

Item wise Detailed Specifications

Part I Road

Item No 1

Clearing and grubbing road land including uprooting rank vegetation grass bushes, shrubs, sapling and trees girth upto 300 mm removal of stumps of trees cut earlier and disposal of unserviceable materials and same to be used auctioned including all lead and lift or as directed by engineer in charge also including removal and disposal of top organic soil not exceeding 150 mm thickness by mechanical means in area of thorny jungle.

1.1. Scope

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed less than one month in advance of earthwork operations and in accordance with the requirements of these specifications. Areas requiring clearing and grubbing shall be determined by the Engineer. The contractor shall arrange for all the permissions from competent government authorities for completion of this item.

1.2. Preservation of Property/Amenities

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

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

1.3. Methods, Tools and Equipments

Only such methods, tools and equipment as are approved by the Engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree

stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Notwithstanding the above provisions, the Contractor shall obtain the Engineers express approval before removing any trees with diameter greater than 100mm. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these limits, trees and stumps required to be removed as directed by the Engineer shall be cut down to 1 m below ground level so that these do not present an unsightly appearance.

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

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

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

1.4 Disposal of Materials

All materials arising from clearing and grubbing operations shall be the property of Government and shall be disposed of by the Contractor as hereinafter provided or directed by the Engineer.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the Engineer. Stacking of stumps, boulders, stones etc., shall be done at specified spots with all lifts and upto a lead of 2000 m.

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

1.5. Measurements for Payment

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

The payment shall be made unit of a Hectare.

Item No 2

Earth work for embankment having CBR not less than 8% using yellow earth brought from out side with all lead & lift having PI value less than 15 including braking clods, dressing with all lead & lift, and including watering, rolling and consolidation of sub-grade in layers not exceeding 200 mm thickness at OMC to required dry density including filling the depressions which occur during the process using earth compactor.

Item to be executed as per directed by Engineer in charge.

The payment shall be made unit of a cum.

Item No 3

Graded Granular sub base (GSB)

Construction of granular sub-base by providing & laying of compacted thickness of 200 mm Grading 5th Granular sub base (GSB) in Two equal layers (each layer should be less than 125 mm) of graded granular material consisting of machine cut black trap stone aggregate as per grading - V given in table 400-1 of the specification MORT&H and compactor to the required density with vibratory roller in all seasons as per MORT&H, maintaining the required slope & grade during the operation as approved by the engineer in charge & watering to the proper moisture content and sprinkled with the help of truck mounted water tank fitted with suitable arrangement. (fully saturated having CBR value minimum 30)

Scope: This work shall consist of laying and compacting well-graded material on prepared subgrade 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.

Materials

The material to be used for the work shall be **machine cut black Trap stone aggregate, as per grading - V given in table 400-1 of the specification MORT&H**. The material shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table 400-1. While the grading in Table 400-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding grading for the coarse- graded materials for each of the three maximum particle sizes are given

TABLE 400-1. GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS

IS Sieve	Per cent by weight passing the IS sieve					
Designation	Grading I	Grading II	Grading III	Grading VI	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	10-0	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	10-25	10-15	--	--	0-5	0-8
0.075 mm	<5	<5	<5	<5	--	0-3

TABLE 400-2. GRADING FOR COARSE GRADED GRANULAR SUB -BASE MATERIALS

IS Sieve	Per cent by weight passing the IS sieve		
Designation	Grading I	Grading 11	Grading III
75.0 mm	100	--	--
53.0 mm		100	--
26.5 mm	55-75	50-80	100
9.50 mm	10-30	15-35	25-45
4.75 mm			
2.36 mm			
0.425 mm	<10	<10	<10
0.075 mm			
CBR Value (Minimum)	30	25	20

Note: - The material passing 425 micron (0.425 mm) sieve for all the here grading when vested according to IS : 2720 (Pan 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

Strength of sub-base

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

Construction Operations

Preparation of subgrade: Immediately prior to the laying of sub-base, the subgrade 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.

Spreading and compacting: The sub-base material of grading specified in the Contract 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.

When the sub- base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix- in-place method.

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

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot- drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0,7 MN/m² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super- elevation and shall commence at the edges and progress towards the centre for portions having crossfall on both sides. Each pass of the roller shall uniformly overlap not less than one- third of the track made in the preceding pass. During rolling, the grade and crossfall (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 desired density is achieved 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.

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.

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

Measurements for Payment: Granular sub -base shall be measured as finished work in position in cubic metres. 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.

Rate: The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for: Making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions; furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts; all labour, tools, equipment and incidentals to complete the work to the Specifications; carrying out the work in pan widths of road where directed; and carrying out the required tests for quality control.

9.0 TESTING OF MATERIAL

9.1 A site Testing Laboratory shall be set up by the contractor at his own cost. The equipments for following tests, in addition to the equipment already specified, are to be arranged by the contractor.

9.1.1 Aggregate Impact value (IS: 5640)

9.1.2 Sieve Analysis of Coarse and Fine aggregate (IS: 2386 Pt 1)

9.1.3 Flakiness Index (IS: 2386 Pt 1)

9.1.4 Moisture Content (IS: 2720 Pt II)

9.1.5 Plasticity (IS: 2720 Pt V) 9.1.6 Proctor Density test (IS 2720 Pt VIII)

9.1.7 Field Density (IS 2720 Pt III) 9.1.8 Water Absorption test (IS 2720 Pt III)

9.1.9 Surface Moisture Content of aggregates

9.2 Wherever possible, the materials shall be got tested at site lab of the contractor.

The cost of samples including packing, transportation and other incidental charges shall be borne by Contractor.

9.3 The testing of materials, if required by the Officer-in -charge of the Quality control wing of NBCC or his authorized representative, beyond specified frequency of testing shall also be carried out at site laboratory of the contractor or wherever possible by the contractor without any extra cost. The cost of samples including packing, transportation and other incidental charges shall be borne by the contractor.

9.4 In case the tests are conducted at any laboratory other than site laboratory of the contractor, the testing charges shall be borne by the contractor. Here the selection of laboratory will be done by Engineer-in-charge. However cost of samples including packing, transportation, and other incidental charges shall be borne by the contractor.

9.5 The test result shall be final and binding on the contractor. The decision of Engineer-in-charge in this regard shall be final and binding on the Contractor.

9.6 All necessary tests as per CPWD specification / relevant BIS codes shall be carried out on all the materials whether ISI marked or otherwise. Wherever CPWD specification / relevant BIS codes are not available the tests shall be carried out as per directions of Engineer-in charge. Nothing extra will be payable on this account.

9.7 At the time of handing over of completed work to the department all the damages, pot holes and undulations caused by any traffic shall be made good and road repaired properly by the contractor to the satisfaction of Engineer-in-charge.

Nothing extra shall be payable to the contractor.

9.8 Necessary platforms of required size etc shall be made by the contractor to prevent the blinding material (for W.B.M) and other items of work from coming into direct contact with the local soil. Nothing extra will be payable to the contractor.

9.9 Geo Textile and Geo-grid material testing should be approved by BTRA and the ultimate tensile strength of bi-axial geo grid and remaining material properties should be satisfied as per IRC:113-2013.

10.0 No payment will be made to the contractor for damages caused by cyclones, hurricanes, sand storms, flood waters or by pounding of water due to any reason etc, during execution of the work and no claims on these accounts will be entertained.

11.0 Some restrictions may be imposed by the security staff/BSF/Army etc on the working and /or movement of labour, vehicles, materials etc on BSF Link roads and in Ran of Kutch and contractor shall be bound to follow all such restrictions/ instructions and nothing extra shall be payable on this account or due to less /reduced working hours etc.

12.0 Royalty at the prevalent rates wherever payable, shall have to be paid by the contractors on the boulders, metal, shingle, sand and bajri etc or any other materials collected by him for the work direct to the revenue authority of the District /State Government concerned. He should submit money receipts in lieu of deposits made or obtain clearance from Geological Department for getting released his final bill.

13.0 The contractor shall ensure that sufficient quantity of water (suitable for construction) is available at site for proper execution of work. Nothing extra for arranging of water at site will be paid to the contractor by the corporation.

14.0 Unless otherwise specified in the schedule of quantities, the rates for all items of work shall be considered as inclusive of pumping out or bailing out water from all depths if required for which no extra payment will be made. This will include water encountered from any source, such as rains, floods, sub soil water being high due to any other cause whatsoever etc.

15.0 The malba /garbage, removed from site shall be disposed off by the Contractor at his own cost to any suitable place as directed by Engineer in-charge.

16.0 The existing salty and slushy layer if any of borrow pits, and earth filling area should be removed and disposed off as directed by the Engineer in charge. Nothing extra shall be paid to the contractor on this account.

17.0 The contractor should make all arrangements for the alignment, survey and fixing the shortest distance by using GPS and measuring the distance by using road meter etc., Nothing extra will be payable on this account

Item No 4: Wet Mix Macadam (WMM)

Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the materials with water at OMC in mechanical mix plant carriage of mixed materials by tipper to site, laying in uniform layers (Layer should not be more than 200 mm) with paver in sub base/base course on well prepared surface and camber with Sensor paver consolidation by vibratory road roller to achieve the desired density by using machine crushed chips as per required gradation mixing with required optimum quantity of water incl material, labour, plant and machinery and equipment etc. complete by plant mix method. (Using mechanical paver).

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

Materials:

Aggregates:

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 - 1 below.

TABLE -1 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) IS-2386 (Part-4) or IS 5040
2	Combined Flakiness and Elongation index (Total	IS:2380(Part-4) or IS 5040 IS: 2380 (Part-1)

Aggregate may satisfy requirements of either of the two tests.

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

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).

Grading requirements: The aggregates shall conform to the grading given in Table –2

TABLE -2 GRADING REQUIREMENT 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	15-30
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

The material finer than 425 micron shall have plasticity Index (PI) not exceeding 6.

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

3.0 Construction Operations

3.1 Preparation of base:

The surface of the subgrade/sub-base /base to receive the WMM course shall be prepared to the specified lines and cross fall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base/base/surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course) to I.R.C. Clause 501.

As far as possible, laying WMM course over an existing thick 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. However, where the intensity of rain is low and the interface drainage facility is efficient, WMM can be laid over the existing thin bituminous surface by cutting 50 mm X 50 mm furrows at an angle of 45 degrees to the centre line of the pavement at one meter intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

3.2 Provision of lateral confinement of aggregates: While constructing wet mix macadam, arrangement shall be made for the lateral IRC 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 Clause I.R.C. 407.4.1.

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 force positive mixing arrangement quantity of wet mix works, the Engineer may permit the mixing to be done in concrete mixers. Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part - S) 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.

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

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

The paver finish shall be self-propelled, having the following features:

Loading hoppers and suitable distribution mechanism

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

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

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 large and fine particles should be allowed. The aggregates as spread should be of uniform gradations with no pockets of fine materials.

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

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

Along forms, kerbs, wall 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 subgrade 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 metre 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 cross fall. In no case should 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:2820 (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 re compacted.

3.6 Important Considerations in Construction Process

While due care and attention is required on the whole process of WMM construction, the following are important points needing more attention:-

Sometimes because of moisture in the fines, these will not flow out from the bin of the three-bin feeder to the belt. In such situation, it would be necessary to have a small vibrator fitted on one of the side walls of the bin to intermittently shake it.

Control on water in the mix is of utmost importance; hence there should not be any variation in the grading, particularly of fines as it will affect the moisture content and uniform mixing. Similarly, excessive fluctuations in the moisture content of the fines should be avoided. If necessary, slight increase may be made in the moisture contents to account for the moisture loss in transit to the laying site.

Excessive silt or clay in fines should not be permitted, as besides spoiling the quality of mix, it will cause clogging in pug mill and storage silo.

The mixed material should be transported directly to site. Stockpiling of mixed material should be discouraged as excessive handling is the cause of segregation and moisture loss, both of which are detrimental to the quality of the wet mix macadam.

There should be minimum joints in laying wet mix macadam. To ensure this, the daily output should at least be 500 linear meters. The width of laying also should be so adjusted to avoid the necessity of laying narrow strips e.g. against kerbs.

Single paver of 7m width or two pavers each of 3.5m width working in tandem within the short distances should be used for obtaining good results.

3.7. CONSTRUCTION PROCESS

The construction process of wet mix macadam involves the following sub-activities:-

Production of aggregates in required sizes.

Proportioning of aggregates and mixing with water.

Transportation of mix.

Spreading and laying.

Compaction.

The whole process should be such that methods adopted and equipment used meet the laid down requirements of end result specifications in respect of sizes and grading of aggregates, optimum moisture content, proper mixing, laying in uniform thickness to the correct profile and required compaction.

3.8 PROPORTIONING OF AGGREGATES AND MIXING

Proportioning and mixing can be done in different ways depending on the total methodology of work adopted.

3.8.1 Concrete Mixer

For small quantities of WMM, concrete mixer can be used for production of mix and different fractions can be added by box measurement as in the case of manual feeding of mixer for producing concrete. In this method, the usual facility of measuring water is a overhead tank which will not be very accurate. Further, because of limitations such as the size and capacity of mixer, manual feeding and non –continuous production of mix makes, this method is unsuitable for large scale work.

3.8.2 Batching and Mixing Plant

3.8.2.1 In order to obtain uniform WMM material using batch plant, only pan type mixing plant should be used, since it provides the force mixing of the different constituents of the mix. The mixing time may have to be increased for more uniform dispersal of low water content in the mix. Blending of aggregates and mixing can be achieved through storage bins and weigh hoppers.

3.8.3 Bin feeder & pug mill

For continuous production of mix in a pug mill in sufficient quantity, the best way to feed the aggregates and control the grading is by means of a 3 or 4 bins feeder with belt conveyor. It is similar to the bin feeder of a hot mix plant but without variable speed motors and load sensor as the required grading can be achieved with the adjustment of gate openings itself. Such a unit consisting of 3 or 4 bins feeder, belt conveyors, pug mill and water pump arrangement is the most suitable equipment for production of wet mix macadam.

3.9 Important features: The following are some of the important features to be kept in view: Under each bin, there should be an adjustable quadrant gate and belt feeder to regulate the aggregate supply. Giggli screen should be provided over the coarse aggregate bins to exclude oversize material, if any.

A surface vibration should be provided on the outside of the sand/fines bin to maintain uniform flow. Belt feeder, gathering conveyors and secondary conveyor should have independent motors.

The angle of inclination of secondary conveyor should not be more than 19 degrees. The twin-shaft pug mill should have replaceable inner liner plates.

The clearance between the tips of the paddles and liners should be less than maximum stone size so that the aggregates are pushed forward while mixing. This type of paddles should be adjustable so that clearance can be set according to maximum size of aggregate.

The mixing of aggregates and water is done in a continuous twin-shaft pug mill or paddle mixer. Unlike a drum mixer where mixing is achieved by rotation of the drum and flights inside it, there is forced action – mixing in a pug mill which is better for uniform coating of film of moisture. As such the use of Drum Mix Plant is not suitable for producing WMM. The controlled amount of water is added in the pug mill by a spray bar with the help of a variable speed pump and a flow meter. This arrangement provides a precise control on the quantity of water which is very critical for the success of WMM construction. In this method, feeding of aggregates, addition of water and mixing are continuous operations. The mix can be either directly discharged into the tipping truck or taken through a belt conveyor to a storage silo. It is advantageous to have a storage silo, as it helps in continuous production of mix even when no tipping truck is readily available for loading. Also loading of tipper through storage silo takes less time. Thus there will be saving in the number of tipping trucks required.

3.10 TRANSPORTATION

Transportation of mix is usually done by tipping trucks. In order to avoid moisture loss in transit due to evaporation, mix should be covered with Tarpaulin.

3.11 SPREADING AND LAYING

For this job, there are two clear alternatives in the choice of equipment. These are motor grader and paver finisher. Both these are suitable for the work.

3.12 Setting and drying: After final compaction of wet mix made course, the road shall be allowed to dry for 24 hours.

4.0 Opening to Traffic

Preferably no vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

5.0 Surface Finish and Quality Control of Work

5.1 Surface evenness: The surface finish of construction shall conform to the requirements of Clause IRC-902.

The surface levels of a wet mix layer laid as a sub-base shall have a tolerance of not more than +10mm and –20mm from the designed longitudinal and cross profile. When laid as a base course with machines, the tolerance shall be +10mm and –10mm. For checking compliance with this, surface levels shall be taken on a grid of points placed 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the above tolerances, thus one measurement being not in excess of 5mm above the permitted tolerance.

