Engineer is satisfied that compliance is being achieved.

602.11.7.4 After the dowel bars have been examined, the remainder of the concrete shall be removed over a width of 500 mm on each side of the line of the joint and reinstated to the satisfaction of the Engineer. The dowels shall be inserted on both sides of the 1 m wide slab by drilling holes and grouting with epoxy mortar. Plastic sheath as per Clause 602.6.5.5 shall be provided on dowels on one of the joints. The joint groove shall be widened and sealed as per Clause 602.10.

602.11.8 Inspection of Tie Bars

To check the position of the tie bars, one meter length 0.5 m on either side of the longitudinal joint shall be opened when the concrete is green (within 20 to 30 minutes of its laying). The pit shall be refilled with the fresh concrete of same mix after checking.

602.12 Measurement of Texture Depth - Sand Patch Method

602.12.1 The following Apparatus shall be used:

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

602.12.2 Method

The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylindrical container shall be filled with the sand, tapping the base 3 times on the surface to ensure compaction, and striking off the sand level with the top of the cylinder. The sand shall be poured into a heap on the surface to be treated. The sand shall be spread over the surface, working the disc with its face kept flat in a circular motion so that the sand is spread into a circular patch with the surface depressions filled with sand to the level of peaks.

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

602.12.4 Measurement of Texture Depth - Tinning**602.12.4.1 The following apparatus shall be used**

- i) Tire Tread Depth Gauge

A stainless-steel tire tread depth gauge with graduations with least count of 1.0 mm. The gauge end may be modified to measure depth of tine texture.

- ii) A stainless-steel caliper to measure spacing of tines. If necessary, the caliper may be modified to measure the spacing and width of tine texture. The gauge shall be used after making necessary calibration.

- iii) Wire brush

- iv) Corborundum stone

- v) Steel straight edge to remove snots etc. sticking to the surface. The straight edge may be of 6 x 25 x 300 mm size.

602.12.4.2 Test Section

A unit of testing shall be 75 m per lane. If the length of construction is less than 75 m it shall be taken as one unit.

602.12.4.3 Test Procedure

In each 75 m section, along the diagonal line, 10 points shall be selected for making checks of depth, width and spacing of tine grooves. The surface where tests are to be conducted shall be cleared carefully with a wire brush or a steel straight edge or using a corborundum plate to remove any upward projection of concrete. When the base plate of the gauge is in contact with the concrete surface, the gauge shall be pressed to the bottom of groove and the depth shall be measured and

recorded at this location. At the same location, the spacing of tines shall be measured to verify whether the pattern recommended in Clause 602.9.11.1 is complied or not.

The average of depth and width at 10 locations shall be calculated and recorded to the nearest 1 mm. The spacing of spectrum measured at 10 locations shall be recorded separately.

602.12.5 The average depth shall be 3 to 4 mm. When the depth is less than 2.5 mm and in excess of 4.5 mm, the Contractor shall stop concreting till he corrects his tine brush or replaces it. The sensors associated with work shall be again calibrated to achieve the required texture. The textured groove less than 2.5 mm shall be re-grooved using concrete saw at the cost of Contractor. Variation in texture width in the range of $3+1$ mm and $3 - 0.5$ mm will be acceptable. If the variation of width is in excess of this range, the Contractor shall stop work and correct the brush and technique. When the spacing of spectrum is not satisfactory, the Contractor shall replace the entire brush.

602.13 Opening to Traffic

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

602.14 Acceptance Criteria in Quality and Distress

i) Tolerances for Surface Regularity, Level, Thickness and Strength: The tolerances for surface regularity, level, thickness and strength shall conform to the requirements given in Clause 903.5. Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900 as shown under

903.5.2 Pavement Concrete

903.5.2.1 Sampling and Testing of Beam and Cube Specimens At least three beams and three cube specimens, one set of three each for 7-day and 28-day strength tests shall be cast for every 150 cum (or part thereof) of concrete placed during construction. On each day's work, not less than three pairs of beams and cubes shall be made for each type of mix from the concrete delivered to the paving plant. Each pair shall be from a different delivery of concrete and tested at a place to be designated by the Engineer in accordance with the testing procedure as outlined in Clause 602.3.3. Groups of four consecutive results from single specimens tested at 28 days shall be used for assessing the strength for compliance with the strength requirements. The specimens shall be transported in an approved manner to prevent sudden impact causing fractures or damage to the specimen. The flexural strength test results shall prevail over compressive strength tests for compliance.

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

The crushing strengths of cylinders with height to diameter ratios between 1 and 2 may be corrected to correspond to a standard cylinder of height to diameter ratio of 2 by multiplying with the correction factor obtained from the following equation:

$$f = 0.11n + 0.78$$

where f = correction factor and

n = height to diameter ratio

The corrected test results shall be analyzed for conformity with the specification requirements for cube samples. Where the core tests are satisfactory, they shall have precedence for assessing concrete quality over the results of moulded specimens. The diameter of cores shall not be less than 150 mm.

If, however, the tests on cores also confirm that the concrete is not satisfying the strength requirements, then the concrete corresponding to the area from which the cores were cut should be replaced, i.e., at least over an area extending between two transverse joints where the defects could be isolated or over larger area, if necessary, as assessed by additional cores and their test results. The equivalent flexural strength at 28 days shall be estimated in accordance with Clause 602.3.3.2.

In order to ensure that the specified minimum strength at 28 days is attained in 1 in 20 of all test beams, the mix shall be proportioned to give an average strength at 28 days exceeding the specified strength by 1.65 times the standard deviation calculated first from the flexural strengths of test beams made from the trial mix and subsequently from the accumulating result of flexural strengths of job control test beams. shall be re-calculated from the test results obtained after any change in the source or quality of materials and the mix shall be adjusted as necessary to comply with the requirements. An individual 28-day test strength below the specified strength shall not be evidence for condemnation of the concrete concerned if the average 28-day strength of this beam plus the preceding 5 and succeeding 4 beams exceeds the specified strength by 1.65 times the standard deviation and provided that there is no other evidence that the concrete mix concerned is substandard.

Beams shall be made each day in pairs at intervals, each pair being from a different batch of concrete. At the start of the work, and until such time as the Engineer may order a reduction in the number of beams required, at least six pairs of beams and cubes shall be made each day, one of each pair for testing at 28 days for determination of minimum permissible flexural strength and the other for testing at an early age for the Engineer to assess the quality of the mix. When the first thirty number of 28-day results are available, and for so long as the Engineer is satisfied with the quality of the mix, he may reduce the number of beams and cubes required.

During the course of construction, when the source of any material is to be changed, or if there is any variation in the quality of the materials furnished, additional tests and necessary adjustments in the mix shall be made as required to obtain the specified strength.

The flexural strengths obtained on beams tested before 28 days shall be used in conjunction with a correlation between them and the 28-day flexural strengths to detect any deterioration in the quality of the concrete being produced. Any such deterioration shall be remedied without awaiting the 28-day strengths but the earlier strengths shall not constitute sole evidence of non-compliance of the concrete from which they were taken.

Concrete shall be deemed not to comply with the Specification when more than one test beam in a batch has a 28-day strength less than the specified strength and the average 28-day flexural strength of the batch of beams is less than the specified strength plus 1.65 times the standard deviation of the batch.

Should the concrete fail to comply with the Specification for strength as described above, the Contractor may, all at his own expense, elect to cut cores from the suspect concrete as the Engineer shall direct. From the relation between cube strength and flexural strength, the core strength shall be converted to flexural strength.

The equivalent flexural strength at 28 days shall be the estimated in-situ strength multiplied by 100 and divided by the age-strength relation obtained from Table 900-5.

Any concrete that fails to meet the strength specification shall be removed and replaced at Contractor's expense.