5.2 The longitudinal profile shall also be checked by a 3 meter straight edge at the middle of each traffic lane parallel to the centre line of the road. The maximum allowable difference between the road surface and underside of a 3 meter straight edge shall be 8 mm.

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

5.4 The frequency of the Quality Control tests shall be as under:-

Gradation One Test per 100 m³

Plasticity Index One test per 200 m³

Moisture Content prior to compaction One test per 250 m²

Density of compacted layer One test per 500 m²

Aggregate Impact Value or Los Angeles Abrasion Value One test per 200 m³

Flakiness and Elongation Index One test per 200 m³

5.5 For testing the compaction requirements, test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of 5-10 density determinations. The number of tests in one set of measurements shall be 6 (if non-destructive tests are carried out, the number of tests shall be doubled) as long as it is felt that sufficient control over the constituent materials forming the mix is being exercised. If considerable variations i.e. 15% and above are observed between individual density results, the minimum number of tests in one set of measurements shall be increased to 10. The acceptance criteria shall be subject to the condition that the mean density of a set of measurement shall not be less than the specified density plus.

$$1.65 - \frac{1.65}{\sqrt{\text{(No. of samples)}}} \times \text{standard deviation}$$

6.0 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, reshaped with added premixed material or removed and replaced with fresh premixed materials applicable and re-compacted in accordance with IRC 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.

7.0 Arrangement for Traffic

During the period of construction, arrangement of traffic shall be done as per IRC Clause 112.

8.0 Measurements for Payment

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

9.0 Rates

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.

Item No 5 - Providing and applying primer coat with bitumen emulsion SS1 on prepared surface of granular Base including clearing of road surface and spraying primer at the rate of 0.70 kg/sqm using mechanical means.

Providing & applying bitumen emulsion coat at the rate of 7.0 kg / 10m² of road area with bitumen emulsion (SS1 grade) complying IS 8887 as per MORT&H over prepared surface of wet mix base including spraying uniformly by using self propelled or towed bitumen pressure sprayers equipped for spraying the material uniformly at specified rates and temperature with self-heating arrangement, heating the bitumen, cleaning the road surface as per MORT&H specifications etc. complete including all labor charges and cost of all materials involved in the work , transportation charges, material testing charges and incidental charges as directed etc complete.

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.

Materials

Primer: Primer shall be bitumen emulsion of SS-1 grade complying with IS 8887

Primer viscosity:

The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with the standards. Guidance on viscosity and rate of spray is given in Table 500-1.

TABLE 500-1. VISCOSITY REQUIREMENT AND QUANTITY OF LIQUID BITUMINOUS PRIMER

Type of Surface	Kinematic Viscosity of Primer at 60o C (Centistokes)	Quantity of Liquid Bituminous Material per 10 Sq.M. (kg)
Low porosity	30 – 60	6 to 9
Medium porosity	70 – 140	9 to 12
High porosity	250 – 500	12 to 15

3.Weather and Seasonal Limitations

Bituminous primer shall not be applied to a wet surface (see 502.4.2) or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10o C. Surfaces which are to receive emulsion primer should be damp. But no free or standing water shall be present.

Construction

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 as directed by the Engineer.

4.2 Preparation of road surface: The surface to be primed shall be prepared in accordance with Clause 501.8.

501.8 This work shall consist of preparing an existing granular surface and shall be performed on such widths and lengths as shown on the drawing or as directed by the Engineer

Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the inter locked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

4.3 Application of emulsion bituminous primer: The rate of application of the primer shall be at rate of 7.0 Kg / 10 Sq.m. or as directed. The bituminous primer shall be sprayed uniformly in accordance with Clause 501. 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.

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. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

Quality Control of Work:

For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 901 of MORT & H specifications shall apply.

Arrangements for Traffic

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

Measurement for Payment

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

Rate:-

The contract unit rate for prime coat with adjustments as described in Clause 502.7 of MORT&H specification shall be payment in full for carrying out the required operations including full compensation for all components listed below

[i] Making arrangements for traffic to Clause 112 as above 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 lift.

[iii] All labour, tools, equipment and incidentals to complete the work to the specifications.

[iv] Carrying out the work in part widths of road where directed, and

[v] Carrying out the required tests for quality control.

Payment shall be made on the basis of the provision of prime coat at an application rate of 7.0 kg per 10 square meter, with adjustment, plus or minus, for the variation between this amount and the actual amount approved by the Engineer after the preliminary trials referred to in Clause 502.4.3. of MORT&H specification stated above.

Item No 6: DBM

Providing & laying compacted 60 mm thick dense graded bituminous macadam (DBM) Grade-II in Single layer using 100-120 TPH batch type HMP with tack coat at the rate of 2.5 kg / 10 m² (VG10) in each using crushed aggregates of specified grading premixed with bituminous binder @ 4.5% (VG - 40) bitumen by weight of total mix and filler, transporting the hot mix to work site laying with a hydrostatic paver finisher with sensor control with full road carpet width (Single screed) or as directed by Engineer in charge to the required grade, level and alignment, rolling with smooth wheeled roller, intermediate rolling 8-10 tonnes dead weight or vibratory roller & pneumatic tire roller of 12 to 15 tonnes weight having sufficient width and pressure & the finishing rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers to achieve the desired compaction as per MORT&H specification etc complete in all respects. The agency shall have to get the mix design done from approved laboratory and submit to the Engineer in charge for approval. (Va = 3.5% & Vbe = 11.50% must be considered in mix design) If the asphalt (bituminous) content is more than above, the agency shall have to bear the cost of additional asphalt. The payment shall be done on the permissible field density achieved on the site instead of density derived in the mix design. (The density obtained by mix design above 2.31 MT/M³ shall be borne by agency)

1.0 Scope

This clause specifies the construction of Dense Graded Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50mm to 100mm.

Note: Agency to ensure that Va = 3.50 % & Vbe = 11.50 %

2.0 Materials

2.1. Bitumen: The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS: 73, and of the penetration indicated in Table 500-10 for dense bitumen macadam

2.2. Coarse aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, 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 have poor affinity for

bitumen, as a condition for the approval of that source, the bitumen shall be treated- with an approved anti-stripping agent, as per the manufacturer's recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the physical requirements specified in Table 2.2-1, for dense bituminous macadam.

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

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

The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part 3).

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)

**TABLE 2.2-1. PHYSICAL REQUIREMENTS FOR COARSE
AGGREGATE FOR DENSE GRADED BITUMINOUS MACADAM**

Property	Test	Specification
Cleanliness(dust)	Grain size analysis ¹	Max 5% passing 0.075mm sieve
Particle shape	Flakiness and Elongation Index (Combined) ²	Max 30%
Strength*	Los Angeles Abrasion Value ³	Max 35%
	Aggregate Impact Value ⁴	Max 27%
Durability	Soundness: ⁵	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption ⁶	Max 2%
Stripping	Coaling and Stripping of Bitumen Aggregate Mixtures ⁷	Minimum retained coating 95%
Water Sensitivity**	Retained Tensile Strength ⁸	Min 80%

Notes :1. IS : 2386 Part 1 5. IS : 2386 Part 5

IS : 2386 Part 1 6. IS : 2386 Part 3

(the elongation test to be done only on non-flaky aggregates in the sample)

IS: 2386 Part 4* 7. IS: 6241

IS: 2386 Part 4* 8. AASHTOT283**

Aggregate may satisfy requirements of either of these two tests.

** The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

2.4. Filler: Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer.

The filler shall be graded within the limits indicated in Table 2.4-1

TABLE 2.4-1. GRADING REQUIREMENTS FOR MINERAL FILLER

IS Sieve (mm)	Cumulative per cent passing by weight of total aggregate
0.6	100
0.3	95-100
0.075	85-100

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by weight of total aggregate, shall be Portland cement or hydrated lime and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

2.5. Aggregate grading and binder content: When tested in accordance with IS:2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 2.5-1, for dense bituminous macadam grading 1 or 2 as specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

TABLE 2.5-1. COMPOSITION OF DENSE GRADED BITUMINOUS MACADAM PAVEMENT LAYERS

Grading	1	2
Nominal aggregate size	40mm	25mm
Layer Thickness	80-100 mm	50-75 mm
IS Sieve1 (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 ²	Min4.0	Min4.5
Bitumen grade (pen)	65 or 90	65 or 90

Notes: 1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

Determined by the Marshall method.

3.0 Mixture Design

3.1. Requirement for the mixture: Apart from conformity with the grading and quality requirements for individual ingredient the mixture shall meet the requirements set out in Table 3.1-1.

TABLE 3.1-1. REQUIREMENTS FOR DENSE GRADED BITUMINOUS MACADAM

Minimum stability (KN at 60°C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-6
Percent voids in mineral aggregate (VMA)	See Table 500-12 below.
Per cent voids filled with bitumen (VFB)	65-75

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 3.1-2.

TABLE 3.1-2. MINIMUM PER CENT VOIDS IN MINERAL AGGREGATE (VMA)

Nominal Maximum Particle Size ¹ (mm)	Minimum VMA, Per cent Related to Design Air Voids, Per cent ²		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0

25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Notes: 1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 per cent.

Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.

3.2. Binder content: The binder content shall be optimized to achieve the requirements of the mixture set out in table 3.1-1 and the traffic volume specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in The Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve by the aggregates passing the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

Where 40 mm dense bituminous macadam mixture is specified, the modified Marshall method described in MS-2 shall be used. This method requires modified equipment and procedures; particularly the minimum stability values in Table 3.1-1 shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

3.3. Job mix formula: The Contractor shall inform the Engineer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details:

Source and location of all materials:

Proportions of all materials expressed as follows where each is applicable:

Binder type, and percentage by weight of total mixture;

Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;

A single definite percentage passing each sieve for the mixed aggregate:

The individual grading of the individual aggregate fractions, and the proportion of each in the combined grading.

The results of tests enumerated in Table 3.1.1 as obtained by the Contractor;

Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch.

Test results of physical characteristics of aggregates to be used;

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 mixture 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.

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 3.4-1.

TABLE 3.4-1. PERMISSIBLE VARIATIONS FROM THE JOB MIX FORMULA

Description	Permissible variation	
	Base/binder course	Wearing coarse
Aggregate passing 19nun sieve or larger	±8%	±7%
Aggregate passing 13.2mm, 9.5mm	±7%	±6%
Aggregate passing 4.75mm	±6%	± 5%
Aggregate passing 2.36mm, 1.18mm, 0.6mm	±5%	±4%
Aggregate passing 0.3mm, 0. 15mm	±4%	±3%
Aggregate passing 0.075mm	±2%	± 1.5%
Binder content	±0.3%	±0.3%
Mixing temperature	±10°C	±10°C

Once the plant trials have demonstrated the capability of the plant, and the trials are approved, the laying operation may commence. Over the period of the first month of production for laying on the works, the Engineer shall require additional testing of the product to establish the reliability and consistency of the plant.

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 3.5.1. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing, by the Engineer. The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of the project road, and 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.

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.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sq.cm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the real roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300mm

In portions with super-elevated and uni-directional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.

Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement

Construction Operations

4.1: Weather and seasonal limitations: Laying shall be suspended while free-standing water is present on the surface to be covered, or during rain, fog and dust storms. After rain, the bituminous surface, prime or tack coat, shall be blown off with a high pressure air jet to remove excess moisture, or the surface left to dry before laying shall start. Laying of bituminous mixtures shall not be carried out when the air temperature at the surface on

which it is to be laid is below 10°C or when the wind speed at any temperature exceeds 40 km/h at 2m height unless specifically approved by the Engineer.

4.2. Preparation of base: The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air. In locations where mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

4.3. Stress absorbing layer: Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements.

4.4. 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 The primer shall be bitumen emulsion, complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer. The use of medium curing cutback as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

4.5. Tack coat: The binder used for tack coat shall be bitumen emulsion complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

The use of cutback bitumen, as per IS 217 shall be restricted only for sites at sub-zero for emergency applications as directed by the Engineer.

4.6. Mixing and transportation of the mixture:

4.6.1 Mixing

Pre-mixed bituminous materials, including bituminous macadam, dense bituminous macadam, semi-dense bituminous concrete and bituminous concrete, shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures can be found in Table 500-5 of these Specifications; the difference in temperature between the binder and aggregate should at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time.

If a continuous mixing plant is to be used for mixing the bituminous bound macadam, the Contractor must demonstrate by laboratory analysis that the cold feed combined grading is within the grading limits specified for that bituminous bound material. In the case of a designed job mix, the bitumen and filler content shall be derived using this combined grading. Further details are available in the Manual for Construction and Supervision of Bituminous Works.

4.6.2 Transporting

Bituminous materials shall be transported in clean insulated vehicles, and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

4.7 Spreading: Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, levelled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver, and its method of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and levelled with suitable hand tools by experienced staff, and compacted to the satisfaction of the Engineer. The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300mm short of the joint. The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145°C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.

Hand placing of pre-mixed bituminous materials shall only be permitted in the following circumstances:

- For laying regulating courses of irregular shape and varying thickness.

- In confined spaces where it is impracticable for a paver to operate.

- For footways.

- At the approaches to expansion joints at bridges, viaducts or other structures.

- For laying mastic asphalt in accordance with Clause 515.

- For filling of potholes.

- Where directed by the Engineer.

Manual spreading of pre-mixed wearing course material or the addition of such material by hand-spreading to the paved area, for adjustment of level, shall only be permitted in the following circumstances:

- At the edges of the layers of material and at gullies and manholes.

- At the approaches to expansion joints at bridges, viaducts or other structures.

- As directed by the Engineer.

Cleanliness and overlaying: Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a binder course is to be sealed or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated the Contractor shall make it good to the satisfaction of the Engineer, in compliance with Clause 501.8.

Binder course material shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the Contract, for more than three consecutive days after being laid. The Engineer may extend this period, by the minimum amount of time necessary, because of weather conditions or for any other reason. If the surface of the base course is subjected to traffic, or not covered within three days, a tack coat shall be applied, as directed by the Engineer.

4.8. Rolling: 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.

5.0. Opening to Traffic

The newly laid surface shall not be open to traffic for at least 24 hrs after laying and completion of compaction, without the express approval of the Engineer in writing.

6.0 Surface Finish and Quality Control of Work

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer, subject to the permitted tolerances described herein-after:

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in Table 6.0-1.

TABLE 6.0-1. TOLERANCES IN SURFACE LEVELS

1. Subgrade	+ 20 mm - 25mm
Sub-base + 10 mm Flexible pavement Concrete pavement [Dry clean concrete or Rolled concrete]	-20mm + 6 mm -10mm
Base-course for flexible pavement Bituminous course Other than bituminous Machine laid (ii) Manually laid	+6 mm -6mm +10mm -10mm + 15 mm -15 mm
Wearing course for flexible pavement Machine laid (b) Manually kid	+ 6 mm - 6mm + 10mm - 10mm
5. Cement concrete pavement	+ 5 mm -6mm*

This may not exceed - 8 mm at 0 - 30 cm from the edges.

7.0 Arrangements for Traffic

The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of. traffic

approaching or passing through the section of the highway under improvement. Before taking up any construction, an agreed phased program for the diversion of traffic on the highway shall be drawn up in consultation with the Engineer.

The barricades erected on either side of the carriageway/portion of the carriageway closed to traffic, shall be of strong design to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise.

At the points where traffic is to deviate from its normal path (whether on temporary diversion or part width of the carriageway) the channel for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device to the directions of the Engineer. At night, the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-lane traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours.

For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns/lights.

On both sides, suitable regulatory/warning signs as approved by the Engineer shall be installed for the guidance of road users. On each approach, at least two signs shall be put up, one close to the point where transition of carriageway begins and the other 120m away. The signs shall be of approved design and of reflectory type, if so directed by the Engineer.

8.0 Measurement for Payment

Dense Graded Bituminous Materials shall be measured as finished work in Metric tonne.

9.0 Rate

The contract unit rate for Dense Bituminous Macadam shall be payment in full for carrying out the all required operations as specified. The rate shall include the provision of bitumen, at 4.5 per cent by weight of the total mixture.

Item No 7 BC

Providing and laying compacted 40 mm thick Bituminous Concrete (BC) Grade -II in single layer using 100-120 TPH batch type hot mix plant and using emulsion asphalt as a tack coat @ 2.5 kg / 10 sq.m (VG 10) in each using crushed stone aggregate of specified gradation and filler, Premix with VG-40 grade bituminous binder at 5.40 % by total weight of mix & filler incl. transporting the hot mix to work site and laying with hydrostatic paver finisher having sensor control with Full road carpet width (Single screed) or as directed by Engineer in charge to the required grade, level and alignment, rolling with smooth wheeled roller, intermediate rolling 8-10 tonnes dead weight or vibratory roller & pneumatic tire roller of 12 to 15 tonnes weight having sufficient width and pressure & the finishing rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers to achieve the desired compaction as per MORT&H specification etc complete in all respects. The agency shall have to get the mix design done from approved laboratory and submit to the Engineer in charge for approval (Va

= 3.5% & Vbe= 11.50% must be considered in mix design). If the asphalt (bituminous) content is more than above, the agency shall have to bear the cost of additional asphalt. The payment shall be done on the permissible field density achieved on the site instead of density derived in the mix design. (The density obtained by mix design above 2.36 MT/M3 shall be boarn by agency)

Scope

This work shall consist of construction in a single layer of dense bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 40mm in thickness.

Note: Agency to ensure that Va = 3.50 % & Vbe = 11.50 %

Materials:-

2.1 Binder:-

The binder shall be a penetration bitumen of 60/70 (VG-40) grade as specified in the contract satisfying the requirement of IS : 73

2.2 Coarse aggregates:-

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

The aggregates shall satisfy the physical requirements set forth in Table 500-3 as under.

Table 500.3 Physical, Requirements for Coarse aggregates for bituminous Macadam

Property	Test	Specification
Cleanliness	Grain Size analysis	Max. 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Max. 30%
Strength	Los Angeles Abrasion Value	Max. 40%
	Aggregate Impact Value	Max. 30%
Durability	Soundness	Max. 12%
	Sodium Sulphate	
	Magnesium Sulphate	Max. 18%
Water Absorption	Water Absorption	Max. 1%
Stripping	Coating and stripping of Bitumen aggregate Mixtures.	Minimum retained coating 95%
Water Sensitivity	Retained Tensile Strength	Minimum 80%

Notes :-

[1] IS : 2386 Part – 1 [2] IS : 2386 Part – 1 [the elongation test to be done only on non-flaky aggregate in the sample] [3] IS : 2386 Part – 4 [4] IS : 2386 Part – 5 [5] IS : 2386 Part – 3 [6] IS : 6241 [7] The water sensitivity test is only to be carried out if the minimum retained coating in the stripping test is less than 95 %

Aggregate may satisfy requirements of either of these two tests.

2.3 Fine aggregates:-

The Fine aggregates shall consist of crushed rock, passing the 2.36 mm sieve and retained on the 75 micron sieve. These shall be clean, hard, durable, uncoated mineral particles, dry and free from injurious, soft or flaky particles and organic or deleterious matter.

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)

2.4 Filler: -Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer.

The filler shall be graded within the limits indicated in Table 500-9

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

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. When the coarse aggregate is gravel, 2 percent by weight of total aggregate, shall be Portland cement or hydrated lime and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregate 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 added without additional cost.

2.5 Aggregate grading and binder content:-

When tested in accordance with IS :2386 Par I (wet sieving method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table 500-15 for grading II as specified in the contract.

Table 500.15 Composition of Semi Dense Bituminous Concrete Pavement Layers

Grading	2
Nominal aggregate size	10 mm
layer thickness	25 mm
IS : Sieve [MM]	Cumulative % by weight of total aggregate passing.
13.2	100
9.5	90 – 100

4.75	35 - 51
2.36	24 - 39
1.18	15 - 30
0.6	-
0.3	9 - 19
0.15	-
0.075	3 - 8
Bitumen content % by weight of total mixture	5.40
Bitumen Grade	60/70 (VG-40)

Note: 1 The combined aggregate grading shall not vary from the below limit on one sieve to the high limit on adjacent sieve.

2 Determined by the marshal method

The quantity of binder used for premixing in terms of straight run bitumen 60/70 grade shall be 5.4% by weight of total mix.

Mixture Design

Requirements for the mixture:

Apart from conformity with the grading and quality requirements for individual ingredients the mixture shall meet the requirements set out in Table 500 -16

Table 500-16. Requirements for Semi Dense Bituminous Pavement Layers

Minimum stability (kn at 600C	8.2
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3.5
Per cent voids in mineral aggregate (VMA)	See table 500-12
Per cent voids filled with bitumen (VFB)	65 - 78

Note: Agency to ensure that $V_a = 3.50$ & $V_{be} = 11.50$

Table 500-12. Minimum per cent voids in mineral aggregate (VMA)

Nominal Maximum particle Size (mm)	Minimum VMA, per cent related to Design Air Voids, Per cent		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0

19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Notes: 1 The nominal maximum particle size is one size larger than the first sieve to retain more than 10 per cent.

Interpolate minimum voids in the mineral aggregate (VMA) for design air voids value between those listed.

Binder Content

The binder content shall be optimized to achieve the requirements of the mixture set out in Table 500-16 and the traffic volume as specified in the contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5mm sieve and retained on the 22.4mm sieve, where approved by the Engineer.

Job mix formula

The contractor shall inform the Engineer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details;

Source and location of all materials;

Proportion of all materials expressed as follows where each is applicable;

Binder type, and percentage by weight of total mixture;

Coarse aggregate/ Fine aggregate/ Mineral filler as percentage by weight of total aggregate including mineral filler;

A single definite percentage passing each sieve for the mixed aggregate;

The individual grading of the individual aggregate fractions and the proportion of each in the combined grading.

The results of tests enumerated in Table 500-16 as obtained by the contractor.

Where the mixture is a batch mixer, the individual weight of each type of aggregate, and binder per batch,

Test results of physical characteristics of aggregates to be used;

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 mixture 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 supply of materials be proposed,

a new job mix formula shall be forwarded to the Engineer for approval before the placing of the material.

Plant trials - permissible variation in job mix formula:

Once the laboratory job mix formula is approved, the Contractor shall carry out 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 percentage 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 from the Job Mix Formula

Description	Permissible variation	
	Base/binder course	Wearing course
Aggregate passing 19mm sieve or larger	+ 8 %	+ 7 %
Aggregate passing 13.2mm, 9.5mm	+ 7 %	+ 6 %
Aggregate passing 4.75	+ 6 %	+ 5 %
Aggregate passing 2.36mm, 1.18mm, 0.6mm	+ 5 %	+ 4 %
Aggregate passing 0.3mm, 0.15mm	+ 4 %	+ 3 %
Aggregate passing 0.075mm	+ 2 %	+ 1.5 %
Binder content	+ 0.3 %	+ 0.3 %
Mixing temperature	+ 10 ⁰ C	+ 10 ⁰ C

Once the plant trials have demonstrated the capability of the plant, and the trials are approved, the laying operation may commence. Over the period of the first month of production for laying on the works, the Engineer shall require additional testing of the product to establish the reliability and consistency of the plant.

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, unless specifically approved in writing, by the Engineer. The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of 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.

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.

Construction Operations:-

The provision of following Clauses shall apply.

Weather and seasonal limitations: -

Laying shall be suspended while free standing, water is present on the surface to be covered or during rain, fog and dust storms. After rain the bituminous surface, prime or tack coat, shall be blow off with a high pressure air jet to remove excess moisture or the surface left to dry before laying shall start, laying of bituminous mixtures shall not be carried out when the air temperature at the surface on which it is to be laid is to be laid is below 100 C or when the wind speed at any temperature exceeds 40 K.M./H at 2 Mt. height unless specifically approved by the Engineer.

Preparation of base:-

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clause 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 location where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

Mixing and transportation of the mixture. :-

The provisions as specified in Clause 501.3 and 501.4 shall apply

Clause 501.3 Mixing:

Pre-mixed bituminous materials including semi dense bituminous concrete, shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures shall be as per Table 500-5

Table 500.5 Manufacturing and Rolling Temperatures.

Penetration	Bitumen Mixing [C]	Aggregate Mixing [C]	Mixed Material [C]	Rolling [C]	Laving [C]
35	106-170	160-175	170 Maximum	100 Maximum	130 Maximum
65	150-165	150-170	165 Maximum	90 Maximum	125 Maximum
90	140-160	140-165	155 Maximum	80 Maximum	115 Maximum

The difference in temperature between the binder and aggregate should at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregate, the hot mix plant shall be calibrated from time to time.

Clause 501.4: Transporting

Bituminous material shall be transported in clean insulated vehicles, and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

Spreading: -

The premixed material shall be spread by suitable means to the desired thickness grades and cross-fall. Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, levelled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay

The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of paver, and its method of operation, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and levelled with suitable hand tools by experienced staff, and compacted to the satisfaction of the Engineer.

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300mm short of the joint. The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145°C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.

Hand placing of pre-mixed bituminous materials shall only be permitted in the following circumstances:

For laying regulating courses of irregular shape and varying thickness.

1 In confined spaces where it is impracticable for a paver to operate.

2 For footways,

3 At the approaches to expansion joint at bridges, viaduct or other structures,

For filling of pot holes

Where directed by the Engineer.

Manual spreading of pre-mixed wearing course material or the addition of such material by hand spreading to the paved area, for adjustment of level, shall only be permitted in the following circumstances:

At the edges of the layers of material and at gullies and manholes

At the approaches to expansion joints at bridges, viaducts or other structures.

As directed by the Engineer.

4.5 Rolling:

As soon as sufficient length of bituminous material has been laid, rolling shall commence with 8-10 tonne rollers smooth wheel tandem type or other approved equipment. Rolling shall begin at the edge and progress toward the center longitudinally except that on superelevated and unidirectional cambered portions it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled and all the roller marks eliminated. In each pass of the roller the proceeding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels. In no case shall fuel, lubricating oil be used for this purpose. Excess use of water for this purpose shall also be avoided.

Rollers shall not stand on newly laid material. Rolling operations shall be completed in every respect before the temperature of the mix falls below the minimum rolling temperature stated in the relevant part of these Specifications. Joints along and transverse to the surfacing laid and compacted earlier shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with a thin coat of appropriate binder before the new mix is placed against it.

Opening to Traffic

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the Engineer in writing.

Surface Finish and Quality Control

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

Arrangements for Traffic

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

Measurement for Payment:-

The payment shall be made on the tonnage basis of the weight of mix aggregates and bitumen. For this purpose, the contractor shall have to install a weigh-bridge of suitable capacity for the purpose of weighing dumpers at suitable place at his cost as directed.

Weight of empty dumpers and weight of loaded dumper will be recorded in bound and numbered register on plant site.

Department will be free to get some loaded dumpers test checked at other weigh bridge. Weigh bridge will be periodically got calibrated and verified from weight and measure authorities.

For the purpose of application of tack coat, if the theoretical area as per sanctioned estimate for basis of tonne differs with the actual area of work done in the field then the reduction in or addition to payment shall have to be effected to the contractor on pro-rate basis depending upon the area reduced or exceeded respectively.

Weight of mix materials will be done in presence of responsible person, not less than the rank of Supervisor of Department and the measurements shall be recorded by the Deputy Executive Engineer or Assistant Engineer or Additional Assistant Engineer, if so authorized. Record of each dumper will be mentioned separately in bond and numbered register which will be maintained by the Department representatives and signed by the contractor. Proper gate pass system shall be established for the vehicle coming to the plant site and going from the site. The location of the K.M. hectometre and meter in which individual dumpers are unloaded shall be recorded carefully.

508.9 Rate for premixed bituminous materials: - The contract unit rate shall be for all as specified in clause 507.9 except that the rate shall include the provision of bitumen at 5.4 % by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down accordingly. The unit rate for premixed bituminous material shall be payment in full for carrying out the required operation including full compensation for, but not limited to:

Making arrangements for traffic to clause 112 except for initial treatment to verge, shoulders and construction of diversions.

Preparation of the surface to revive the materials.

Providing all materials to be incorporated in the work including arrangement for stock yards. All royalties, fees rents where necessary and all leads and lifts. Mixing transporting, laying and compacting the mix as specified. All labour, tools equipment, plant including installation of hot mix plant, power supply units and all machinery incidental to complete the work to these specification. Carrying out the work in part widths of the road where directed.

Carrying out all tests for control of quality, and The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in actual percentage of bitumen used will be assessed and the payment adjusted accordingly. The rate for premixed material are to include for all wastage in cutting of joints etc. The rates are to include for all necessary testing mix design transporting and testing of samples, and cores. If there is not a project specific laboratory, the contractor must arrange to carry out all necessary testing at an outside laboratory approved by the Engineer, and all costs incurred are deemed to be included in the rate quoted for the material.

The cost of all plant and laying trials as specified to prove the mixing and laying methods is deemed, to be included in the contractor's rates for the materials.

Item no 8

Providing and applying asphalt for painting surface with bitumen VG-40 at the rate of 6.00 Kg/ 10 Sq.m on bituminous road surface using asphalt pressure sprayer etc. complete including clearing the road surface including the cost of asphalt ,labour, plant and machinery and equipment etc. complete including spreading the stone dust at the rate of 0.30 m³/ m² of road surface etc. complete as directed by engineer in charge.

1 Scope:-

This work shall consist of the application of a single coat of bitumen 60/70 (VG-40) grade to an existing bituminous road surface in accordance with the following specifications.

2 Materials:-

2.1 Bitumen:-The bitumen used for asphalt painting shall be 60/70 (VG-40) grade complying with IS: 73 or as directed by the Engineer.

2.2 Stone Dust:-

2.2.1. This shall be obtained from crushing hard black trap or equivalent. It shall not contain more than 8% of silt as determined by field test using measuring cylinder. The method of determining silt contents by field test is given as under:

2.2.2. A sample of stone dust to be tested shall be placed without drying in 200 mm. measuring cylinder. The quantity of the sample shall be such that it fills the cylinder up to 100 mm. mark. The clean water shall be added up to 150 mm. mark. The mixture shall be stirred vigorously and the content allowed to settle for 3 hours.

2.2.3. The height of silt, visible as settled layer above the stone dust shall be expressed as percentage of the height of the stone dust below. The stone dust containing more than 8% silt shall be washed so as to bring the content within the allowable limit.

2.2.4. The fineness modulus of stone dust shall not be less than 1.80

3 Weather and Seasonal Limitations:-

Bituminous material shall not be applied to a wet surface or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C.

4 Construction:-

Equipment:-

The asphalt painting shall be applied through a distributor and it shall be a self propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at a specified rate, hand spraying of small areas, inaccessible to the distributor in narrow strips, shall be sprayed with a pressure hand sprayer or as directed by the Engineer.

Preparation of base:-

The surface on which the asphalt painting is to be applied shall be clean and free from dust, dirt and any extraneous material and other wise prepared in accordance with the requirements of Clauses-501.8 & 513 of MORT & H as appropriate. Immediately before the application of the asphalt painting the surface shall be swept clean with a mechanical broom and high-pressure air jet or by other means as directed by the Engineer.

Application of asphalt painting:-

The application of asphalt for painting shall be at 6.0 Kg/ 10 Sq.mt. as specified in the contract and shall be applied uniformly. The asphalt shall be heated in the tanker and the temperature of the asphalt at the time of spraying shall be in the range of 150°C -177°C. The method of application of the tack coat 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 a spraying trial that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

5.0 Spreading of Stone Dust & rolling.

Soon after the spraying of asphalt, the stone dust shall be spread evenly with a twisting motion of baskets at the rate of 0.013Cum/10 Sqm. The entire surface shall be broomed to ensure uniform application of the stone dust. The surface shall be rolled with pneumatic tyred roller as directed by the Engineer in charge. While the traffic is allowed on the painted surface and at later stage if additional stone dust is required, it shall be carried out by the contractor without any extra payment.

6.0 Opening to Traffic:-

Traffic may be allowed immediately after completion of flushing of stone dust on asphalt painted surface and rolling with PTR roller is completed.

7.0 Arrangement of Traffic:-

The provision of MOST Specification Clause 112 shall apply as regards the flow of traffic during construction.

8.0 Mode of Measurement &Payment:

The Item shall be measured and paid as finished work in Square meters. The rates shall include the cost of all materials, labour, equipments etc. involved in all the operations described above. The rate shall be for a unit of one sq. meter.

Item No. 09:

Hot Applied Thermoplastic Patta:

Road marking with hot applied thermoplastic paints with asian/ Berger paints with reflectorising glass beads on bitumen surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beds as per IRC:35- 2015. The finished surface to be level, uniform and free from streaks and holes. zebra Patta /bump Patta lane/centre line/ edge line/cut Patta. The white colour marking should provide liminance coefficient on cement road

shall be min 130 mcd/m²/lux and Asphalt road shall be min 100 mcd/m²/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015. Warranty for the Retro reflectivity should be two years.

General :-

Hot Applied Thermoplastic Road Marking.