Table 900-5: Age-Strength Relation of Concrete (Related to 100 percent at 28 Days)

Days	0	2	4	6	8
0	-	41.0	60.0	71.0	77.50
10	81.5	85.0	87.5	90.0	92.0
20	94.0	96.0	97.50	98.5	100.0
30	101.0	102.0	103.50	104.5	105.5
40	106.5	107.0	108.0	109.5	110.0
50	110.5	111.0	112.0	112.5	113.0
60	114.0	114.5	115.0	115.5	116.0
70	116.5	117.0	117.5	118.0	118.5
80	119.0	119.5	119.5	120.0	120.5
90	121.0	121.5	122.0	122.0	122.5
100	123.5	123.5	123.5	124.0	124.5
110	125.0	125.0	125.5	125.5	126.0
120	126.0	126.0	127.0	127.0	127.5
130	127.5	128.0	128.5	128.5	129.0
140	129.0	129.5	129.5	130.0	130.0
150	130.5	130.5	131.0	131.0	131.5
160	131.5	131.5	132.0	132.0	132.5
170	132.5	132.5	133.0	133.0	133.5
180	133.5	134.0	134.0	134.5	134.5
190	135.0	135.0	135.0	135.5	135.5
200	135.5	135.5	136.0	136.0	136.5
210	136.5	136.5	137.0	137.0	137.0
220	137.0	137.5	137.5	137.5	138.0
230	138.0	138.5	138.5	138.5	138.5
240	139.0	139.0	139.0	139.5	139.5
250	139.5	140.0	140.0	140.0	140.0
260	140.5	140.5	140.5	140.5	141.0
270	141.0	141.0	141.5	141.5	141.5
280	142.0	142.0	142.0	142.0	142.0
290	142.5	142.5	142.5	142.5	142.5
300	143.0	143.0	143.0	143.0	143.5

310	143.5	143.5	144.0	144.0	144.0
320	144.0	144.5	144.5	144.5	144.5
330	144.5	145.0	145.0	145.0	145.0
340	145.0	145.5	145.5	145.5	145.5
350	146.0	146.0	146.0	146.0	146.0
360	146.0	146.0	146.5	146.5	146.5

903.5.2.3 In-situ Density

The density of the compacted concrete shall be such that the total air voids are not more than 3 percent. The air voids shall be derived from the difference between the theoretical maximum dry density of the concrete calculated from the specific gravity of the constituents of the concrete mix and the average value of three direct density measurements made on cores at least 150 mm diameter. Three cores shall be taken from trial lengths and in first two km length of the pavement, while the slab is being constructed during normal working. The proportions of the mix and the vibratory effort imparted i.e. the frequency and magnitude of vibration shall be adjusted to achieve the maximum density.

All cores taken for density measurement in the trial section shall also be checked for thickness. The same cores shall be made use of for determining in-situ strength. In case of doubt, additional cores may be ordered by the Engineer and taken at locations decided by him to check the density of concrete slab or the position of dowel/tie bars without any compensation being paid for the same.

In calculation of the density, allowance shall be made for any steel in cores.

Cores removed from the main carriageway shall be reinstated with compacted concrete with mix proportions of 1 part of Portland cement: 2 parts of fine aggregate: 2 parts of 10 mm nominal size single sized coarse aggregate by weight. Before filling the fine mix, the sides shall be hacked and cleaned with water. Thereafter cement-sand slurry shall be applied to the sides just prior to filling the concrete mix.

903.5.2.4 Thickness

Thickness shall be controlled by taking levels as indicated in Clause 902.3. Thickness of the slab at any point checked as mentioned above shall be within a tolerance of -5 mm to + 10 mm of the specified thickness as per Drawing. Thickness deficiency more than 5 mm may be accepted and paid for at a reduced rate given in Clause 602.16.3. In no case, however, thickness deficiency shall be more than 10 mm.

903.5.2.5 Summary of Control Tests

Table 900-6 gives a summary of frequency of testing of pavement concrete.

Table 900-6: Frequency of Quality Control Tests for Pavement Concrete

1)	i) Levels, alignment and texture	Clause 902.3
	Width of pavement and position of paving edges	Clause 902.2
	iii) Pavement thickness	Clause 902.3 and Clause 903.5.2.4
	iv) Alignment of joints, widths, depth of dowel grooves	To be checked @ one joint per 400 m length or a day's work
	v) Surface regularity both transverse and longitudinally	Once a day or one day's work without disturbing the curing

vi) Alignment of dowel bars and their accuracy/tie bars		To be checked in trial length as per Clause 602.6.5.2 and once on every 2 km.
vii) Texture depth		Clause 602.12
2)	Quality of materials and concrete shall be as under:	
1) Cement Physical and Chemical Tests		IS:269 IS:455 IS:1489 IS:8112 IS:12269
Once for each source of supply and occasionally when called for in case of long/improper storage. Besides, the Contractor also will submit daily test data on cement released by the manufacturer		
2) Coarse and Fine Aggregate	i) Gradation	IS:2386
	One test for every day's work of each fraction of coarse aggregate and fine aggregate, initially; (may be relaxed later at the discretion of the Engineer)	
	ii) Deleterious constituents	IS:2386 (Pt.2)
3) Coarse Aggregate	iii) Water absorption	IS:2386 (Pt.3)
	Regularly as required subject to a minimum of one test a day for coarse aggregate and two tests a day for fine aggregate. This data shall be used for correcting the water demand of the mix on a daily basis.	
	i) Los Angeles Abrasion value or Aggregate Impact test	IS:2386 (Pt.4)
4) Water	ii) Soundness	IS:2386 (Pt.5)
	Before approving the aggregates and every month subsequently.	
	iii) Alkali aggregate reactivity	IS:2386 (Pt.7) IS:456
5) Concrete	Chemical Testa	IS:2386
	Once for approval of source of supply. subsequently only in case of doubt	
	i) Strength of Concrete	IS:516
	2 cubes and 2 beams per 150 Cum or part thereof (one for 7 day and other for 28 day strength) or minimum 6 cubes and 6 beams per day's work whichever is more	
	ii) Core strength on hardened concrete	IS:516
	As per the requirement of the Engineer, only in case of doubt.	
	iii) Workability of fresh concrete- Slump Test	IS:1199
	One test per each dumper load at both Batching plant site and paving site initially when work starts. Subsequently sampling may be done from alternate dumper.	
	iv) Thickness determination	
	From the level data of concrete pavement surface and sub-base at grid points of 5/6.25 m x 3.5 m	
	v) Thickness measurement for trial length	3 cores per trial length
	vi) Verification of level of string line in the case of slip form paving and steel	String line or steel forms shall be checked for level at an interval of 5.0 m or 6.25 m. The level tolerance allowed shall be 1 2 mm. These shall be got approved 1-2 hours

		forms in the case of fixed form paving		before the commencement of the concreting activity.
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ii) Tolerances in Distress: The acceptance criteria with regard to the types of distresses in rigid pavement shall be as per IRC: SP-83. "Guidelines for Maintenance, Repair and Rehabilitation of Cement Concrete Pavements". The cracks (of severity rating not more than 2) which may appear during construction or before completion of Defect Liability Period shall be acceptable with suggested treatments as given in IRC: SP-83.

Cement Concrete Pavement slabs having cracks of severity rating more than 2 i.e. cracks of width more than 0.5 mm for single discrete cracks, multiple and transverse cracks and cracks of width more than 3 mm in case of longitudinal cracks and of depth more than half of the Concrete pavement slabs, shall be removed and replaced as per IRC: SP -83

602.15 Measurements for Payment

602.15.1 Cement Concrete pavement shall be measured as a finished work in cubic meters of concrete placed based on the net plan area and thickness as measured in accordance with Clause 602.15.2.

602.15.2 The finished thickness of concrete for payment on volume basis shall be computed in the manner described in Clause 113.3 with the following modifications:

i) The levels shall be taken before and after construction at grid points 5m centre to centre longitudinally in straight as well as at curves.

ii) A day's work is considered as a 'lot' for calculating the average thickness of the slab. In calculating the average thickness, individual measurements which are in excess of the specified thickness by more than 10 mm shall be considered as the specified thickness plus 10 mm.

602.15.3 Individual areas deficient by more than 10mm shall be verified by the Engineer by ordering core cutting and if in his opinion the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans.