The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.

The Thermoplastic compound shall be screened / extruded on to The pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall be produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.

The colour of the compound shall be white or yellow (IS : colour No. 356) as specified in drawings or as directed by the Engineer.

Where the compound is to be applied to cement concrete pavement sealing primer as recommended by the manufacture, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and / or curing compound shall be removed before the marking are applied.

THERMOPLASTIC MATERIALS

GENERAL:

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads.

REQUIREMENT:

Composition: the pigment, beads and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 800 – 3.

Table 800 – 3 PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL (percentage by weight)

Component	White	Yellow
Binder	18.00 min.	18.00 min.
Glass Beads	30 – 40	30 – 40
Titanium Dioxide	10.00 min.	- - -
Calcium Carbonate and Inert Fillers	42.00 max	See Note
Yellow Pigments	- - -	- do -

Note: Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provide all other requirement of this Specification are met.

II Properties : The properties of thermoplastic material, when tested in accordance with ASTM D36/ BX-3262- (Pa. T1) shall be as below :

Luminance:

White: Daylight luminance at 45 degree 65 per cent min. as per AASHTO M 249.

Drying time : When applied at a temperature specification by the manufactures and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

Skid resistance : not less than 45 as per BS 6044.

Cracking resistance at low temperature : The material shall show no cracks on application to concrete blocks.

Softening point : $102.5 \div 9.5$ " as per ASTM D 36.

Flow resistance : Note more than 25 per cent as per AASHTO M 249.

Yellowness index (for white thermoplastic paint) not more than 0.12 as per AASHTOM 249.

III Storage life : The materials shall meet the requirement of there Specifications for period of one year. The thermoplastic material must also melt uniformly with no evidence of skins of un-melted particles for the one-year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/ supplier/ contractor.

IV Reflectorisation : Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.3 of MORT & H Specification.

V Marking : Each container of the thermoplastic material shall be clearly and indelibly marked with the following information.

The name, trademark or other means of identification of manufacturer.

Batch number.

Date of manufacture.

Colour (White or Yellow)

Maximum application temperature and maximum safe heating temperature.

VI Sampling and testing : The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Employer a copy of certified test report from the manufacturer of the thermoplastic material showing results of all tests specified therein and shall certify that the materials meets all requirements of this Specification.

REFLECTORIZING GLASS BEADS

GENERAL : This Specification covers two types of glass beads to be used for to production of reflectorized pavement markings. Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800 – 3 and type – 2 beads are those which are to be sprayed on the surface vide Clause 803.6.3.

The glass beads shall be transparent, colourless and free from milliness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in clause 5.4.3.3.

SPECIFIC REQUIREMENTS.

A GRADATION :

The glass beads shall meet the gradation requirements for the two types as given in Table 800 – 4

TABLE 800-4 GRADATION REQUIREMENT FOR GLASSBEADS

Sieve Size	Per Cent Retained	
	Table – 1	Table – 2
1.18 mm	0 to 3	- -
850 micron	5 to 20	0 to 5
600 micron	--	5 to 20
425 micron	65 to 95	- -
300 micron	- -	30 to 75
180 micron	0 to 10	10 to 30
Below 180 micron		0 to 15

B. ROUNDNESS:

The glass beads shall have a minimum of 70 per cent true spheres.

C. REFRACTIVE INDEX:

The glass beads shall have a minimum refractive index of 1.50.

D. FREE FLOWING PROPERTIES:

The glass beads shall be free of hard lumps and clusters and shall dispense readily under any condition suitable for paints striping. They shall pass the free flow-test.

TEST METHODS:

The specific requirement shall be tested with the following methods.

I Free-flow test: Spread 100grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccators which is filled within 25 mm of the top of a desiccators plate with sulphur acid water solution (specific gravity 1.10) Cover the desiccators and let it stand for 4 hours at 20 to 29 degree C. Remove Sample from desiccators, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.

II The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS 6088 and BS 3262 (Part 1).

III The Contractor shall furnish to the Employer a copy of certified test report from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified therein and shall certify that material meets all requirements of this

Specification. However, if so required, these test may be carried out as directed by the Engineer in charge.

APPLICATION PROPERTIES OF THERMOPLASTIC MATERIAL

The thermoplastic materials shall readily get screed / extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and share edges. The materials upon heating to application temperatures shall not exude fumes which are toxic. Obnoxious of injurious to persons property.

PREPARATION:

The material shall be melted in accordance with the manufacturer's instructions in a heater fined with a mechanical sairrer to give a smooth consistency to the thermoplastic materials to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature started by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic materials. Which has natural binders or is otherwise sensitive to prolonged heating the materials shall be maintained in a molten condition for more than 4 houses.

II) After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

PROPERTIES OF FINISHED ROAD MARKING:

The stripe shall be not be slippery when wet.

The marking shall not lift from the pavement in freezing weather.

After application and proper drying the stripe shall show no appreciable deformation of discoloration under traffic and under road temperatures up to 60 C.

The marking shall be deteriorate by contact with sodium chloride calcium chloride or oil drippings from traffic.

The stripe of marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.

The colour of yellow marking shall conform to IS Colour No. 356 as given in IS : 164.

REFLECTORISED PAINT:

Refectories paint, if used shall conform to the specification by the manufacturers and approved by the engineer. Reflectorizing glass beads for reflectorizing paints where used shall conform to the requirements of Clause 5.3.

REFLECTORISED PAINT:

Refectories paint, if used shall conform to the specification by the manufacturers and approved by the engineer. Reflectorizing glass beads for reflectorizing paints where used shall conform to the requirements of Clause 5.3.

APPLICATION

Marking shall be done by machine. For locations where painting cannot be done machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

The thermoplastic materials shall be applied hot either by screening or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10 C. during application. All surface to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing on overlay of new material directly over an old line of compatible material. Such new material shall so bend itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted specification shall be sprayed uniformly into a mono layer on to the hot paint line quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square meter area.

The minimum thickness specified in exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS- 3262 (Part 3).

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

MEASUREMENT FOR PAYMENT.

The painted marking shall be measured in sq. meters of actual area marked (excluding the gaps. If any).

In respect of markings line directional arrows and lettering. Etc., the measurement shall be in Square meter basis.

Rate

The contractor unit rate for road markings shall be payment in full compensation of furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these specification complete as per the approved drawing (s) or as directed by the Engineer and other incidental cost necessary to complete the work to these Specifications. Rate for this item shall be for sq. meters of actual area marked

Item No. 10:

Cateyes Road Stud: Supplying of moulded twin shakes 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 with minimum reflective area of 13 sqm 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+/- 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 manufacture's recommendation and the colour of the marker should be as per the IRC 35 2015 and as directed by Engineer in Charge.

1. General

Reflective Pavement marker (RPM) or road stud is device which is

Bonded to or anchored within the road surface for lane marking and delineation

for night time visibility. It reflects incident light in directions close to the direction from which it came.

2. Definitions

Description of Terms Specific to this standard

(a) Coefficient of luminous intensity (CIL) or specific intensity = the ratio of luminous intensity of the retro-reflector in the direction of observation to luminance at the retro-reflector on a plane perpendicular to the direction of the incident light expressed in terms of Milaca deal as per incident lux (med/ lx).

(b) Horizontal entrance angle – the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

(c) Observation angle – the angle in the reflector between the illumination axis and the observation axis.

(d) Retro – reflection – reflection in which the radiation is returned in direction close to the direction from which it came, this property being maintained over were variations of the direction of incident radiation.

(e) Head – that part of a road stud which is above the road surface where the road stud is fixed in position in the road.

(f) Upper surface – that part of the external surface of road stud which is visible when the road stud is fixed in position in the road.

(g) Anchorage – that part of a road stud which is below the road surface above the road stud is fixed position in the road.

3. Material

Description of Terms Specific to this standard

- (a) Coefficient of luminous intensity (CIL) or specific intensity = the ratio of luminous intensity of the retro-reflector in the direction of observation to luminance at the retro-reflector on a plane perpendicular to the direction of the incident light expressed in terms of Milaca deal as per incident lux (med/ lx).
- (b) Horizontal entrance angle – the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.
- (c) Observation angle – the angle in the reflector between the illumination axis and the observation axis.
- (d) Retro – reflection – reflection in which the radiation is returned in direction close to the direction from which it came, this property being maintained over were variations of the direction of incident radiation.
- (e) Head – that part of a road stud which is above the road surface where the road stud is fixed in position in the road.
- (f) Upper surface – that part of the external surface of road stud which is visible when the road stud is fixed in position in the road.
- (g) Anchorage – that part of a road stud which is below the road surface above the road stud is fixed position in the road.
- (a) Plastic body of RPM road stud shall be moulded from ASA (Acrylic Sterner Acrylonitrile) or HIPS (Impacts polystyrene) or ABS or any other suitable material approved by the Engineer-in-charge. The marker shall support a load of 13635 kg tested in accordance with ASTM D4280.
- (b) Reflective panels shall consist if number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be molded of methyl

Methacrylate conforming to ASTM D 788 or equivalent.

4. Design

Sq.cm.

- (a) The slope or retro-reflecting surface shall preferably be 35 ± 5 degree to base.
- (b) The area of each retro-reflecting surface shall not be less than 13.0

5. Optical Performance

Unidirectional and bi-directional studs

- (a) Each reflector or combination of reflectors on each face of the stud shall have a CIL not less than given in Table 1 or 2 as appropriate.

Table 1 Minimum C.I.L. Values for Category "A" studs.

Entrance angle	Observation angle	C.I.L. in med 1 x		
		White	Amber	Red
0° U 5° L & R	0.3°	220	110	44
0° U 10° L & R	0.5°	120	60	24

Table 1 Minimum C.I.L. Values for Category "B" studs.

Entrance angle	Observation angle	C.I.L. in med 1 x		
		White	Amber	Red
0° U 6° L & R	0.3°	20	10	4
0° U 10° L & R	0.5°	15	7.5	3

Note: The entrance angle of 0°U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.

(a) A stud that incorporates one or more corner cube reflectors shall be considered to be included in category "A". A stud that incorporates one or more biconvex reflectors shall be considered to be included in category "B".

(b) Omni – directional studs: Each Omni-directional stud shall have a minimum C.I.L. of not less than med/ lx.

(c) Tests

Coefficient of luminance intensity can be measured by produced described in

ASTMD 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS 873 Part 4:1973. Under test conditions a stud shall

not be considered to fall the photometric requirements of the measured C.I.L. at

any one position of measurement is less than the values specified in Table 1 or 2 provided that.

- The value is not less than 80% of the specified minimum, and
- The average of the left and right measurements for the specific angle is greater than the specified minimum.

6. Fixing of Reflective Markers

Requirements

(a) The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic.

- (b) The reflecting portions of the studs shall be free from crevice or ledges where dirt might accumulate.
- (c) All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacture.
- (d) Marker height shall not exceed 20 mm.
- (e) Marker width shall not exceed 130 mm.
- (f) The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configured. The outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface.

Placement

- (a) The reflective marker shall be fixed to the road surface using the adhesives and the produced recommended by the manufacturer. No nails shall be used to affix the marker as nails are hazardous for the roads.
- (b) Regardless of the type of adhesive used. The markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing unit the surfacing has been opened to traffic for a period of not less than 14 hours.
- (c) The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.
- (d) Use a wire brush, if necessary to loosen and remove dirt. Then brush or blow clean.
- (e) The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom to the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place.
- (f) For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits or kerosene may be used as necessary to remove adhesive from exposed faces of pavement marker.

7. Warranty and durability

The contractor shall obtain from the manufacturer a two-year warranty for satisfactory light performance including stipulated retro-reflectance of the reflecting panel and submit the same to the Engineer. In addition, a two-year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carried out the work of fixing of reflective road markers. In case the markers are displaced, damaged or get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer at his own cost and with no extra remuneration to be paid for such works.

8. Measurement for Payment

The measurement of Cats eye (MMC) shall be in numbers of markers supplied and fixed.

9. Rate

The contract unit rate for Cats eye (MMC) shall be payment in full compensation for furnishing all labour, material, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specifications complete as per approved drawings or as directed. The contract unit rate shall be for a unit of one No.

Item no. 11:

Providing and fixing pre-cast concrete kerb stone of grey cement based concrete block 30cm length, 30cm height and 15cm thick of M200 grade concrete 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) etc. complete.

Providing and fixing approved quality and make rubber molded precast cement concrete blocks of M-200 having 30 cm length and 30 cm width, 15 cm depth with top shape of edge chamfered as per attached drawing and manufactured in automatic press machine. The minimum compressive strength of the kerb blocks should be 200kg/ cm². The blocks to be laid as per drawing and details given by the Engineer in charge. Kerb blocks to be laid in required line and level with flush joints filled up in C. M. (1:1) Including painting on kerbing, lines, dashes, arrows, letter on block in two coats with road marking paint as approved by engineer incharge brushing including cleaning the surface of all dirt, dust and other foreign matter etc complete Rate includes cost of all materials, labour, transportation, equipments and all taxes etc.

MATERIAL

- The size of precast cement concrete block of M-200 having 30 cm length and 30 cm width, 15 cm depth with top shape of edge chamfered as per attached drawing and as per shape approved by the Engineer in Charge, manufactured in rubber molded automatic press machine.
- Shape - Uniform unit shape
- Tolerance in size ± 1 mm in length and width all sides
- Colour: Natural Cement Colour. The top and outer surface should be a smooth shining surface.
- Compressive strength - Minimum 200 kg/cm² as specified
- Testing norms - 5 blocks out of 10000 Nos. of paving blocks

WORKMANSHIP

Laying of inter Kerb blocks to be started after completion of road work.

Kerb blocks to be laid with the joints between the block should not exceed 15mm. The spacing shall be constant so that uniform pattern can be maintained. After laying Kerbing proper curing shall be done.

Laying shall be done in true line & level/ slope in 30 Mtrs spans by use of string.

Mode of measurements & payment

The longitudinal length of block shall be measured under this item.

Mode of measurement: The payment shall be made unit running meter.

Item no. 12:

Providing and fixing DD Plan made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 244 x 122 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 4.0mtr (2 Nos.) long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 50 x 50 x 5mm; 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 Cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 7 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. (B) Class-B Type-4 Retro Reflective sheeting.

Item to be executed as per directed by Engineer in charge.

The payment shall be made unit of a Numbers.

Item no. 13:

Facility Informatory Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 80 x 60 cms. rectangular as per design of IRC-67-2012. Pretreated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; 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 Cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 7 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.

(B) Class-B Type-4 Retro Reflective sheeting.

The colour, configuration, size and location of all informatory sign boards for all roads shall be in accordance with the code of practice for Road Signs, IRC:67 or as shown on the drawings. In the absence of any details or for any missing details, signs/details shall be provided as directed by the Engineer in charge.

2.0) The signs/lettering shall be either reflectorised or non-reflectorised as shown on the drawings or as directed by the Engineer in charge. When they are of reflectorised type, they shall be of retro-reflectorised type and made of encapsulated lense type reflective sheeting. Fixed over aluminum sheeting as per specifications.

Clause 801.3

3.0) 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 in charge.

4.0) Materials:-

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

4.1) Concrete:-

Concrete shall be of the grade shown on the contract drawings or otherwise specified in the item description or as directed by the Engineer in charge.

4.2) Reinforcement Steel:-

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

4.3) Bolts, nuts, washers:-

High strength bolts shall conform to IS : 1367 whereas precision bolts, nuts etc. shall conform to IS : 1364.

4.4) Plates and supports:-

Plates and supports sections for the signposts shall conform to IS : 226 and IS : 2062 or any other relevant IS specifications.

4.5) Aluminum: -

Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminum alloy conforming to IS : 736-Material designation 24345 or 1900.

4.6) Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick. All others shall be at least 2 mm thick. The thickness of the sheet be related to the size of the sign and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.

4.7) In respect of sign sizes not covered by IRC : 67, the structural details (thickness etc.) shall be as per the approved drawings.

5.0) Traffic Signs having Retro-reflective Sheeting:- 5.1) General Requirements:-

The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and shown 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 unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory by manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or high density Grade with encapsulated lens. The type of sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

5.2) High intensity grade sheeting:-

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 Standard E : 810) as indicated in Table 800-1.

TABLE 800-1.

ACCEPTABLE MINIMUM COEFFICIENT OF RETRO REFLECTION FOR HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX PER SQUARE METER).

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

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

5.4) Messages/Borders:-

The messages (legends, letters, numbers etc.) and borders shall be either be screen-printed or of cut-outs. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. Cut-outs shall be of materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer.

5.5) For screen-printed transparent coloured areas on white sheeting, the co- efficient of retro-reflection shall not be less than 50 percent of the value of corresponding colour in Tables 800-1 and Table 800-2, as applicable.

5.6) Cut-out messages and borders, wherever used, shall be made out of retro- reflective sheeting (as per Clause 5.2 or 5.3 as applicable), except those in black which shall be of non-reflective sheeting.

5.7) Colour:-

Unless otherwise specified, the general colour scheme shall be as stipulated in IS: 5 “Colour for Ready Mixed Paints” viz.

Blue	IS Colour No:- 166: French Blue.
Red	IS Colour No:- 537: Signal Red.
Green	IS Colour No:- 284: Indian Green.

5.8) Adhesives:-

The sheeting shall either have a pressure-sensitive adhesive of the aggressive- tack type requiring no heat, solvent or other preparation for adhesive to a smooth clean surface, or a tack free adhesive activated by heat, applied in a heat-vacuum applicator, 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. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's Specifications. Sheeting with adhesives requiring use of solvent or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

5.9) Reimbursement:-

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminum backing pre-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

5.10) Fabrication:-

Surface to be reflectorised shall be effectively prepared to receive the retro- reflective sheeting. The aluminum sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain in 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 slices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. Sheeting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours are proposed, only butt jointing shall be used. The materials 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.

5.11) Warranty and Durability:-

The Contractor shall obtain from the manufacturer a seven years warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of high intensity grade and a five years warranty for the adhesive sheeting of Engineering grade and submit the same to the Engineer in charge. In addition, a seven year and a five year warranty for satisfactory in- field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the Contractor/supplier and passed on to the Engineer in charge. The Contractor/supplier shall also furnish a certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty.

Processed and applied in accordance with recommended procedures, the reflective materials shall be weather resistant and, following cleaning, shall show no appreciable percent of the specified minimum reflective intensity values (Table 800-1 and 800-2) when subjected to accelerated weathering for 100 hours, using type E or EZH Weatherometer (AASHTO Designation M268).

6.0) Installation:-

6.1) 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 0.98 sq.

m. shall be sign supports may be of mild steel, reinforced concrete or galvanized iron (G.I.) 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.

6.2) All the components of signs and supports, other than reflective portion and G.I. posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any pan of mild steel (MS) post below ground shall be painted with three coats of red lead paint.

6.3) 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 G.I. posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

7.0) Measurements for Payment: -

The measurements of standard cautionary, mandatory and information signs shall be in numbers of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by no.

8.0) Rate: -

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

The contract unit rate shall be for a unit of Numbers.

Item No. 14:

Cautionary Warning Signs:- Providing and Fixing sign boards made out of 2 mm aluminium sheet, size 90x90x90cms equilateral triangle as per the design of IRC-67-1977. Pre treated with phospheting process and acid etching coated with one coat of epoxy primer and two coat of best quality epoxy paint, reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications, 3.1 m long Stand post and frame fabricated from suitable size iron angle of 35x35x3mm, 75x75x6mm as required, painted with best quality epoxy coating 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 45x45x60 cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge :

(B) High intensity grade.....

SCOPE:

This work shall include supplying, fabricating, furnishing, transporting at site, excavation, fixing in CC block 1:2:4, plastering, water proofing cement paint, Providing & sticking the digitally prepared figuring & lettering for plots, roads nos., arrows etc. as per given drawing on radium sheet of given thickness & shade as per given detailed drawing and painting the Road signage board in conformity with the drawing or as directed by the Engineer-in-charge.

1) Material :

Cement shall be of approved make (List of approved make attached with Technical Bid) and shall conform to **M-3** of Specification of Materials attached herewith.

Sand shall conform to **M-6** of Specification of Materials attached herewith.

Course sand shall be used for outer finishing.

Grit shall conform to **M-8** of Specification of Materials attached herewith.

Coarse aggregate shall conform to **M-10 & 11** of Specification of Materials attached herewith.

Cement mortar in proportion 1:3 (1-cement: 3 - coarse sand) for base coat and Cement mortar in proportion in 1:1 (1- cement: 1- coarse sand) for outer finishing coat shall conform to **M-9** of Specification of Materials attached herewith.

Water shall conform to **M-1** of Specification of Materials attached herewith.

The Structural steel shall be of approved make shall (List of approved make attached with Technical Bid) and conform to **M - 17** of Specification of Materials attached herewith.

3 mm thick aluminum composite panel (ACP) shall be of best quality & approved make and conform to relevant IS code.

Radium sheet shall be of best quality & approved make and conform to relevant IS code.

Synthetic enamel paint shall be of approved make shall (List of approved make attached with Technical Bid) and shall conform to IS-1932-1964 or as revised from time to time.

Read lead paint shall conform to IS-102-1962.

The enamel paint shall be of approved make shall (List of approved make attached with Technical Bid) and shall conform to IS 2932-1974 or as revised from time to time. Primer shall conform to IS- 102-1962 or as revised from time to time.

Water proofing cement paint shall be of approved make shall (List of approved make attached with Technical Bid) and shall conform to IS – 5410-1969 or as revised from time to time.

The relevant specifications under MoRTH clause No. 1000 shall be made applicable.

2) Workmanship :

The Road signage board should be fabricated to the design & patterns shown in the drawing or as directed by the Engineer – in - charge. At least 4 Nos. hold fast of Angle 35 x 35 x 3mm, **75x75x6mm as required** having at least 300 mm length shall be fixed to the fabricated column as per the drawing.

Welding shall be done with the prior approval of Engineer-in-charge and workmanship shall conform to the specification of IS - 816 or other relevant I.S.

The fabrication work shall be carried out as per I.S. - 1038-1975 or as revised from time to time & P.W.D. manual and as directed by the Engineer-in-charge. All members of board / frame shall be exactly at right angle. All members of board / frame shall be straight without any warp and shall have smooth surface well planned on the all sides exposed at right angle to each other. M.S. hold fasts and all members of board abutting the concrete a faces shall be properly treated by applying a coat of approved primer (Anti-corrosive paints)

Covering work of **ACP** sheet shall be done only after approval of frame work of board by the Engineer-in-charge.

The steel frame shall be covered with 3 mm thick aluminum composite panel. The work of providing & fixing the 3 mm ACP for covering the steel frame shall be carried out as per best modern practices and as directed by the Engineer.

The figuring & lettering for plots, roads nos., arrows etc. for each Board shall be electronic digitally prepared & designed on computer as per the instruction of the Engineer-in-charge & before printing the same on radium sheet, shall be got approved from the Engineer.

The approved design of figuring & lettering shall be electronic digitally print out on radium sheet. The computerized printed radium sheet shall be stick on ACP sheet as per best modern practices.

The painting & primer coat shall be done in accordance with IS-1447 (Part-I).

The fixing work of Road signage board in position with CC 1:2:4 block of 45x45x60 cms shall be carried out as directed by the Engineer-in-charge and in good workman like a manner.

The excavation work in all strata shall be carried out as per the standard P.W.D. practice.

The board shall be embedded in CC 1:2:4 of size 45x45x60 cms as shown in the drawing. The board shall be fixed in the position have plumb with strong support from both sides and embedded in CC. The 10mm thick cement plaster with neat cement slurry shall be carried out on the top block of size 45x45x60 cms with the three coats of water proofing cement paint.

The contractor shall be held responsible for damage to board during fixing the work.

The entire work shall be carried out as per the detailed drawings, standard method laid down in P.W.D. hand book, modern practices, General Technical Specification attached herewith and as directed by the Engineer-in-charge.

The work shall be executed in accordance with best modern practices.

3) Mode of measurement & Payment:

A) Supplying the MS frame fabricated from square hollow MS pipes, iron angles, MS flats etc. incl. painting as described above as per given detailed drawing

The unit contract rate for providing & supplying Road signage board shall include the cost of all materials, all tools, and plants required for fabrication, painting and incidentals necessary to complete the work

B) Providing & fixing 2 mm thick aluminum composite panel (ACP) on MS frame as per given detailed drawing

The unit contract rate for providing & fixing 3 mm thick aluminum composite panel (ACP) on MS frame as per given detailed drawing shall include the cost of all materials, all tools, and plants required for fixing the ACP on fabricated MS frame, painting and incidentals necessary to complete the work

C) Proving & sticking the electronic digitally prepared figuring & lettering for plots, roads nos., arrows etc. as per given drawing on radium sheet of given thickness & shade as per given detailed drawing

The unit contract rate for Proving & sticking the electronic digitally prepared figuring & lettering for plots, roads nos., arrows etc. on radium sheet as per given detailed drawing shall include the cost of all materials, cost of computerized print out, all tools & plants and incidentals necessary to complete the work.

D) Fixing the road signage board at site of work in 1:2:4 cement concrete block of following size incl. nece. excavation, curing, formwork, P/L 10mm thick cement plaster in C.M. 1:3 finishing with neat cement slurry on exposed faces of top block incl. three coat of water proofing cement paint-

I) Cement concrete (1:2:4) block of 1.05 x 0.70 x 0. 75 M size below Ground Level & 1.05 x 0.70 x 0. 30 M size above GL as per detailed drawing

The unit contract rate for fixing Road signage board shall include the cost of all materials, excavation, labour, tools, and plants required for erecting at site, concreting, plastering, painting, cost of temporary structure required for fixing the board & incidentals necessary to complete the work.

The measurement shall be taken on the Number basis of road Signage Board fixed at site of work.
The contract rate shall be for a unit of one No. of road Signage Board fixed at site of work.

Item No.: 15:

Regulatory / Mandatory Signs:- Providing and Fixing sign boards Made out of 2mm aluminium sheet size 60 cms diameter circle as per the design of IRC-67-1977. Pretreated with phospheting process and acid etching, coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per Latest M.O.S.T. Specifications, 3.1 m long Stand post and frame fabricated from suitable size iron angle of 35x35x3mm, 75x75x6mm as required; painted with best quality epoxy coating in black and white bends. The details of symbol for each board shall be as per the instruction of engineering in charge. The fixing at site shall be in 1:2:4 CC block of size 45x45x60cms. for each leg including excavation curing etc. complete under the supervision of engineer in charge.

(B) High intensity grade.....

SCOPE:

This work shall include supplying, fabricating, furnishing, transporting at site, excavation, fixing in CC block 1:2:4, plastering, water proofing cement paint, Providing & sticking the digitally prepared figuring & lettering for plots, roads nos., arrows etc. as per given drawing on radium sheet of given thickness & shade as per given detailed drawing and painting the Road signage board in conformity with the drawing or as directed by the Engineer-in-charge.

Material :

Cement shall be of approved make (List of approved make attached with Technical Bid) and shall conform to **M-3** of Specification of Materials attached herewith.

Sand shall conform to **M-6** of Specification of Materials attached herewith.

Course sand shall be used for outer finishing.

Grit shall conform to **M-8** of Specification of Materials attached herewith.

Coarse aggregate shall conform to **M-10 & 11** of Specification of Materials attached herewith.

Cement mortar in proportion 1:3 (1-cement: 3 - coarse sand) for base coat and Cement mortar in proportion in 1:1 (1- cement: 1- coarse sand) for outer finishing coat shall conform to **M-9** of Specification of Materials attached herewith.

Water shall conform to **M-1** of Specification of Materials attached herewith.

The Structural steel shall be of approved make shall (List of approved make attached with Technical Bid) and conform to **M - 17** of Specification of Materials attached herewith.

3 mm thick aluminum composite panel (ACP) shall be of best quality & approved make and conform to relevant IS code.

Radium sheet shall be of best quality & approved make and conform to relevant IS code.

Synthetic enamel paint shall be of approved make shall (List of approved make attached with Technical Bid) and shall conform to IS-1932-1964 or as revised from time to time.

Read lead paint shall conform to IS-102-1962.

The enamel paint shall be of approved make shall (List of approved make attached with Technical Bid) and shall conform to IS 2932-1974 or as revised from time to time. Primer shall conform to IS- 102-1962 or as revised from time to time.

Water proofing cement paint shall be of approved make shall (List of approved make attached with Technical Bid) and shall conform to IS – 5410-1969 or as revised from time to time.

The relevant specifications under MoRTH clause No. 1000 shall be made applicable.

4) Workmanship :

The Road signage board should be fabricated to the design & patterns shown in the drawing or as directed by the Engineer – in - charge. At least 4 Nos. hold fast of Angle 35 x 35 x 4mm having at least 300 mm length shall be fixed to the fabricated column as per the drawing.

Welding shall be done with the prior approval of Engineer-in-charge and workmanship shall conform to the specification of IS - 816 or other relevant I.S.

The fabrication work shall be carried out as per I.S. - 1038-1975 or as revised from time to time & P.W.D. manual and as directed by the Engineer-in-charge. All members of board / frame shall be exactly at right angle. All members of board / frame shall be straight without any warp and shall have smooth surface well planned on the all sides exposed at right angle to each other. M.S. hold fasts and all members of board abutting the concrete a faces shall be properly treated by applying a coat of approved primer (Anti-corrosive paints)

Covering work of **ACP** sheet shall be done only after approval of frame work of board by the Engineer-in-charge.

The steel frame shall be covered with 3 mm thick aluminum composite panel. The work of providing & fixing the 3 mm ACP for covering the steel frame shall be carried out as per best modern practices and as directed by the Engineer.

The figuring & lettering for plots, roads nos., arrows etc. for each Board shall be electronic digitally prepared & designed on computer as per the instruction of the Engineer-in-charge & before printing the same on radium sheet, shall be got approved from the Engineer.

The approved design of figuring & lettering shall be electronic digitally print out on radium sheet. The computerized printed radium sheet shall be stick on ACP sheet as per best modern practices.

The painting & primer coat shall be done in accordance with IS-1447 (Part-I).

The fixing work of Road signage board in position with CC 1:2:4 block of 45x45x60 cms shall be carried out as directed by the Engineer-in-charge and in good workman like a manner.

The excavation work in all strata shall be carried out as per the standard P.W.D. practice.

The board shall be embedded in CC 1:2:4 of size 45x45x60 cms as shown in the drawing. The board shall be fixed in the position have plumb with strong support from both sides and embedded in CC. The 10mm thick cement plaster with neat cement slurry shall be carried out on the top block of size 45x45x60 cms with the three coats of water proofing cement paint.

The contractor shall be held responsible for damage to board during fixing the work.

The entire work shall be carried out as per the detailed drawings, standard method laid down in P.W.D. hand book, modern practices, General Technical Specification attached herewith and as directed by the Engineer-in-charge.

The work shall be executed in accordance with best modern practices.

5) Mode of measurement & Payment:

A) Supplying the MS frame fabricated from square hollow MS pipes, iron angles, MS

flats etc. incl. painting as described above as per given detailed drawing

The unit contract rate for providing & supplying Road signage board shall include the cost of all materials, all tools, and plants required for fabrication, painting and incidentals necessary to complete the work

B) Providing & fixing 2 mm thick aluminum composite panel (ACP) on MS frame as per given detailed drawing

The unit contract rate for providing & fixing 3 mm thick aluminum composite panel (ACP) on MS frame as per given detailed drawing shall include the cost of all materials, all tools, and plants required for fixing the ACP on fabricated MS frame, painting and incidentals necessary to complete the work

C) Proving & sticking the electronic digitally prepared figuring & lettering for plots, roads nos., arrows etc. as per given drawing on radium sheet of given thickness & shade as per given detailed drawing

The unit contract rate for Proving & sticking the electronic digitally prepared figuring & lettering for plots, roads nos., arrows etc. on radium sheet as per given detailed drawing shall include the cost of all materials, cost of computerized print out, all tools & plants and incidentals necessary to complete the work.

D) Fixing the road signage board at site of work in 1:2:4 cement concrete block of following size incl. nece. excavation, curing, formwork, P/L 10mm thick cement plaster in C.M. 1:3 finishing with neat cement slurry on exposed faces of top block incl. three coat of water proofing cement paint-

II) Cement concrete (1:2:4) block of 1.05 x 0.70 x 0. 75 M size below Ground Level & 1.05 x 0.70 x 0. 30 M size above GL as per detailed drawing

The unit contract rate for fixing Road signage board shall include the cost of all materials, excavation, labour, tools, and plants required for erecting at site, concreting, plastering, painting, cost of temporary structure required for fixing the board & incidentals necessary to complete the work.

The measurement shall be taken on the Number basis of road Signage Board fixed at site of work.

The contract rate shall be for a unit of one No. of road Signage Board fixed at site of work.