602.16 Rates

602.16.1 The Contract unit rate for the construction of the cement concrete pavement shall be payment in full for carrying out the operations required for the different items of the work as per these Specifications including full compensation for all labour, tools, plant, equipment, providing all materials i.e. aggregates, dowel bars, tie bars, PVC membrane, cement, stabilizers (lime, cements or any other stabilizers approved by the Engineer), storing, mixing, transportation, placing, compacting, finishing, curing, testing, all royalties, fees, rents where necessary, all leads and lifts and incidentals to complete the work as per Specifications.

The unit rate shall all include the full costs of construction, expansion, contraction and longitudinal joints including joint filler, sealant, primer, debonding strip and all other operations for completing the work. The construction and testing of trial length shall be included in the contract unit rate for the pavement and shall not be paid separately.

602.16.2 Where the average thickness for the lot is deficient by the extent shown in Table 600-6, payment for cement concrete pavement shall be made at a price determined by adjusting the contract unit price as per Table 600-6

Table 600-6: Payment Adjustment or Deficiency in Thickness

Deficiency in the Average Thickness of Day's Work	Percent of Contract Unit Price Payable
Up to 5 mm	100
6-10 mm	87

602.16.3 No additional payment shall be made for the extra thickness of the slab than shown on the drawings.

The payment will be made on cubic meter basis of the finished work.

Item No.: - 33.

Providing and fixing pre-cast concrete kerb stone of grey cement based concrete block 30 cm length, 30 cm height and 15 cm thick of M-250 grade concert as per approved design and including excavation for fixing in proper line and level, filling the joint with C:M 1:3 (1 cement : 3 fine sand) including Yellow and Black painting with one coat of priming coat and two coats of oil painting etc. complete.

1.0. General:

This work shall consist of providing and fixing pre-cast grey cement based concrete kerbing of size 30 cm x 30 cm x 10 cm size as per detailed drawing having grade of concrete M-250 grade, including necessary excavation for fixing in proper line and level, filling joints in C.M. 1:3 with smooth finished, including Yellow and Black painting with one coat of priming coat and two coats of oil painting etc. complete. as directed by Engineer in charge.

2.0. Material:

Excavation for fixing block as per Item No. 10 (A) / P-23 of General Technical Specifications for Road Works Booklet.

Pre-cast concrete block of M-250 for kerbing as per approved design and controlled / ordinary concrete mix shall conform as per Item No. 71 / P-80 of G.T.S. Booklet for Road works. The concrete block shall be M-25 grade and 30 cm length, 30 cm height and 15 cm thick size or as per detailed drawing or as directed by Engineer in charge.

Brick bat cement concrete shall confirm to Item No. 78 (B) / P-84 of General Technical Specifications for Road Works Booklet.

The cement mortar for pointing shall conform to Item No. 72 (A) / P-40 of General Technical Specifications for Road Works Booklet.

3.0. Workmanship:

The concrete kerb stone shall be approved design. Before laying of concrete kerb stone the base should be leveled and compacted as directed by Engineer in charge, so that there should not be any settlement afterwards. The kerb block should be of the design such that it gives good flooring appearance. The thickness of the stones work shall be uniform throughout and shall not be less than the height of the riser depending upon the slope of the embankment as stated above

For pointing, the mortar shall be filled and pressed into the raked-out joints before giving the required finished. The pointing shall then be proper type given on the drawings. If type of pointing is not mentioned on the drawing the same shall be ruled pointing. For ruled pointing after the mortar has been filled and pressed into the joints and finished off level with the edges, it shall while still green be ruled along the center with a half round tool of such width as may be specified by the Engineer in charge. The superfluous mortar shall then be cut off from the edgewise of the lines and the surface of the masonry shall also be cleaned off all mortar.

4.0 Primer Coat:

Materials: The ready mixed paint, brushing red lead shall conform to IS: 102-1962.

The thinner (linseed oil) shall conform to IS: 75-1973. If for any reason, tinning is necessary in case of ready-mix paint, the brand of thinner recommended by manufacturer shall be used.

Workmanship:

Preparation of Surfaces: The surfaces to be painted shall be cleaned of all rust, scale, dirt and other foreign matter sticking to it with wire brushes, steel wool, scrapers, sand paper etc. This surface shall then be wiped finally with mineral turpentine which shall also remove grease and perspiration of hand marks. The surface shall then be allowed to dry.

Application of primer: After the preparation of the surface, the priming coat shall be applied immediately. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer of the particular primer. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing alternately in opposite directions, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

During painting, every time after the priming coat has been worked out of the brush bristles or after the brush has been unloaded of the bristles of the brush shall be opened up by striking the brush against portion of the unpainted surface with the end of the bristles, held at right angles to the surface, so that bristles thereafter will collect the correct amount of paint when dipped again into a paint container. The primary coat shall be allowed to dry completely before painting is started.

No hair marks from the brush or clogging at paint puddles in the corner or panels angles of moldings etc. shall be left on the work.

Special care shall be taken while painting over bolts, nuts, rivets overlap etc.

The container when not in use shall be kept close and free from air so that paint does not thicken and also shall be kept guarded from dust.

5.0 Oil Painting:

Materials: The enamel paint shall satisfy in general requirements in specification of oil paints, Enamel paint shall conform to IS: 2933-1975.

Workmanship:

General: The materials required for work of painting work shall be obtained directly from approved manufacturers or approved dealer and brought to the site in maker's drums etc. with seal unbroken.

All materials not in actual use shall be kept properly protected, lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. The materials which have become stale or flat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers, while applying also the paint shall be continuously stirred in smaller container. No left-over paint shall be put back into stock tins. When not in use, the containers shall be kept properly closed.

If for any seasons, thinning is necessary, the brand of thinner recommended by the manufacturer shall be used.

The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt and grease shall be thoroughly removed before painting is started. No painting on exterior or other exposed parts of the work shall be carried out in wet, damp or otherwise unfavorable weather and all the surfaces shall be thoroughly dry before painting work is start.

Application: Brushing operations are to be adjusted to the spreading capacity advised by the manufacture of particular paint. The paint shall be applied evenly and smoothly by means of crossing and lying off. The crossing and laying off consist of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and lying off will constitute one coat.

Each coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand paper and loose particles brushed off before next coat is applied. Each coat shall vary slightly in shade and shall be got approved from Engineer-in-charge before next coat is started.

Each coat except the last cost shall be lightly rubbed down with sand-paper of fine pumice stone and cleaned of dust before the next coat is applied. No hair marks from the brush or clogging of paint puddles in the corners of panels angles of moldings etc. shall be left on the work.

Special care shall be taken while painting over bolts, nuts, rivets, overlaps etc. Approved best quality brushes shall be used.

All the work shall be measured net in the decimal system, as executed subject to the following limits unless otherwise stated hereinafter.

Dimensions shall be measured to the nearest 0.01 meter. Areas shall be worked out to the nearest 0.01 Sqm.

No deductions shall be made for openings not exceeding 0.5 Sqm each and no addition shall be made for painting to beddings, moldings, edges, jambs, soffits, sills etc. of such opening.

The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer in charge for connecting to storm water drains. Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed-off as directed by the Engineer in charge. Nothing extra shall be paid for this.

6.0. Mode of Measurements & Payment:

The rate shall include the cost of all the material, labour and tools including cement pointing to complete the work involved in all the operations described above.

The rate shall include the cost of all conveyance loading unloading and placing in position with compressor pressing etc. complete as directed by Engineer in charge.

The payment will be made on running meter basis of the finished work.

Item No.: - 34.

Providing and fixing pre-cast Rubber Dye / Steel dye inter locking concrete block 60 mm thick with grade of concrete M-300 pneumatic compressed / vibrated by mechanically and as per approved design confirming to IS: 15658-2006, including 35 mm sand layer for levelling and filling the joint with sand in proper line and level as per guidelines of IRC SP: 63-2018 etc. complete.

General:

This work shall consist of providing and laying precast Rubber dye / steel dye interlocking concrete block 60 mm thick with grade of concrete M-300 pneumatic compressed / vibrated mechanically and as per approved design confirming to IS 15658: 2006 including 35 mm thick layer of sand of the shape and dimensions shown on the drawings and conforming to these specifications or as approved by the Engineer in charge.

Material:

Water shall conform to M-1 & Cement shall conform to M-3 of General Technical Specifications for Building Works shall be applicable.

Precast Rubber dye / steel dye interlocking concrete block shall be grade of concrete M-300.

Precast Rubber dye / steel dye interlocking concrete block shall be of approved size brand and make as approved by Engineer in charge.

The size shape and design of precast Rubber dye / steel dye interlocking concrete block shall generally be as per manufacturers product or as directed by the Engineer in charge and Architect.

The precast Rubber dye / steel dye interlocking concrete block shall satisfy the tests as regards compress strength transverse strength resistance to wear and water absorption.

The colour size shape and design of the precast Rubber dye / steel dye interlocking concrete block shall be directed by Engineer or Architect.

The precast rubber dye / steel dye interlocking concrete block shall be of best quality and design & colour shade as approved by the Engineer in charge. They shall be flat and true to shape. They shall be free from cracks, crazing spots, chipped edges, and corners. The glazing shall be of uniform shade.

Sand:

Sand shall be natural sand, clean well graded, hard strong durable and gritty free from immures amounts of dust, clay, kankar modules.

For masonry works sand shall confirm to the requirements of IS: 2116.

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works fine aggregates shall consist of clean, hard strong and durable pieces of crushed stone, crushed gravel or suitable combination of natural sand crushed stone or gravel, they shall not contain dust lumps soft or flaky materials mica or other deleterious materials in such quantities as to reduce the strength and durability of concrete, or to attack the embedded steel. Motorized sand washing machines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS 383 and tests for conformity shall be carried out as per IS 2386 (Part I to VIII) The contractor shall submit to the Engineer in charge the entire information indicated in Appendix A of IS 383. The fineness modulus of fine aggregate shall neither be less than 2.00 nor greater than 3.5.

Sand fine aggregates for structural concrete shall conform to the following grading requirements as shown in the table below.

Fine Sand: The fineness module shall not exceed 1.0 the sieve analysis of fine sand be as under:

IS. Sieve Designation	% by weight passing		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 MC	15-34	35-59	60-79
300 MC	5-20	8-30	12-40
150 MC	0-10	0-10	0-10

Coarse Sand: The fineness modules of coarse sand shall not be less than 2.5 and shall not exceed 3.0. The sieve analysis of coarse sand be as under:

I. S. Sieve Designation	% by weight passing
4.75 mm	100
2.36 mm	90 to 100
1.18 mm	70 to 100
600 MC	30 to 100
300 MC	85 to 70
150 MC	00 to 50

Workmanship:

The precast Rubber dye / steel dye interlocking concrete block shall be laid on a layer 35 mm thick layer of coarse sand. The slope in the floors shall be provided in the sub grade. The base layer shall be properly watered, rammed, and consolidated. Before laying the pavers blocks, it shall be moisture. Plinth masonry offset shall be depressed to allow the sub grade concrete to rest on it.

Precast Rubber dye / steel dye interlocking concrete block of approved quality shape and design and shall be laid evenly to level and slope as directed by Engineer-in-charge over a bed of a base layer consisting of 35 mm thick sand layer.

Laying: The precast Rubber dye / steel dye interlocking concrete block shall be laid in plain, diagonal or another pattern as directed. The cement concrete blocks shall be laid properly and set home by gentle tapping.

End portion of pavement shall be finished with C.M. 1:3 as per detailed drawing etc. complete.

Mode of Measurements & Payment:

The unit rate precast Rubber dye / steel dye interlocking concrete block flooring shall include the cost of all materials, tools and plant required for supplying and laying material like brick bats sand pavers blocks, laying of base layer in true level and slope as required applying & placing pavers blocks in position, compacting, finishing, curing.

The length and breadth shall be measured correct to a square meter correct to 2 places of decimal. Length and breadth shall be measured to correct to a centimeter and between the finished the finished face of the skirting, dedo or wall plaster and no deduction shall be made nor extra paid for any opening in floors or areas up to 0.1 square meter.

The Rate shall also include all tools, plants, equipment, scaffoldings, labour, taxes, conveyance, and other incidentals for satisfactory completion of the work including necessary wastage involved for the work as directed by Engineer-in-charge. No extra payment will be given for any reason.

The payment will be made on square meter basis of the finished work.

Item No.: - 35.

Excavation for foundation in sand, gravel, clay soft soils and murrum etc. including shoring, strutting dewatering as necessary and disposing of the excavated stuff as directed. For all depth with all lead and lift.

1. Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, headwalls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements, of these specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer-in-charge. The work shall be including all necessary sheeting, shoring, bracing, draining and pumping and the removal of all logs, stumps, shrubs, and other deleterious matter and obstruction necessary for the foundations, trimming bottoms of excavations; back filling and clearing up the site and the disposal of all surplus material.
2. After the site has been cleared the limits of excavation shall be sot out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as strings, pegs nails bamboos, stones, lime, mortar, concrete, etc. required in connection with the siting out of works and the establishment of bench mark, centre line stones and other marks and stakes as long as in the opinion of the Engineer-in-charge, they are required for the work.
3. Excavation shall be taken to the width of the lowest step of the footing. The contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personal and works and to the satisfaction of the Engineer-in-charge.
4. The depth to which the excavation is to be carried out shall be is shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer-in-charge.
5. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the contractor shall take adequate measures such as bailing pumping, to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion

or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the contractor but subject to approval of the Engineer-in-charge. Approval of the Engineer in-charge shall, however not relieve the contractor of the responsibility for the adequacy of dewatering, and production arrangements and for the quality and safety of the works.

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

7. The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer-in-charge. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer-in-charge. the extra depth shall be made up with concrete or masonry of the foundation grade at the cost of the contractor. Ordinary filling shall not be used for the purpose to bring the foundation to level. If there are any slips or blows in the excavation, these shall be removed by the contractor at his own cost.

8. Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures.

9. Backfilling shall be done with approved materials after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 250 mm loose layers, which shall be watered and compacted.

10. All the excavated materials shall be the property of the Government. Where the excavated materials are to be used in the construction of embankment, it shall be directly deposited at the required location, within 100 meters lead.

11. All useful materials not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer-in-charge within 100 meters lead. Unsuitable and surplus materials not intended for use shall be disposed-off as directed by the Engineer in charge.

12. Excavation for structures shall be measured in cubic meters for each class of materials encountered, limited to the dimensions shown on the drawing or as directed by the Engineer-in-charge. Excavation over increased width cutting of slopes, shoring, shuttering and planking shall be deemed as convenience for the contractor in executing the work and shall not be measured and paid for separately.

13. The contract unit rate for the items of excavation for structures shall be paid in full for carrying out the required operations including: -

1. Setting out and fixing bench marks and centre lines stones.
2. Construction of necessary shoring and bracing and their subsequent removal.

3. Removal of all logs, stumps, Grubs and other deleterious matter and obstructions for placing the foundations including trimming of bottoms of excavations;
4. Foundation sealing, dewatering including pumping;
5. Backfilling, clearing up the site and disposal, of all surplus material within ail lifts and lead upto 100 meters;
6. All labour, materials, tools equipment, safeguards and incidentals necessary to complete the work to the specification.

14. Excavation shall be for ordinary soil such as vegetation or organic soil, turf, sand, silt, loam, clay, mud, black cotton soil, soft shale or soft murrum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, or other ordinary digging equipment. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

The payment will be made on cubic meter basis of the finished work.

Item No.: - 36.

Providing and casting in situ ordinary cement concrete M-100 mix and providing necessary pin headers including shuttering, scaffolding, laying, vibrating, curing and finishing complete with V-Groves. For all Height as directed.