Part II SWD

Item No.: 16:

Excavation for foundation upto 1.5 m depth including sorting out and stacking of useful materials and disposing off the excavated stuff for all lead and lift with refilling the trenches as and when required as directed by Engineer incharge (A) Loose or soft soil

SCOPE:

This item shall consist of excavation, removal and satisfactory disposal of all materials necessary widening of Road, Re-sectioning & Profile correction of Road., Side Shoulder & Road by using cutting stuff received from cutting, in accordance with the requirement

of these specification including all lead and lift and conformity with the lines, grades and cross sections shown in the drawings or directed by the engineer- in – charge. This work shall include the hauling and stacking of or hauling to sites of embankment for land scapping Island, Road work & side shoulder construction etc. of suitable cut materials as required and also the disposal of unsuitable cut materials in specified manner, including all lead and lifts including trimming and finishing of the road to specified dimensions or as directed by the engineer in charge including rolling and watering etc. complete.

CLASSIFICATION OF EXCAVATED MATERIALS:

Before excavation bidder shall carry out the preliminary survey / contouring preparing L-S for road, formation level & work out the cutting / filling quantity within the estate shall be got approved from the engineer in charge. The excavated stuff utilized in embankment in road area as well as speeded & filled up in low laying area within the estate as directed by engineer in charge.

Classification:

All materials involved in excavation shall be classified by the engineer in charge in the following groups:

- 1) All sorts of soil and soft murrum
- 2) Hard murrum
- 3) Soft rock not required blasting
- 4) Hard rock (not required blasting)
- 5) Hard rock (required blasting)
- 6) Hard rock (blasting prohibited)

Authority for Classification:

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

2. CONSTRUCTION OPERATIONS:

3.1) SITE CLEARANCE:

The land width on which the earth work is to be done, shall be cleared from all trees, bushes, shrubs, rubbish and other objectionable materials. Useful material shall be arranged in convenient stacks and un-useful material shall be burnt or otherwise disposed off by contractor at his own cost. MoRTH specification clause No.201 shall be also followed.

SETTING OUT:

After the site has been cleared, the limits of excavation and the alignment of the road shall be set out true to lines, curves, slopes, grades and sections as shown on the

drawings or as directed by the Engineer in charge. The contractor provide all labour and materials such as strings, time pegs, stones etc. required in connection with the setting out of works and establishment of Temporary & permanent Bench mark, center line stone & other marks. The contractor shall be responsible for the maintenance of the bench mark and other marks, and stacks as long as in the opinion of the Engineer in charge. Before start of the work, toe line of embankment shall be marked on ground.

COMPACTING ORIGINAL GROUND:

The original ground, where construction of embankment for land scrapping Island, Road work, side shoulders and water way to be done, with excavated stuff shall be consolidated by rolling as directed by Engineer in charge and in accordance with MoRTH specification Clause No.305.3.4.

EXCAVATION:

All excavation shall be carried out in a manner approved by the Engineer in charge and in conformity with the directions laid herein under and in manner approved by the Engineer in charge. The work shall be so done that the suitable materials available from excavation are satisfactory utilized as decided upon beforehand.

While planning or executing excavations, the contractor shall take all adequate precaution against soil erosion, water pollution etc. as per MoRTH Clause No.306 & take appropriate drainage measures to keep the site free from water in accordance with the MoRTH Clause No.311.

The excavation shall conform to the lines, side slopes, and levels shown on the drawings or directed by the Engineer in charge. The contractor shall not excavate outside the limit of excavation subject to the permitted tolerance, any excess depth/width excavated beyond the specified levels/ dimensions on the drawing shall be made at the cost of contractor with suitable material of characteristics similar to that removed and compacted to the requirements of MoRTH clause No.305.

Care shall be taken to see that excavation is arranged in a safety way so that there will be no risk to the work or workmen. If slides occur in cutting during the process of the construction, they shall be removed at the cost of contractor as ordered by the Engineer in charge. While planning or executing excavations, the contractor shall take all adequate precautions against soil erosion, water pollution etc. as per MoRTH specification clause no.306.

All debris and loose materials on the slopes of cutting shall be removed. No back filling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in instruction of the Engineer in charge & the resulting cavities filled with suitable materials and thoroughly compacted in an approved manner.

For rock excavation, specifications under MoRTH clause No. 301.3.5 shall be followed.

DISPOSAL & UTILIZING OF EXCAVATED STUFF:

All the excavated material shall be property of the corporation. The material obtained from the excavation of roadways, widening work, SWD, foundation for structures etc. shall be used for the work of embankment, for land scrapping Island, Road work, embankment for

side shoulder of roads & embankment work as directed by the Engineer in charge including leveling & spreading with all lead and lift and no extra payment shall be made for the same.

Unsuitable and surplus materials not intended for use shall be removed from site of the work to outside estate limit or within estate limit by suitable means. No extra payment shall be made for the same..

The useful excavated materials shall be used in embankment and it shall be directly deposited at the required location in specified layer. No handling or conveyance charges shall be paid. If no DGIDCIEA land is available, but the excavated useful stuff is to be stacked temporarily before use under the same agreement, the contractor shall make his own arrangements for the stacking of this material temporarily on private land or land of plot holders, by paying rent etc. without claiming any compensation. Surplus material not required for use on embankment or unsuitable materials may be used of his own cost to uniformly widen embankment to flatten slopes and fill low places in the road land or plot land, if so permitted by the Engineer in charge. Material not required for any use whatsoever may be disposed off by the contractor at his own cost in a manner approved by the Engineer in charge.

The excavation shall be finished neatly, smoothly and evenly to the correct lines, curves, grades sections and side slopes as shown on the plans or directed by the Engineer. Any damage to the existing works or work in hand caused as a result of his operations or negligence shall be made good by the contractor at his own cost. Road side gutters shall be excavated to the specified section.

SPREADING THE EXCAVATED STUFF IN LAYERS:

The excavated stuff shall be spread uniformly over the entire width of embankment for land scrapping Island, Road work, side shoulders in layers not exceeding 250 mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down in the detailed specifications of MoRTH

Clods or hard lumps of cutting stuff shall be broken as directed by the Engineer in charge.

DEWATERING:

If water is met with the excavation due to springs, seepage, rain etc. shall be removed by suitable diversions, pumping or bailing out and the excavation part kept dry whenever so required or directed. Care shall be taken to discharge, the drained water into suitable outlets as not to cause damage to the works, demarcated plots, crops any other property. Due to any negligence on the part of the contractor, if any such damage is caused, it shall be the sole responsibility of the contractor to repair/ restore to the original condition at his own cost or compensate for the damage. MoRTH Specification Clause No. 304.3.3 shall also apply.

PUBLIC SAFETY:

Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The contractor shall take adequate protective measures to see that the

excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS: 3764.

PRESERVATION OF PROPERTY:

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

REPARATION OF CUT FORMATION

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

Any unsuitable material encountered in the sub grade level shall be removed as directed by Engineer in charge & replace with suitable materials compacted in accordance with the MoRTH clause no.305.

In rock formations, the surface irregularities shall be corrected and the level brought up to the specified elevation with granular base material as directed by the Engineer in charge, laid and compacted in accordance with the respective specifications of these materials. After satisfying the density requirement, the cut formation shall be prepared and to receive the sub-base / base course in accordance with MoRTH Clause No.310 & 311 to receive the sub-base/ base course.

FINISHING OPERATIONS:

Finishing operations shall include the work of properly shaping and dressing all excavated surface/embankment works, and shall conform to MoRTH specification Clause No.301.7 and 305.3.9.

The finished cut surface shall satisfy the surface tolerance described in MoRTH Clause 902.

3. QUALITY CONTROL OF WORK:

Control on the quality of materials and works shall be exercised by the Engineer-in-charge in accordance with these specifications and general specification for quality control on works and materials attached herewith. All testing charges shall be borne by the contractor.

4. ARRANGEMENT FOR TRAFFIC:

MoRTH specification Clause –112 shall be applicable.

5. MODE OF MEASUREMENT & PAYMENT:

The contract rate shall be for a unit of one cubic meter for the strata mentioned in the wording of the item of excavation acceptable completed and limited to the dimensions shown on the plans and construction of embankment/ side shoulders with cutting stuff, acceptably completed and limited to the dimensions only. Excavation shall be measured in its original position by taking cross sections before the work starts and after it is entirely completed, or levels shall be taken before and after construction. The quantity shall be worked out by the average end area method. Where it is not feasible to compute volumes by this method, because of erratic location of isolated deposits, the volumes shall be computed of the strata changes, the contractor shall bring this to the notice of the Engineer-in-charge who will then verify and if necessary take levels for the changed strata for purposes of measurements.

Levels and sections of the ground shall be taken in the presence of the contractor or his authorized agent before the excavation is started so as to serve as the basis of measurement. The contractor or his representative shall sign the field book in token of his acceptance of the levels. If there is any disagreement the contractor shall inform of it in writing to the officer concerned with the specific reference to the sections before starting further work. Once the work is started, no cognizance of any complaint shall be taken. Merely not signing of the field book shall not be deemed as disagreement.

The contract unit rate for this item shall be payment in full for carrying out the required operations including full compensation for setting out, transporting the excavated materials & disposing the same on site of the embankment/ work of side shoulder etc. as directed within all lead and lift. trimming bottoms and slopes of excavation, dewatering, keeping the work free of water as per clause 311, all materials, labours, tools, equipment, safety measures all testing charges, making arrangement for traffic and incidentals necessary to complete the work to the specifications above and all leads and lifts. No extra payment shall be made for the cutting stuff used in embankment/ shoulders.

The contract unit rate shall be for a unit of one Cubic meter of finished work at the site of work.

Item No.: 17:

Providing and Laying controlled cement concrete (1:3:6) and with M/C stone aggregate and curing etc. complete, including the cost of formwork but excluding the cost of reinforcement for R.C.C work in Foundation and Plinth.

The work shall cover furnishing & providing plain cement concrete foundation placed in open excavation for Head wall of C.D. works, below pipes of C.D. works etc in accordance with these specifications and in conformity with the lines, grades & dimensions, as shown on the drawings or as directed by the Engineer- in-charge.

1.0) GENERAL:

A method statement for construction indicating the following shall be submitted by the contractor for approval of the Engineer, well in advance of the commencement of open foundation & structures:

- i) Sources of materials
- ii) Design, erection and removal of formwork
- iii) Production, transportation, laying and curing of concrete
- iv) Personnel employed for execution and supervision
- v) Tests and sampling procedures
- vi) Equipment details
- vii) any other points

Arrangements for execution under water wherever necessary, shall be indicated in method statement.

Dimensions, lines and levels shall be set out and checked with respect to permanent reference lines and permanent bench mark.

2.0) MATERIALS:

Cement conforming to IS: 269/ IS: 8112 or IS: 12269 as approved shall be used.

Coarse aggregate shall consist of clean, hard, strong, dense, nonporous, and durable pieces of crushed stone. Aggregate shall not consists pieces of disintegrated, stones, soft, flaky, elongated particles, salt, alkali, vegetable matters or other deleterious materials in such quantity as to reduce the strength and durability of the concrete. All coarse aggregate shall conform to IS: 383 & test for conformity shall be carried out as per IS: 2386 (Part 1 to 8).

The size (maximum nominal) of coarse aggregate for concrete to be used for various components shall be 20mm nominal size. The maximum value of flakiness index for coarse aggregate shall satisfy the following requirement of grading:

T A B L E

IS sieve size Percentage by passing the sieve.

20mm nominal size coarse aggregate

40mm	100
20mm	95 – 100
12.5mm	--
10mm	25 – 55
4.75mm	0 – 10

Sand and fine aggregates:

For PCC work, fine aggregates shall consist of clean, hard, strong, dense, non-porous, and durable pieces of crushed stone.

Aggregate shall not consist of pieces of disintegrated, stones, soft, flaky, elongated particles, salt, alkali, vegetable matters or other deleterious materials in such quantity as to reduce the strength and durability of the concrete. All coarse aggregate shall conform to IS: 383 & IS: 456 – 1978 & test for conformity shall be carried out as per IS: 2386 (Part – 1 to 8).

The sand shall be natural & clean well graded, hard, strong, durable & free from all amount of dust, clay & other deleterious substance and shall be got approved from the Engineer-in-charge. Sand to be used for concrete work shall be of grades as specified in IS: 383 – 1970 with fineness modules varying from 2.6 to

3.6 as per requirement.

Water:

Water shall conform to MORTH clause No. 1000 shall be made applicable.

3.0) WORKMANSHIP:

Before starting the concreting, foundation of head wall shall be cleared from all loose materials, levelled, watered and rammed as directed.

The grade of concrete shall be ordinary cement concrete M – 100.

In the designation of concrete mix, letter “ M “ refers to the mix and the number to the specified 28 days works. Cube compressive strength of that mix on 150mm cubes, expressed in kg / cm² (M – 100 > 100 Kg/cm² compressive strength at 28 days works cube)

The ordinary cement concrete M – 100 shall be by volume equivalent to 1: 3: 6 (1 part of cement : 3 part of sand and 6 parts of coarse aggregate nominal 20mm size).

The proportion of cement to sand and coarse aggregates shall be 1: 3: 6 i.e. 1 part of cement: 3 parts of sand and 6 part of coarse aggregate by volume.

For cement, which normally comes in bags and is available by weight, volume shall be worked out taking 50 kg cement as a 0.035 m³ in volume, while measuring aggregate by volume, sinking, ramming & hammering shall not be done. Proportioning of sand shall be per its by dry volume, in case it is damp, allowance for “Bulking “shall be made as per IS : 2386 (Part – III).

Concrete shall be mixed in a concrete mixture as approved by the Engineer-in- charge. Hand mixing shall not be permitted. The mixture shall be at a approved location considering the properties of the mixes and the transportation arrangement available with the contractor. The mixer shall be approved by the Engineer-in-charge.

Form work shall including all temporary / permanent forms required for forming the concrete. Forms for concrete shall be constructed of metal and be of substantial and rigid construction true to the shape and dimensions shown on the drawings. All bolts and rivets shall be countersunk and well ground to provide a smooth plane surface.

The Engineer-in-charge shall be informed in advance by the contractor of his intention of strike any form work. While fixing the time for removal of form work, due consideration shall be given to local condition, character of structure. The weather conditions that influence the setting of concrete and of the material used in the mix. All form work shall be removed without causing any damage to the concrete. No form work shall be removed prior to obtaining written permission from Engineer-in-charge.

The form work shall also conform to MORTH clause No. 1500.

Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained & each individual particle of the coarse shows complete coating of mortar containing its proportionate amount of cement.

The concrete work shall be carried out as per relevant specification of MORTH clause No. 1700, 2100, 2200 & 2300. Necessary vertical pin headers incl. machine mixing, vibrating, ramming, curing, form work etc. incl. laying in line, grade & slope and finishing etc. complete as directed at any height /depth shall be provided as directed by the Engineer-in-charge and as per requirement laid down in P.W.D. manual.

All concrete work shall be compacted to produce a dense homogeneous mass with the assistance of vibrator. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.

Weep holes shall be provided as directed by the Engineer-in-charge. P.V.C. pipe 6 kg, per cm² of 100mm diameter shall be used for weep holes.

Exposed surface of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacks, canvas or similar material and shall be kept constantly wet for a period of not less than 14 days from the date of placing of concrete.

4.0) FINISHINGWORK:

The surface finish shall be smooth. Finishing work shall be carried out as per MoRTH specification clause No. 1714.

Providing sand bedding (Minimum thickness: 15 cm)

5.0) TEST& STANDARD OF ACCEPTANCE:

MORTH clause No. 2100, 2200 & 2300 shall be made applicable.

6.0) QUALITY CONTROL OF WORK:

Testing of all materials to be used in the P.C.C. work shall be carried out as and when required by the Engineer-in-charge. All testing charges shall be borne by the contractor.

Control on the quality of materials and works shall exercised by the Engineer-in- charge in accordance with these specifications and general technical specifications for quality control on works and materials attached here with and norms for testing given on page no. 21/15 of B1 agreement. The Engineer-in- charge shall have the right to modify the frequencies of testing according to the needs. MORTH clause No. 1703 shall also be made applicable.

7.0) MODE OF MEASUREMENT AND PAYMENT :

The mode of measurement shall be as specified in IS 1200 part – II – 1974 or as revised from time to time so far as applicable for measurement of cement concrete work and MORTH specification clause 2100, 2200 & 2300.