This item is for providing and filling in foundation with ordinary cement concrete M-150 mix and providing necessary vertical pin headers including formwork, vibrating, ramming and curing complete.

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and coarse aggregates are specified by volume as given in table below for different grades of concrete designated as ordinary M-100, M-150, M-200 and M-250.
2. In the designation of a concrete mix, letter "M" refers to the mix and the number the specified 28 days works cube compressive strength of that mix on 150 mm cubes expressed in Kg / cm².
3. The ordinary concrete mix shall generally be specified by volume. For cement which normally comes in bags and is used by weight, volume shall be worked out taking 50 Kilogram of cement as 0.035 cubic meter in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume. In case it is dump, allowance for "bulking" shall be made as per IS: 2386 (Part-III).
4. Ingredients required for ordinary concrete containing one 50 Kg bag of cement of different proportions of mix shall be as given in Table below.

TABLE

Grade of Concrete	Mix By Volume	Total quantity of dry aggregates by volume Per 50 Kg. of cement, to be taken as sum of the individual volumes of fine and coarse aggregates max.	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 Kg. of cement max.
1.	2.	3.	4.	5
(1 Cubic meter = 1000 Liters)				
Ordinary	Liters			Liters
M-100	1:3:6	300	General 1:2 for fine aggregate to coarse aggregate by volume but subject to a upper limit of 1:1. ½ & a lower limit of 1:3	34
M-150	1:2:4	220		32
M-200	1:1. ½ : 3	160		30
M-250	1:1:2	100		27

NOTE - The proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer & the maximum size of coarse aggregate becomes larger.

Example - For an average grading of fine aggregate (that is Zone II of IS: 383-1963) the proportions shall be 1: 1 ½, 1:2 and 1:3 for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively (after carrying out sieve analysis).

Note-2 A mix leaner than **M-150 (1:2:4)** may be used for non-structural parts, if provided in the contract. In such case grading of aggregates shall be by volume. Other requirements for mixing, placing & curing shall be the same.

5. Following shall be the maximum nominal size of coarse aggregate for the different items of work:

Sr. No.	Item of construction	Maximum nominal size of coarse aggregate
(i)	R.C.C. well curb, R.C.C. well staining and R.C.C. Piles	40 mm
(ii)	R.C.C. wall staining	63 mm
(iii)	Well cap or pile cap; solid type pipes, abutment and wing walls and their pier caps.	40 mm
(iv)	R.C.C. works in cross girders deck slab, wearing coats, kerb, light posts, blast walls, approach slab etc. and hollow type piers, abutments, wing walls and their pier caps:	20 mm
(v)	R.C.C. bearings.	20 mm
(vi)	For any other item of construction not covered by items (i) to (v)	As specified on the drawing or as desired by the Engineer-in-charge in case it is not specified on drawing.

For heavily reinforced concrete members as in the case of fibs of main beams nominate maximum size of aggregate shall usually be restricted to 5 mm less than the minimum lateral clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement, whichever is the smaller.

6. Fine aggregate shall be clean, hard, coarse sand; it shall be free from dust and such other substances. The sand be got approved by the Engineer-in-charge,

7. All materials shall be stored as to prevent their deterioration or intrusion of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the works.

8. Cement shall be stored above the ground level in perfectly dry and water tight sheds. Wherever bulk storage containers are used, their capacity should be sufficient to cater to thy requirements at site and should be cleaned at least once every 3 to 4 months. The aggregate shall be stored in such a way as to prevent admixture of foreign materials. Different size of fine or coarse aggregate shall be stored in separate stock-piles sufficiently away from the each other to prevent inter mixing the material.

9. The water for mixing shall be potable water to satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.

10. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate show complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

11. When hand mixing is permitted by the Engineer in-charge for small jobs or for certain other reasons. It shall be done in a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 per cent above that specified.

12. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

13. The method of transporting and placing concrete shall be approved by the Engineering-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes places. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No

concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer in charges. Concreting being given it shall proceed 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. Concrete shall be compacted in its final position within 30 minutes of its discharge from (he mixer unless carried in properly design agitators, operating continuously, when this time shall be within 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator Except where otherwise agreed to be the Engineer in charge, concrete shall be deposited in horizontal layers to a compacted depth of nor more than 0.45 meter when internal vibrators are used and not exceeding 0.30 meter in all other cases.

15. Unless otherwise agreed to by the Engineer in charge concrete shall not be dropped into place from a height exceeding 2 meters. When trucking or chutes are used, they shall be kept clean and used in such a way as to avoid segregation. 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. This 13 mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the well surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness and shall be well rammed against old work particular attention being given to corners and close spots.

16. All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators cannot be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.

17. Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and driving out process. It shall be covered with wet sacking, hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation may be started after 48 hours of its laying but the curing of concrete shall be continued for a period of 14 days.

18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Form work shall however be divided into following two distinct categories: -

(1) Shuttering i.e., form work required for forming the concrete.

(2) Scaffolding i.e., form work required for supporting shuttering.

Forms for shuttering shall be constructed only in metal suitably lined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be of substantial –rigid

construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and rivets shall be counter-sunk and well ground to provide a smooth, plane surface.

19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration, without deflection from the prescribe lines occurring during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure, especially in long spans to counteract the effects of any fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chambers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

20. The inside surfaces of shuttering shall, except in the case of permanent form work or where otherwise agreed to by the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement or pre-stressing tendons and anchorages. Different release agents shall not be used in form work for concrete which will be visible in the finished works.

21. Special measures shall be taken to ensure that the form work does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Where ever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures having regard to the deformation of a false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting pre-stressed structures. Where there are re-entrant angles in the concrete sections the form work should be removed at those sections soon as possible after the concrete has set in order to avoid cracking due to shrinkage of concrete, from work shall be tight enough to prevent any appreciable loss of cement during vibrations, suitable utterances should be provided in the harm work. 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 false work and forms as to their strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility safety of men, machinery, materials and for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete, the removal of the load-supporting or soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subjected at the time of striking props including the effect of any further addition of loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and walls may be removed after 2 days. The props of slabs and beams may be removed after Hand 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Centering shall be

gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25 mm cover to the finished concrete surface. Where it is intended to refuse the formwork, it shall be cleaned and made good to the satisfaction of the Engineer in charge.

23. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm below the surface of the concrete and the resulting holes be filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry as consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty-four hours. If rock pockets / honeycombs, in the opinion of the Engineer-in-charge are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

24. In the case of reinforced concrete work workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and methods of vibration of concrete, shall be determined by regular slump tests. Following slump shall be adopted for different types of works.

	Type of Work	Slumps Were vibrators are used	Were vibrators are not used
(i)	Mass concrete in R.C.C. foundations, footings and retaining walls	10 mm to 25 mm	80 mm
(ii)	Beams, slabs and columns simply reinforced.	25 mm to 40 mm	100 mm to 120 mm
(iii)	Thin R.C.C. section or section with congested Steel	40 mm to 50 mm	125 mm to 150 mm

25. Works strength tests shall be made in accordance with IS: 516. Each test shall be conducted on ten specimens/five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic meter of concrete or a part thereof. However, if concreting done in & day is less than 15 cubic meters, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveal a poor quality of concrete and in other special cases.

26. The average strength of the group of cubes cast for each day shall not be less than the specified works cube-strength. 20 per cent of the cubes cast for each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall provide so that steel reinforcement in position is not disturbed. For ensuring proper cover, motor blocks of suitable size shall be cast and tied to the reinforcement. Timber, Kapchi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Assistant Engineer / Additional Assistant Engineer, Overseer or as instructed by the Engineer-in-charge. After removal of form work checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

29. All necessary labour, materials, equipment, etc., for sampling, preparing test cubes, curing etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

30. The payment will be made on Cubic meter basis of the finished work.

31. The unit rate for concrete shall include the cost of all materials, labour, tools and plan required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as show on the drawings and according to these specifications. The rate shall also include the cost of making / fixing and removing of all centers and forms required for the work.

Item No.: - 37.

Providing and casting in-situ controlled cement concrete M-200 for R.C.C. Return as per drawings including centering shuttering, scaffolding where necessary, laying vibrating, curing and finishing etc. complete. For all Height as directed (1) Piers (2) Abutment (3) RCC Return

The grade of concrete shall be M-200. The concreting shall be done for pier cap abutment cap and dirt wall including controlled cement concrete M- 250 bed block or pedestals of required size below bearing as per detailed drawing. The contract unit rate includes centering, shuttering, scaffolding, wherever necessary laying, vibrating, curing and finishing complete. The contract rate shall be for a unit of 1 Cum for completed item.

Controlled Concrete

1. For controlled concrete, design of the mix shall be approved after preliminary tests and all necessary precautions shall be taken in its production to ensure that the required works cube strength is attained and maintained. The controlled concrete shall be in eight grades designated as M-100, M-150, M-200, M-250, M-300, M-350, M-400 and M-450 with the suffix controlled added to it.

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cubs' compressive strength of that mix on 150 mm. cubes, expressed in kg/cm² where ordinary Portland cement conforming to IS: 269 or Portland blast furnace cement Conforming to IS:

455 is used, the compressive strength, requirements for various grades of concrete shall be as given below:

Grade of Concrete		Compressive works test strength in kg/Cum on 150 mm. cubes, conducted in accordance with IS: 516	
		Min. at 7 days	Min. at 28 days
M 100	--	70	100
M 150	--	100	150
M 200	--	135	200
M 250	--	170	250
M 300	--	200	300
M 350	--	235	350
M 400	--	270	400
M 450	--	300	450

NOTE - In all cases, the 28 days compressive strength specified in the above Table shall alone be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in the above Table such concrete shall be classified for all purposes as a concrete belonging to the lower or the two grades between which its strength lies.

3. Concrete mix shall be designed on the basis of preliminary tests so as attain strength at least 33 per cent higher than that required on work tests. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available. Except where it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be controlled by obtaining the coarse aggregates in different sizes and blending them in the right proportions as required. Aggregates of different sizes shall be stocked in separate stock piles. Required quantity-of material shall be stock piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

4. In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the maker's weight per bag, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stocks at site and not by bags, it shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

5. It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture cement. For the determination of moisture content in the aggregates, IS: 2386 (Part -II) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. Minimum quantity if cement to be used in controlled concrete shall not be less than 210 Kg. per cubic meter in plain concrete and not less than 300 kg/per cubic meter in reinforced concrete structural members. The minimum quantity of cement for pre-stressed concrete work shall not less than 360 kg/per cubic meter of concrete nor shall it be more than 540 kg/per cubic meter of concrete.

6. Following shall be the maximum nominal size of coarse aggregate for the different items of work:

Sr. No	Item of construction	Maximum nominal size of Coarse aggregate
	R.C.C. well curb, R.C.C. well staining and R.C.C. piles.	40 mm
	P.C.C. well staining	63 mm
	Well cap or pile cap; solid type piers, abutments and wing-walls, their pier caps.	40 mm
	R.C.C. work in cross girders, deck slab, wearing coarse, kerb, light posts, blast walls approach Slab etc., and hollow type piers, abutments, wing-walls and their pier caps.	20 mm
	R.C.C. bearings	20 mm
	For any other item of construction not covered by items (i) to (v) above	As specified on the drawing or as desired by the Engineer-in-charge in case it is not specified on drawing.

For heavily reinforced concrete members as in the case of ribs of main beams; nominal maximum size of aggregate shall usually be restricted to 5 mm. less than the minimum lateral clear distance between the main bars or 5 mm. less than the minimum cover to the reinforcement whichever is the smaller.

7. Fine aggregate shall be clean, hard, coarse sand. It shall be free dust and such other substances. The sand be get approved by the Engineer-in-charge.

8. All materials shall be stored as to prevent their deterioration of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the works.

9. Cement shall be stored above the ground level in perfectly dry and watertight sheds. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirements at site and should be cleaned at least once every 3 to 4 months. The aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of fine or coarse aggregate shall be stored in separate stock piles sufficiently away from such other to prevent inter mixing the materials.

10. The water for mixing shall be potable water to satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required work ability for the job.

11. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

12. Mixer which has been out of use more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

13. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes place. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. 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 then shall proceed 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. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer-unless carried in properly design agitators, operating continuously when this time shall be within 3 hours of the addition of cement to the mix a within 30 minutes of its discharge from the agitator. 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 0.45 meter when internal vibrator is used not exceeding 0.30 meter in all other cases.

15. Unless otherwise agreed to be the Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 meters. When trunking or chutes are used, they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept clean, thoroughly wetted and covered with a 10 mm. thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed arid then coated with neat cement grout. The first layers of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old particular attention being given to corners and close sports.

16. All concrete shall be compacted to produce a dense homogeneous mass with the assistance of Vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators cannot be used. Sufficient vibrator in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.

17. Immediately after compaction, concrete shall be protected against harmful effects of weather including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and drying out process. It shall be covered with wet sacking, Hessian or other similar absorbent material approved by the Engineer-in- charge soon after the initial set and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days.

18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Formwork shall however be divided into following two district categories:

(1) Shuttering i.e., from work required for forming the concrete.

(2) Scaffolding i.e., formwork required for supporting shuttering.

Forms for shuttering shall be constructed only, in metal suitably fined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be substantial rigid construction and shuttering shall be true to shape and dimensions show on the drawings. All bolts and rivets shall be counter-suck and well ground to provide a smooth, plane surface.

19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to with stand all pressure, ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure especially in long spans to counter act the effects

of any deflection. The formwork shall be so fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

20 The inside surface of shuttering shall, except in the case of permanent form work or where otherwise agreed to be the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcements or prestressing tendons and anchorages. Different release agent shall not be used in form work for concrete which will be visible in the finished works.

21. Special measures shall be taken to ensure that the form does not binder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The formwork should take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structure having regard to the deformation due of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting pre-stressed structures. Where they are re-entrant angles in the concrete sections the form work should be removed at these sections as soon as possible after the concrete has set in order to avoid cracking due to shrinkage of concrete. Form work shall be tight enough to prevent any appreciable loss of cement during vibrations. Suitable tolerance should be provided in the formwork. 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 false work and forms as to their strength, alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of men, machinery, materials and for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions that influence the setting of concrete and of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete the removing of the load supporting of soffits forms may commence when concrete has attained strength props including the effect or any further additional of loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and walls may be removed after 2 days, the props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to cleaned and made good to the satisfaction of the Engineer-in-charge.

23. Immediately after the removal of forms, &I exposed bars; or bolts passing through the Cement Concrete member to a depth of at least 25 mm. below the surface of the. Concrete with the resulting holes be Red by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure through filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty-four hours. If rock pockets/honey-combs, in the opinion of the Engineer-in-charge are of such an extent or character as to affect the strength of the structure

materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

24. In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and methods of vibration of concrete, shall be determined regular slump tests. Following slump shall be adopted for different types of works.

Type of work	Slumps	
	Where vibrators are used	where vibrators are not used
Mass concrete in R.C.C. foundations, footings and retaining walls	10 mm to 25 mm	80 mm
Beams, slabs and columns simply reinforced	25 mm. to 40 mm	100 mm. to 120 mm
Thin R.C.C. section or section with congested steel 50 mm 150 mm	40 mm. to 50 mm	125 mm to 150 mm

25. For controlled concrete preliminary tests shall consist of three sets of separate tests, and in each set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day of the six specimens in each set; three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to be attained at 28 days. Work strength tests shall be made in accordance with IS: 516. EACH test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 23 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic meter of concrete or a part thereof. However, if concreting done in a day is than, 15 cubic meters, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in- charge. Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure to tests given above reveals a poor quality of concrete and in other special cases.