The unit rate for concrete shall cover costs of all materials, labour, tools, plant & equipments required for mixing, transporting & placing in position, vibrating & compacting, finishing and curing as direction of Engineer-in-charge, including all cost towards quality control test, sampling and testing, quality assurance and supervision, & all other incidental expenses for producing concrete of specified strength to complete the structure its components as shown on the drawing and according to this specifications. The contract unit rate for concrete shall also include the cost of providing, fixing and removing all centering and formwork required for the concrete work as per MORTH clause No. 1500

The contract unit rate shall be for a unit of one cubic meter of finished compacted work in position at the site of work.

Item No.: 18:

P/L IS standard RCC pipes in standard lengths of NP-4 Class of following dia suitable for either collar joints or rubber ring joints incl. all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to site including Labour charges for lowering, laying and jointing in C.M. (1:2) RCC NP-4 pipes in proper position, grade (To level or slope) and alignment as directed by the Engineer in charge etc.

Item to be executed as per directed by Engineer in charge.

The payment shall be made unit of Rmt..

Item No.: 19:

P/L Brick work using conventional common burnt clay building bricks having crushing strength not less than 35 kg/cm² in foundation and plinth in Cement Mortar 1:6 (1 Cement: 6 Fine Sand) etc. complete.

Item to be executed as per directed by Engineer in charge.

The payment shall be made unit of a cum.

Item No.: 20:

Providing & Fixing service Crossing pipe line Indicating stones having size 150 mm x 150mm x 750 mm height of controlled cement concrete M -20 with use of one 8 mm dia. vertical TMT steel bar and curing complete including the cost of form work, reinforcement, two coats of oil painting over one coat of primer on all surfaces, fixing

in C.C. (1:4:8) up to 0.45 Mtr. depth, lettering on two sides on exposed surfaces with enamel paint etc. for pipe line indication as per the instruction of Engineer in charge.

Item to be executed as per directed by Engineer in charge.

The payment shall be made unit of Number.

Item No.: 21:

Providing and laying - Fitter Media 600mm thick directed at the back of abutments, returns and wing walls as per detailed specifications.

This item shall be executed as per directions of the engineer incharge.

MODE OF MEASUREMENT AND PAYMENT:

This item shall be measured and paid in Square meters of work done.

Item No.: 22:

Providing, Supplying & Installation of Precast Box Culvert units of various size. The product should be meeting BIS requirements. The product shall be duly steam cured in the plant to have requisite compressive strength and having load carrying capacity of total 25 Tonnes vehicle load or 5 Tonnes wheel load for heavy vehicle movement. The product shall be made by using advanced precast technology using high performance self-compacting concrete of M50 grade and Fe 500 D grade TMT steel reinforcement bar. The product shall have tie shape groove of 10-20 mm width and 25 mm depth on both sides of each precast unit product for jointing two precast units. The product shall have flange plate at corner haunch and male - female groove in each precast unit product for jointing two precast units. Rubber gasket shall be placed at the given groove to make it a water tight structure. The product shall have in-built insert at optimized locations for mechanical installation activities including supplying, laying with required necessary manpower, machinery and material at site as per instruction of Engineer In-Charge

1. Design, Manufacture & Supply of factory-made (wet cast) Box Culvert of various sizes units of 2000 / 1500 mm length made up of high strength precast reinforced cement concrete duly steam cured in a controlled environment and manufactured by using high performance self-compacting concrete of M- 50 grade using Fe 500/550D grade TMT steel reinforcement bar. The Box Culvert shall be designed to carry load capacity 5 T Wheel load for heavy vehicle movement at road crossing. Design should confirm to BIS / JIS standards / Guidelines/ Codes furthermore taking into consideration expected handling and erection stresses etc. Any international guideline such as AASHTO, FHWA (Accelerated Bridge Construction Guidelines) Japan and EURO codes may be followed. Box culvert shall be manufactured using water tight formwork made up of automobile steel to have accurate dimensional product. Box culvert shall have joining arrangement,

flange bolt connection, rubber gasket etc. for proper connection. Approved make of the product shall be Fuji Silvertch, Teemage and FIT.

2. Supply and Providing accessory: Unloading of precast concrete box culverts shall be done with care. Handling shall be such as to avoid impact. Rubber gasket required to ensure water-tight character and for jointing of each segment flange-bolt connection with 12 mm diameter, 50 mm length Grade-8.8 high tensile bolts with zinc coating and round washer or equivalent nut-bolt connection will be supplied as part of the Box culvert. Technical assistance in form of technical presentation for installation procedure of product and/or one-time visit at site by technical team member of the manufacturer and supplier.

3. Quality Assurance: The product shall be manufactured from standard and tested raw materials including cement, fine aggregate, coarse aggregate, concrete and reinforcement. The water used for manufacturing of concrete should be potable water with TDS value not more than 300 ppm. The product shall be steam cured in the controlled environment for better quality control with a temperature control of 45 ± 2 Deg. Centigrade to 65 ± 2 Deg. Centigrade. The factory-made precast products shall be subject to strict quality control and assurance process by the manufacturer and approved by quality assurance personnel. The product must have reinforcement as per design drawings. The product should be handled mechanically at site. The product shall have in-built inserts at optimized locations for handling/transportation.

4. Precast manufacturer Qualification Criteria: Tenderer/Bidder will be required to enter into MOU with Precast Drain manufacturer fulfilling the following requirements. MOU shall mention all points mentioned below with project experience details in supply of Precast Drain. • The precast manufacturer should have minimum 7 years of work experience with valid legal registration in India to manufacture similar precast products in India.

- The precast manufacturer should have successfully completed or substantially completed i) Three similar works costing not less than the amount equal to 40% of estimated cost of work OR ii) Two similar works costing not less than the amount equal to 50% of estimated cost of work OR iii) One similar work costing not less than the amount equal to 80% of estimated cost of work OR iv) Three similar work for supply of Precast drain, Box culvert and Retaining wall of minimum 40% of total tender BOQ length.

in “last seven & current” financial years. Necessary documents shall be submitted as per requirement.

- Minimum average turnover of precast manufacturer shall be Rs. 100 Cr for previous 3 years. CA certified copy shall be attached.

- Precast manufacturer shall be certified for ISO 9001, ISO 14001 and ISO 45001 from NABCB organisation for design, manufacture and dispatch of products

- Minimum 3 work completion certificate of State / Central Govt projects are required.

- Precast manufacturer shall have a concrete stock yard of minimum 50,000 sq mtr for proper stacking of products and to have round the clock supply throughout the year.

- Precast manufacturer shall submit the design calculation report of each product with calculation details considering lifting loads.
- The precast factory should have in house QA-QC set up to ensure consistent quality of precast products. Degree certificate and PF slip of design team employees are required.
- The precast manufacturer shall have in-house design team for design of products as per site requirement. Degree certificate and PF slip of design team employees are required.
- Product shall be manufactured using RO water for durability criteria. Seperate RO water plant of sufficient capacity to support minimum 200 tonnes per day manufacturing of all precast concrete products.

MOU shall be prepared on Rs 300 stamp paper and shall be attached with Tender submission

i) Approved make: Fuji Silvertch, Teemage, FIT or Equivalent.

ii) Mode of measurement: Rate of precast units shall be for unit of one running meter.

iii) Tolerance: Finished segment tolerances should not exceed the following: a) Length of segment (not cumulative) +/- 5mm b) Web thickness, depths of top and bottom flanges, Width of top and bottom flanges, Overall depth of Segment, Thickness of diaphragm +/- 5mm

The contract unit rate shall be for Running Meter of Box Culvert.

Item No.: 23:

Providing, Supplying and Installation of Precast exposed finish RCC Wall units of various size. The product should be confirming to meeting BIS requirements. The product shall be duly steam cured in the plant to have requisite compressive strength. The product shall be made by using advanced precast technology using high performance self-compacting concrete of M50 grade and Fe 500 D grade TMT steel reinforcement bar. The product shall include flange coupling jointing arrangements and special in-built hanging brackets at appropriate locations for faster and safe mechanical installation of the product. The product shall have in-built insert at optimized locations for mechanical installation activities including supply and transportation at site. The precast product shall be manufactured in controlled environment adhering to stringent pre-defined, atmospheric standards. The factory-made precast product shall be subject to strict quality control and assurance process by the manufacturer and approved by quality assurance personnel. In no case, the site-casting of the product shall be allowed. The product shall have in-built insert at optimized locations for mechanical installation activities including supplying, laying with required necessary manpower, machinery and material at site as per instruction of Engineer In-Charge.

1. Design, Manufacture & Supply of factory-made (wet cast) Retaining Wall of various heights made up of high strength precast reinforced cement concrete duly steam cured in a controlled environment. It shall be manufactured using high performance self-compacting concrete of M- 50 grade using Fe 500/550D grade TMT steel reinforcement bar. Design should conform to IS/ BIS / JIS standards / Guidelines/ Codes furthermore taking into consideration expected handling and erection stresses etc. Any international guideline such as AASHTO, FHWA (Accelerated Bridge Construction Guidelines) Japan and EURO codes may be followed. Drain shall be manufactured using water tight formwork made up of automobile steel to have accurate dimensional product. The product shall include flange coupling jointing arrangements and special in-built hanging brackets at appropriate locations for faster and safe mechanical installation of the product. Approved make of the product shall be Fuji Silvertch, Teemage and FIT.

2. Laying and jointing: Unloading of precast concrete retaining walls shall be done as per provided standard guidelines. Handling shall be such as to avoid impact. Retaining wall positions shall be set out by a competent person using surveying techniques. Levels of existing benchmarks shall be confirmed. Necessary earthwork shall be carried out to install the retaining walls in position. Precast retaining walls shall be unloaded from trailer on arrival with hydra / crane of appropriate capacity. Precast retaining wall shall be lifted with suitable lifting devices and aligned to place in the designated position on the prepared foundation. The retaining walls shall be joint by flange bolt connection. Backfilling of the retaining walls shall be done. Draft prevention material and soil particles stop filter shall be provided Installation and joining of each segment shall be done as per direction of site engineer.

3. Quality Assurance: The product shall be manufactured from standard and tested raw materials including cement, fine aggregate, coarse aggregate, concrete and reinforcement. The water used for manufacturing of concrete should be potable water with TDS value not more than 300 ppm. The product shall be steam cured in the controlled environment for better quality control with a temperature control of 45 ± 2 Deg. Centigrade to 65 ± 2 Deg. Centigrade. The factory-made precast products shall be subject to strict quality control and assurance process by the manufacturer and approved by quality assurance personnel. The product must have reinforcement as per design drawings. The product should be handled mechanically at site. The product shall have in-built inserts at optimized locations for handling/transportation.

4. Precast manufacturer Qualification Criteria: Tenderer/Bidder will be required to enter into MOU with Precast Drain manufacturer fulfilling the following requirements. MOU shall mention all points mentioned below with project experience details in supply of Precast Drain.

- The precast manufacturer should have minimum 7 years of work experience with valid legal registration in India to manufacture similar precast products in India.
- The precast manufacturer should have successfully completed or substantially completed i) Three similar works costing not less than the amount equal to 40% of estimated cost of work OR ii) Two similar works costing not less than the amount equal

to 50% of estimated cost of work OR iii) One similar work costing not less than the amount equal to 80% of estimated cost of work OR

iv) Three similar work for supply of Precast drain, Box culvert and Retaining wall of minimum 40% of total tender BOQ length. in "last seven & current" financial years. Necessary documents shall be submitted as per requirement.

- Minimum average turnover of precast manufacturer shall be Rs. 100 Cr for previous 3 years. CA certified copy shall be attached.
- Precast manufacturer shall be certified for ISO 9001, ISO 14001 and ISO 45001 from NABCB organisation for design, manufacture and dispatch of products
- Minimum 3 work completion certificate of State / Central Govt projects are required.
- Precast manufacturer shall have a concrete stock yard of minimum 50,000 sq mtr for proper stacking of products and to have round the clock supply throughout the year.
- Precast manufacturer shall submit the design calculation report of each product with calculation details considering lifting loads.
- The precast factory should have in house QA-QC set up to ensure consistent quality of precast products. Degree certificate and PF slip of design team employees are required.
- The precast manufacturer shall have in-house design team for design of products as per site requirement. Degree certificate and PF slip of design team employees are required.
- Product shall be manufactured using RO water for durability criteria. Seperate RO water plant of sufficient capacity to support minimum 200 tonnes per day manufacturing of all precast concrete products.

MOU shall be prepared on Rs 300 stamp paper and shall be attached with Tender submission.

ii) Approved make: Fuji Silvertch, Teemage and FIT.

iii) Mode of measurement: Rate of precast units shall be for unit of one running meter.

iv) Tolerance: Finished segment tolerances should not exceed the following: i) Length of segment (not cumulative) +/- 5mm ii) Web thickness, depths of top and bottom flanges, Width of top and bottom flanges, Overall depth of Segment, Thickness of diaphragm +/- 5mm

The contract unit rate shall be for Running Meter of Retaining wall.

Item No.: 24:

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 90 cm above finished road edge level, fixed on ISMC series channel to center, 1.3 m height, fixing on

top slab by anchor fastener as well as gusset plate, all steel parts and fitments to be galvanised 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 810)

1 Materials

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.

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 x150 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.

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

3.2 Construction Operations

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.

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.

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.

3.3 Installation of Posts

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.

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.

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.

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

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.

3.4 Erection

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.

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.

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.

3.5 End Treatment for Steel Barrier

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.

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.

Mode of measurement& Payment: unit of one running meter.

Item No.: 25:

Providing and laying machine mixed controlled concrete M-250, machine vibrated water tight controlled reinforced concrete (by weigh batching) using machine crushed black trap metal or approved coarse aggregates in all types and size of structure as shown in the drawing including watering, placing (pouring) necessary

scaffolding, hoisting, leaving pockets, for pipes, sockets etc. as directed, keeping grooves, if any including curing, testing etc. complete. Rate includes shuttering, formwork but excluding reinforcement. (only fresh ply shall be used).

i. Beam

ii. Wall

Description

The work shall consist of producing, transporting, placing and compacting of structural concrete including fixing formwork and temporary works etc. and incidental construction in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Engineer.

Materials

All materials shall conform to Section 1000 of these Specifications.

Grades of Concrete

1703.1 The grades of concrete shall be designated by the characteristic strength as given in Table 1700-1, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Table 1700-1: Grades of Concrete

type of Concrete/Grade designation			Characteristic strength in MPa
nominal Concrete	Mix standard Concrete	High Performance Concrete	
M15	M15		15
M20	M20		20
	M25		25
	M30	M30	30
	M40	M35	35
	M45	M40	40
	M50	M45	45
		M50	50
		M55	55
		M60	60
		M65	65
		M70	70
		M75	75
		M80	80
		M85	85
		M90	90

1) Normal Mix Concrete is made on the basis of nominal mix proportioned by weight of its main ingredients – cement, coarse and fine aggregates and water.

2) Standard concrete is made on the basis of design mix proportioned by weight of its ingredients, which in addition to cement, aggregates and water, may contain chemical admixtures to achieve certain target values of various properties in fresh condition, achievement of which is monitored and controlled during production by suitable tests. Generally, concrete of grades up to M50 are included in this type.

3) High Performance Concrete is similar to standard concrete but contains additional one or more mineral admixtures providing binding characteristics and partly acting as inert filler material which increases its strength, reduces its porosity and modifies its other properties in fresh as well as hardened condition. Concrete of grades up to M90 are included in this type.

4) For concrete of grades higher than M90, the design parameters may be obtained from specialized literature and experimental results.

1703.2 The minimum grades of concrete and corresponding minimum cement content and maximum water/cement ratios for different exposure conditions shall be as indicated in Table 1700-2.

1703.3 For concrete subjected to sulphate attack the minimum grades of concrete, minimum cement content and maximum water/cement ratios and types of cement for different concentration of sulphate content shall be as indicated in Table 1700-3.

table 1700-2 : Requirement of Concrete for different exposure Condition using 20 mm aggregate

exposure Condition	Maximum Water Cement Ratio	Minimum Cement Content, kg/m ³	Minimum Grade of Concrete
Moderate	0.45	340	M25
Severe	0.45	360	M30
Very Severe	0.40	380	M40

i) All three provisions given in the above table for a particular exposure condition, shall be satisfied.

ii) The term cement for maximum w/c ratio and minimum cement content shown in Table includes all cementitious materials mentioned in Clause 1715.2. The maximum limit of flyash and ground granulated blast furnace slag in the blended cement shall be as specified in IS:1489 (Part 1) and IS:455 respectively.

iii) For plain cement concrete, with or without surface reinforcement, the minimum grade of concrete can be lowered by 5 MPa and maximum water/cement ratio exceeded by 0.05.