26. The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength 20 per cent of the cubes cast each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position as not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, Kapchi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Assistant Engineer / Additional Assistant Engineer / Overseer or as instructed by the Engineer-in-charge. After removal of form work and shuttering, the Executive Engineer shall inspect the work and satisfies by random checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

29. All necessary labour, materials equipment, etc., for sampling, preparing test cubes, curing etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

30. The payment will be made on cubic meter basis of the finished work.

31. The unit rate for concrete shall include the cost of all materials, M-200 mix, labour, tools and plant required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as shown on the drawings and according to these specifications. The rate shall also include the cost of making fixing and removing of all center and forms required for the works.

Item No.: - 38.

Providing and fixing in position FE-500D T.M.T. bar reinforcement including cutting, bending and tying complete as per detailed drawings. (A) R.C.C. Kerb (B) R.C.C. Footpath (C) R.C.C. Approach slab (D) Wearing Coat etc. complete.

1601. Description:

This work shall consist of furnishing and placing coated or uncoated mild steel or high strength deformed reinforcement bars of the shape and dimensions shown on the drawings and conforming to these Specifications or as approved by the Engineer.

1602. General:

Steel for reinforcement shall meet the requirements of Section 1000 of these specifications.

Reinforcements may be either mild steel or high strength deformed bars. They may be uncoated or coated with epoxy.

1603. Protection of Reinforcement:

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing, etc., as directed by the Engineer. Reinforcements shall be stored on blocks, racks or platforms and above the ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification.

Portions of uncoated reinforcing steel and dowels projecting from concrete, shall be protected within one week after initial placing of concrete with a brush coat of neat cement mixed with water to a consistency of thick paint. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete. Coated reinforcing steel shall be protected against damage to the coating. If the coating on the bars is damaged during transportation or handling and cannot be repaired, the same shall be rejected.

In case of fusion bonded epoxy coated reinforcement or hot dipped galvanized bars used, reference shall be made Clause 1010.3.2 of Section 1000 of these specifications.

1604. Bending of Reinforcement:

Bar bending schedule shall be furnished by the Contractor and got approved by the Engineer before start of work.

Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.

Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer using a proper bar bender, operated by hand or power to obtain the correct shape and radii of bends.

Bars shall not be bent or straightened in a manner that will damage the parent material or the coating.

Bars bent during transport or handling shall be straightened before being used on work. They shall not be heated to facilitate straightening.

1605. Placing of Reinforcement:

- a) The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcements and casting of concrete, which may remit in rust formation on the surface, shall not be permitted.
- b) Reinforcement bar shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS: 280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1 mm.
- c) Bars shall be kept in position usually by the following methods:
 - i) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed between the bars and formwork subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer, provided they have the same strength and specification as those of the member.
 - ii) In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed up to a level just below their location.
 - iii) Layers of reinforcements shall be separated by spacer bars at approximately one-meter intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.
 - iv) Necessary stays, blocks, metal chain, spacers, metal hangers, supporting wires etc. or other subsidiary reinforcement shall be provided to fix the reinforcements firmly in its correct position.
 - v) Use of pebbles broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.

- d) Bars coated with epoxy shall be placed on supports that do not damage the coating. Supports shall be installed in a manner such that plane of weakness is not created in hardened concrete. The coated reinforcing steel shall be held in place by use of plastic or plastic coated binding wires especially manufactured for the purpose. Refer Section 1000 of these specifications for other requirements.
- e) Placing and fixing of reinforcement shall be inspected and approved by the Engineer before concreting is commenced.

1606. Bar Splices:

1606.1. Lapping

All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, shall be permitted without approval of the Engineer. The lengths of the splice shall be as indicated on drawing or as approved by the Engineer. Where practicable, overlapping bars shall not touch each other, and shall be kept apart by 25 mm or 1.25 times the maximum size of coarse aggregate, whichever is greater. If this is not feasible, overlapping bars shall be bound with annealed steel binding wire not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points along the span where stresses are low.

1606.2. Welding

1606.2.1. Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Engineer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

1606.2.2. While welding may be permitted for mild steel reinforcing bars conforming to IS: 432, welding of deformed bars conforming to IS: 1786 shall in general be prohibited. Welding may be permitted in case of bars of other than Fe 240 grade including special welding grade of Fe 415 grade bars conforming to IS: 1786, for which necessary chemical analysis has been secured and the carbon equivalent (CE) calculated from the chemical composition using the formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mg + V}{5} + \frac{Ni + Cu}{15}$$

is 0.4 or less

1606.2.3. The method of welding shall conform to IS: 2751 and IS: 9417, any supplemental specifications and clause 1904.8 of these Specifications to the satisfaction of the Engineer.

Welding may be carried out by metal arc welding process. Oxy-acetylene welding shall not be permissible. Any other process may be used subject to the approval of the Engineer and necessary additional requirements to ensure satisfactory joint performance. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed.

All bars shall be butt welded except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded. Single-V or Double-V butt joints may generally be used. For vertical bars single bevel or double bevel joints may be used.

Welded joints shall be located well away from bends and shall be not less than twice the bar diameter away from a bend.

Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary shall, however, be permitted when the facilities, equipment, process, consumables, operators and welding procedure, are adequate to produce and maintain uniform quality at par with that attainable in shop welding to the satisfaction of the Engineer.

Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall be qualified by tests prescribed in IS: 2751. Inspection of welds shall conform to IS: 822 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not be accepted.

Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding. When welding is done in two or three stages, the surface shall be cleaned properly after each stage. Bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before carrying out welding. Only competent and experienced welders shall be employed on the work with the approval of the Engineer. No welding shall be done on coated bars.

M.S. electrodes used for welding shall conform to IS: 814.

1606.2.4. Welded joints shall preferably be located at points where steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that at any one section, not more than 20 percent of the bars are welded.

1606.2.5. Specimens of Welded pieces of reinforcement taken from the site shall be tested. The number and frequency of tests shall be as directed by the Engineer.

1606.3. Mechanical Couplers and Anchorages:

1606.3.1 Mechanical Couplers:

Bars may be joined with approved patented mechanical devices as indicated on the drawing or as approved by the Engineer e.g., by special grade steel sleeves swaged on to bars in end-to-end contact or by screwed couplers. In case such devices are permitted by the Engineer, they shall develop at least 125 percent of the characteristic strength of the reinforcement bar.

1606.3.2 Anchorages:

Bars may be anchored with approved patented mechanical anchorages as indicated on the drawing or as approved by the Engineer. The anchorages shall be connected to the reinforcing bar by the use of taper thread system. The anchorage shall be capable of developing the characteristic strength of reinforcement without damage to concrete and shall have sufficient diameter and width to develop adequate shear cone strength. The connection shall develop 125% of the characteristic strength of reinforcement bar.

1607. Testing and Acceptance:

The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, will be got carried out by the Contractor at his own cost.

The supply, fabrication and placing of reinforcement shall be in accordance with these specifications and shall be as checked and accepted, by the Engineer.

Manufacturer's test certificate regarding compliance with Indian Standards for each lot of steel, shall be obtained and submitted to the Engineer. If required by the Engineer, the Contractor shall carry out confirmatory tests in the presence of a person authorized by the Engineer. Cost of these tests shall be borne by the Contractor. The sampling and testing procedure shall be as laid down in IS: 1786. If any test piece selected from a lot fails, no re-testing shall be done and the lot shall be rejected.

1608. Measurements for Payment:

For payment, the bar shall be measured correct up to 10 mm length and weight payable works out at the rate specified below:

Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of IS: 1732. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

1609. Rate:

The contract unit rate for coated / uncoated reinforcement shall cover the cost of material, royalty, fabricating, transporting, storing, bending, placing, binding and fixing in position as shown on the drawings and as per these Specifications and as directed by the Engineer, including all labour, equipment, supplies, incidentals, sampling, testing and supervision.

The unit rate for coated reinforcement shall be deemed to also include cost of all material, labour, tools and plant, royalty, transportation, and expertise required to carry out the coating work as well as sampling, testing and supervision required for the work. **No Payment shall be made for Laps.**

The payment will be made on M.T. basis of the finished work.

Item No.: - 39.

Providing and laying weep hole in abutments and returns by using A.C. pipe of 100 mm including laying in proper grade and jointing the completed as per detailed specification.

The item is for providing and laying weep hole in abutment.

The A. C. pipes required for weep holes should be of approved make and quality and shall be got approved from the Engineer in charge.

The weep holes shall be of A. C. with internal dia of 100 mm.

In case of abutment and wing walls weep holes shall be provided to drain moisture from back filling the weep holes. Shall extend through the full width of the masonry with slope of about vertical to horizontal towards the draining face. The spacing of weep holes shall be generally 1 M in either direction with the lowest one at about 15 CM above the low water level or ground level whichever is higher or as directed by the Engineer in charge.

Measurement shall be per number of weep hole.

Unit rate includes cost of all materials, labour and tools to complete the work.

The payment will be made on Number basis of the finished work.

Item No.: - 40.

Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification.

Well graded pebbled or metal of 40 mm to 63 mm size shall be used for providing filter media of 600 mm thick at the back of abutments, returns and wing walls as per detailed specifications. The grading and tolerances of metal of pebbles shall be as under:

Sr. No.	No. of size range	Sieve designation	Percentage by weight Passing Through the sieve.
1	63 mm to 40 mm	90 mm	100 – 00
		63 mm	85 – 100
		50 mm	35 – 70
		40 mm	00 – 15
		20 mm	00 – 05

The size shall be 40 mm to 63 mm where in tolerance limit for over size shall be up to 15% and that for lower size should be up to 15% and below 20 mm, it shall be allowable up to 5%. The filter material shall be tightly placed to a thickness of not less than 600 mm and provided over the entire surface behind abutments, wings or return walls to the full height.

Materials shall be first stacked in boxed of 2 m x 1.5 m x 0.5 m size on fairly level ground and measured.

The measurement for payment shall be made on Sqm basis No deduction shall be made for voids.

The unit rate includes the cost of materials, scaffolding labour, and tools to complete the work.

Item No.: - 41.

Providing Uncoursed rubble stone pitching in Cement Mortar 1:5 for flooring including curing pointing in Cement Mortar 1:3 on exposed faces complete etc. complete as per instruction of Engineer in charge.

Uncoursed rubble stone pitching:

1. Stone shall be hard, sound free from cracks decay and weathering and shall be freshly quarried from approved quarry. Stone, with round surface shall not be use. The Stones when immersed in water for 24 hours shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS: 1125. The length of stone shall not exceed three times its height and the breadth on base shall not be greater than three fourth of the thickness of wall not less than 15 cm. Minimum crushing strength of stone shall not be less than 105 Kg / Sqcm.
2. Cement and sand shall be mixed in proportion as a specified in the item. Cement and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall than be added and the mortar mixed to produce workable consistency.
3. The mixing shall be done intimately, on a clean water tight platform. Cement and sand Shall be first mixed dry in the required proportion to obtain a uniform colour and then after addition of water the mortar shall be mixed for at least two minutes. In case cement mortar has stiffened because of evaporation of water, the same shall be re-tempered by adding water as frequently as needed to restore the requisite consistency but this re-tempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.
4. Dressing of stone shall conform of the general requirements for dressing of stone covered in IS: 1129. Stone shall be sufficiently wetted before laying to prevent absorption of water from mortar. The bed which is to receive the stones shall be cleaned wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and in vertical joints and settled carefully in place with a wooden mallet immediately on placement so that it is solidly bedded in before the same has set. Clean chips and spauls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. Whenever foundation, masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. Vertical joints shall be staggered as far as possible. Sufficient transverse bond shall be provided by the use of bond stones extending from the front to the back of the masonry. In case of thick waifs Bond stones shall overlap each other their arrangement. Bell shaped bond stones or headers shall not be used.
5. At all angular junction stones at each alienate course shall be well bonded into the respective course of the adjustment wall. Ail connected masonry in structure shall be carried up at one uniform level throughout as far as possible but when breaks, are unavoidable, he masonry shall be raked in sufficient long steps to facilitate jointing of new work with old. The stepping of ranking shall not be more than 45° with the horizontal. Wing walls, abutments and piers, etc. shall be carried up truly plumb or to the specified batter. Face work and hearting shall be brought up evenly. The top of each course, however shall not be levelled up by use of fiat chips.
6. Stones shall be hammer dressed on the face, the sides and beds to enable it to come in proximity with the neighboring stone. The bushing on the face shall be more than 4 cm. on exposed face. Chips and spalls of stones may be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are left anywhere in me masonry. The chips shall not be used below hearting stones to bring these upto the level of face stones use of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 per cent of the quantity of stone masonry.

7. The hearting or interior filling wall face shall consist of rubble stones not less than 15 cm in any direction carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid early level with facing and backing. Through bond stones shall be provided in masonry upto 60 cm thickness and in case of masonry above 60 cm, thickness a set of two or more bond stones overlapping each other at least by 15 CM, shall be provided in a line from face to back. In case of highly absorbent type of stones (porous limestone and sand stones, etc.) the bona stone shall extend only about two-third into the wall, as through stone in such cases may give rise to penetration of dampness and, therefore, for all thickness of such masonry a set of two or more bond stones overlapping each other by at least 15 cm shall be provided for every 0.50 square meters of the masonry surface. Bond stone shall be stacked separately and marked to distinguish from other stones. Masonry work shall be started after sufficient number of bond stones are collected on site as directed by the Engineer-in-charge. Vertical bound stones shall be inserted at the rate of one per 3 Sqm and shall be staggered.

8. The quoins shall be laid header and stretcher alternately. Every stone shall be fitted to the adjacent stones so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints, as much as possible. and to avoid long vertical lines of joints.

9. The face joints shall be more than 20 mm thick but be sufficiently thick to prevent stone to stone contact and shall be completely filled with mortar.

10 Green work shall be protected from rain by suitable covering. Masonry work in cement or composite mortar shall be kept consistently moist on surface for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day. During hot weather all finished or partly completed work shall be covered or wetted in such manner as to prevent repaid drying. The raking of joints, where necessary shall be done at the end of day's work when mortar is green.

11. The scaffolding shall be found and strong to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one meter in width or immediately near the screw backs or arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good

12. When fresh masonry is to be placed against existing surface of structure, these shall be cleaned of all loose material, roughened and wetted as directed by the Engineer in charge as to affect a good bond with the new work.

Pointing in C.M. 1:3:

1. For a surface which is to be subsequently jointed, the joints shall be squarely raked out to a depth of 15 mm. while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned, and wetted.

2. Cement and sand shall be mixed in proportions as specified in the item. Cement and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall then be added and the mortar mixed to produce workable consistency.

3. The mixing shall be done intimately by hand-mixing. The operation shall be carried out on a clean watertight platform and cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then the mortar shall be mixed for at least two minutes after addition of water.

In case of cement mortar, that has stiffened because of evaporation of water, the same shall be re-tempered by adding water as frequently as needed to restore the requisite consistency but this re-tempering shall be permitted only with thirty minutes from the time of addition of water at the time of initial mixing.

4. For pointing, the mortar shall be filled and pressed into the raked-out joints before giving the required finish. The pointing shall then be finished to proper type given on the drawings. If type of pointing after the mortar has been filled and pressed into the joints and finished off level with the edge of the bricks, it shall while still green be ruled along the center with a half round tool of such width as may be specified by the Engineer in charge. The superfluous mortar shall then be cut off from the edges of the lines and the surface of masonry shall also be cleaned of all mortar.

5. Curing shall be started as soon as the mortar used for finishing has hardened sufficiently not to be damaged when watered. It shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damage.

6. Stage scaffolding shall be approved for the work. This shall be independent of the structure.

Mode of Measurements & Payment:

The item should be carried out as per item description and as per the instruction of Engineer in charge. The unit rate for stone masonry work shall include the cost of all labour, materials, tools and plant, scaffolding and other expenses incidental to the work. No extra charge will be paid for any other reasons.

The payment will be made on cubic meter basis of the finished work.


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