Cement content shown in the above table shall be increased by 40 kg/m³ for use of 12.50 mm nominal size aggregates and decreased by 30 kg/m³ for use of 40 mm nominal size aggregates.

Table 1700-3: Requirement of Concrete exposed to sulphate attack

Class	Concentration of sulphates as SO ₃		Minimum Cement	Maximum Water	/
	in soils				

	total so ₃ , %	so ₃ in 2:1 Water: soil extract, g/l	in Ground Water, g/l	type of Cement (note ii)	Content, kg/m ³	Cement Ratio	Minimum Grade of Concrete
1)	Traces	< 1.0	< 0.3	-OPC, PPC or PSC	280	0.5	M25
2)	2.0 to 0.5	1.0 to 1.9	0.3 to 1.2	-OPC, PPC or PSC -SRPC	330	0.5	M25
3)	0.5 to 1.0	1.9 to 3.1	1.2 to 2.5	-SRPC, -PPC or PSC	330 350	0.5 0.45	M25 M30
4)	1.0 to 2.0	3.1 to 5.0	2.5 to 5.0	-SRPC	370	0.45	M35
5)	>2.0	>5.0	>5.0	-SRPC with protective coatings	400	0.4	M40

Note: If the requirements of maximum water/cement ratio, minimum grade of concrete and minimum cement content from other durability considerations as given in Table 1700-2 are more stringent than those given in this table, then the former will govern.

OPC: Ordinary Portland Cement, PPC: Portland Pozzolona Cement. PSC: Portland Slag Cement, SRPC: Sulphate Resisting Portland Cement.

The minimum cement content shall be as low as possible but not less than the quantities specified in Table 1700-2 and 1700-3.

The maximum cement content excluding any mineral admixtures (Portland cement component alone) shall not exceed 450 kg/cu.m.

1703.4 Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. 'Design Mix' or 'Nominal Mix'. For all items of concrete, only design mix shall be used, except where nominal mix concrete is permitted as per drawing or by the Engineer. Nominal mix may be permitted only for minor bridges and culverts or other incidental construction, where strength requirements are upto M 20 only. Nominal mix may also be permitted for non-structural concrete or for screed below open foundations.

1703.5 If the Contractor so proposes, the Engineer may permit the use of concrete of higher grade than that specified on the drawing, provided the higher grade concrete meets the specifications applicable. The additional cost of such higher grade concrete shall be borne by the Contractor.

1704 Proportioning of Concrete

Prior to the start of construction, the Contractor shall design the mix in case of design mix concrete or propose nominal mix in case of nominal mix concrete, and submit to the Engineer for approval, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may be used at the Contractor's option, subject to the approval of the Engineer.

1704.1 Requirements of Consistency

The mix shall have the consistency which will allow proper placement and compaction in the required position. Every attempt shall be made to obtain uniform consistency. Slump test shall be used to measure consistency of the concrete.

The optimum consistency for various types of structures shall be as indicated in Table 1700-4, or as directed by the Engineer. The slump of concrete shall be checked as per IS:516.

Table 1700-4 : Requirements of Consistency

Type		slump (mm) (at the time of Placing of Concrete)
1)	a) Structure with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2)	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40 – 50
3)	RCC structure with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm	50 – 75
4)	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75 – 125
5)	Underwater concreting through tremie e.g. bottom plug, cast in-situ piling	150 – 200

Notwithstanding the optimum consistency indicated against Sl. No. 1 to 3, the situation should be properly assessed to arrive at the desired workability with the adjustment of admixture in each case, where the concrete is to be transported through transit mixer and placed using concrete pump. Under these circumstances, the optimum consistency during placement for the items of work of Sl. No. 1 to 3, can be considered ranging from 75 mm to 150 mm. This is, however, subject to satisfying the other essential criteria of strength, durability etc. and approval of the Engineer.

Requirements for design Mixes

Target Mean strength

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the current margin.

- i) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.64 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

ii) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 1700-5 :

table 1700-5 : Current Margin for initial design Mix

Concrete Grade	Current Margin (MPa)	target Mean strength (MPa)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58
M 50	13	63
M 55	14	69
M60	14	74
M 65	15	80
M 70	15	85
M 75	15	90
M 80	15	95
M85	16	101
M90	16	106

The initial current margin given in Table 1700-5 shall be used till sufficient data is available to determine the current margin as per Sub-Clause 1704.2.1(i).

1704.2.2 trial Mixes

The Contractor shall give notice to the Engineer to enable him to be present at the time of carrying out trial mixes and preliminary testing of the cubes. Prior to commencement of trial mix design, all materials forming constituents of proposed design mix should have been tested and approval obtained in writing from the Engineer. Based on test results of material, draft mix design calculation for all grades of concrete to be used in the works, shall be prepared after taking into account the provisions in the Contract Technical Specifications, Guidelines of IS:10262, IS:SP:23 and IRC:112 and submitted to the Engineer for approval. Prior to commencement of concreting, trial mix design shall be performed for all grades of concrete and trial mix which has been found successful, shall be submitted by the Contractor and approval obtained. During concreting with the approved trial mix design, if source of any constituents is changed, the mix design shall be revised and tested for satisfying the strength requirements.

The initial trial mixes shall be carried out in a laboratory approved by the Engineer. However, Engineer may permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. Sampling and testing procedures shall be in accordance with these Specifications.

When the site laboratory is utilized for preparing initial mix design, the concrete production plant and means of transport employed to make the trial mixes shall be similar to those proposed to be used in the works.

For each trial mix, a set of six cubes shall be made from each of three consecutive batches for purposes of testing. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these Specifications. The mean strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

1704.2.3 Control of strength of design Mixes

a) Adjustment to Mix Proportions

Adjustment to mix proportions arrived at in the trial mixes, shall be made subject to the Engineer's approval, in order to minimize the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

b) Change of Current Margin

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with Clause 1704.2.1. The recalculated value shall be adopted as directed by the Engineer, and it shall become the current margin for concrete produced thereafter.

c) Additional Trial Mixes

In case any changes are observed in the properties of fresh concrete and/or strength of hardened concrete on the basis of early age tests, additional mixes and tests shall be carried out during production, so as to control and bring the quality of concrete within acceptable limits. In case of any change in the source or properties of materials, the design of mix shall be established afresh.

1704.3 Requirements of nominal Mix Concrete

Requirements for nominal mix concrete unless otherwise specified shall be as given in table 1700-6.

table 1700-6 : Requirements for nominal Mix Concrete

Concrete Grade	total Quantity of dry aggregate by Mass per 50 kg of Cement to be taken as the sum of individual Masses of Fine and Coarse aggregates (kg)	Proportion of Fine to Coarse aggregate (by Mass)	Maximum Quantity of Water for 50 kg of Cement (litres)	
			PCC	RCC
M 15	350		25	

M 20	250	Generally 1:2, subject to upper limit 1:1.5 and lower limit of 1:2.5	25	22
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1704.4 additional Requirements

Concrete shall meet any other requirements as specified on the drawing or as directed by the Engineer. The overall limits of deleterious substances in concrete shall be as follows:

a) Total acid soluble chloride content in the concrete mix expressed as chloride ions shall not exceed the following values by mass of cement.

Prestressed concrete 0.10 percent

Reinforced concrete (in severe, very severe or extreme exposure condition) 0.20 percent

Reinforced concrete in moderate exposure condition 0.30 percent

b) The total water soluble sulphate content of the concrete mix expressed as SO₃, shall not exceed 4 percent by mass of cement in the mix.

For concrete made with Portland pozzolona cement, Portland blast furnace slag cement or mineral admixtures, the setting time and rate of gain of strength are different from those for concrete made with OPC alone. Such modified properties shall be taken into account while deciding the de-shuttering time, curing period, early age loading and time of prestressing. Additional cube samples may be required to be taken for verifying the concrete properties.

1704.5 suitability of Proposed Mix Proportions

The Contractor shall submit the following information for the Engineer's approval:

a) Nature and source of each material

b) Quantities of each material per cubic metre of fully compacted Concrete

c) Either of the following:

i) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement (s) as specified.

ii) Full details of tests on trial mixes.

d) Statement giving the proposed mix proportions for nominal mix Concrete

Any change in the source of material or in the mix proportions shall be subject to the Engineer's prior approval.

1704.6 Checking of Mix Proportions and Water/Cement Ratio

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement per bag as given by the manufacturer is accepted, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stock at site and not by bag, it shall be weighed separately from the aggregates. Water

shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

The specified water/cement ratio shall always be kept constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined as frequently as possible, the frequency for a given job being determined by the Engineer according to the weather conditions. The amount of water to be added shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates IS:2386 (Part III) shall be referred. Suitable adjustments shall also be made in the weight of aggregates to allow for their variation in weight due to variation in their moisture content.

1704.7 Grading of aggregates for Pumped Concrete

Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe.

The grading of aggregates shall be continuous and shall have sufficient ultra fine materials (material finer than 0.25 mm). Proportion of fine aggregates passing through 0.25 mm shall be between 15 and 30 percent and that passing through 0.125 mm sieve shall not be less than 5 percent of the total volume of aggregate. Admixtures to increase workability can be added. When pumping long distances and in hot weather, set-retarding admixtures can be used. Fluid mixes can be pumped satisfactorily after adding plasticisers and super plasticisers. Suitability of concrete shall be verified by trial mixes and by performing pumping test.

1705 admixtures

1705.1 Chemical admixtures

Chemical admixtures such as superplasticisers, or air entraining, water reducing, accelerating and retarding agents for concrete, may be used with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of their products only after obtaining complete information of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the work. Admixtures/additives conforming to IS:9103 may be used subject to approval of the Engineer. However, admixtures/additives generating hydrogen or nitrogen and containing chlorides, nitrates, sulphides, sulphates or any other material likely to adversely affect the steel or concrete, shall not be permitted.

The general requirements for admixtures are given in Clause 1007 of these Specifications.

Compatibility of the admixtures with the cement and any other pozzolona or hydraulic addition shall be ensured by for avoiding the following problems

- i) Requirement of large dosage of superplasticiser for achieving the desired workability,
- ii) Excessive retardation of setting,

- iii) Excessive entrainment of large air bubbles,
- iv) Unusually rapid stiffening of concrete,
- v) Rapid loss of slump
- vi) Excessive segregation and bleeding.

1705.2 Mineral admixtures

For use of mineral admixtures, refer Clauses 1714.1 and 1715.2.

1706 size of Coarse aggregates

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as given in Table 1700-7.

table 1700-7 : Maximum nominal size of Coarse aggregates

Components	Maximum nominal size of Coarse aggregate (mm)
i) RCC well curb	20
ii) RCC/PCC well steining	40
iii) Well cap or Pile Cap Solid type piers and abutments	40
iv) RCC work in girder, slabs wearing coat, kerb, approach slab, hollow piers and abutments, pier/abutment caps, piles	20
v) PSC Work	20
vi) Any other item	As specified by the Engineer

Maximum nominal size of aggregates shall also be restricted to the smaller of the following values:

- a) 10 mm less than the minimum lateral clear distance between individual reinforcements
- b) 10 mm less than the minimum clear cover to the reinforcement
- c) One quarter of minimum thickness of member

The proportions of the various individual sizes of aggregates shall be so adjusted that the grading produces the densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

1707 equipment

Unless specified otherwise, equipment for production, transportation and compaction of concrete shall be as under:

- a) Production of Concrete:
 - i) For overall bridge length of less than 200 m – batch type concrete mixer, diesel or electric operated, with a minimum size of 200 litres automatic water measuring system and integral weigher (hydraulic/pneumatic type).

ii) For overall bridge length of 200 m or more – concrete batching and mixing plant fully automatic, with minimum capacity of 15 cum per hour.

All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be checked over the range in use, when set up at each site and thereafter, periodically as directed by the Engineer.

The accuracy of the measuring devices shall fall within the following limits:

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

b) Transportation of Concrete:

- i) Concrete dumpers minimum 2 tonnes capacity
- ii) Powered hoists minimum 0.5 tonne capacity
- iii) Chutes
- iv) Buckets handled by cranes
- v) Transit truck mixer
- vi) Concrete pump
- vii) Concrete distributor booms
- viii) Belt conveyor
- ix) Cranes with skips
- x) Tremies

c) For Compaction of Concrete:

- i) Internal vibrators size 25 mm to 70 mm
- ii) Form vibrators minimum 500 watts
- iii) Screed vibrators full width of carriageway
(up to two lanes)

1708 Batching, Mixing, transporting, Placing and Compaction

1708.1 General

Prior to start of concreting, the Contractor shall submit for approval of the Engineer, his programme along with list of equipment proposed to be used by him for batching, mixing, transporting and placing concrete.

1708.2 Batching of Concrete

In batching concrete:

- The quantity of cement, aggregate and mineral admixtures, if used, shall be determined by mass.
- Chemical admixtures, if solid, shall be determined by mass.
- Liquid admixtures may be measured in volume or mass, and
- Water shall be weighed or measured by volume in a calibrated tank.

The concrete shall be sourced from on-site or off-site batching and mixing plants, or from approved Ready Mixed Concrete plants, preferably having quality certification.

Except where supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock piles. The materials should be stock piled several hours, preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible to ensure that the specified grading is maintained.

The water/cement ratio shall always be maintained constant at its correct value. To this end, determination of moisture content in both fine and coarse aggregates shall be made as frequently as possible, depending on weather conditions. The amount of added water shall be adjusted to compensate for any observed variations in the moisture content. To allow for the variation in mass of aggregate due to variation in moisture content, suitable adjustment in the mass of aggregate, shall also be made. Accurate control shall be kept on the quantity of mixing water, which when specified, shall not be changed without approval.

1708.3 Mixing Concrete

1708.3.1 Mixing at site

All concrete shall be machine mixed. In order to ensure uniformity and good quality of concrete the ingredients shall be mixed in a power driven batch mixer with hopper and suitable weigh batching arrangement or in a central mix plant. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall be continued till materials are uniformly distributed, a uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall mixing be done for less than 2 minutes. It shall be ensured that the mixers are not loaded above their rated capacities and are operated at a speed recommended by the manufacturer. When mineral admixtures are added at the mixing stage, their thorough and uniform blending with cement shall be ensured, if necessary by longer mixing time. The addition of water after the completion of the initial mixing operation, shall not be permitted.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch and also before changing from one type of cement to another.

1708.3.2 Ready Mix Concrete

Use of ready mix concrete proportioned and mixed off the project site and delivered to site in a freshly mixed and unhardened state conforming to IS:4926, shall be allowed with the approval of the Engineer.

1708.4 transporting Concrete

Mixed concrete shall be transported from the place of mixing to the place of final deposit as rapidly as possible by methods which will prevent the segregation or loss of the ingredients. The method of transporting or placing of concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position so that no contamination, segregation or loss of its constituents materials take place.

Concrete may be transported by transit mixers or properly designed buckets or by pumping. Transit mixers or other hauling equipment when used should be equipped with the means of discharge of concrete without segregation. During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to be reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

In case concrete is to be transported by pumping, the fresh concrete should have adequate fluidity and cohesiveness to be pumpable. Proper concrete mix proportioning and initial trials should ensure this. The conduit shall be primed by pumping a batch of mortar through the line to lubricate it. Once the pumping is started, it shall not be interrupted, as concrete standing idle in the line is liable to cause plug. The operator shall ensure that some concrete is always there in the pump's receiving hopper during operation. The lines shall always be maintained clean and free of dents.

Pipelines from the pump to the placing area shall be laid with minimum bends. For large quantity placements, standby pumps shall be available. Suitable air release valves, shutoff valves etc. shall be provided as per site requirements. The pumping of priming mix i.e. rich mix of creamy consistency, to lubricate the concrete pump and pipelines, shall precede the pumping of concrete. Continuous pumping shall be done to the extent possible. After concreting, the pipelines and accessories shall be cleaned immediately. The pipes for pumping shall not be made of material which has adverse effect on concrete. Aluminium alloy pipelines shall not be used.

1708.5 Placing of Concrete

All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete.

No concrete shall be placed in any part of the structure until the approval of the Engineer has been obtained. If concreting is not started within 24 hours of the approval being given, the approval shall have to be obtained again from the Engineer. Concreting shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes, unless a proper construction joint is formed.

The concrete shall be deposited as nearly as practicable in its original position to avoid re-handling. Methods of placing should be such as to preclude segregation. Care should be taken to

avoid displacement of reinforcement or movement of formwork. To achieve this, concrete should be lowered vertically in the form and horizontal movement of concrete inside the forms should, as far as practicable, be minimised.

The concrete shall be placed and compacted before its initial setting so that it is amenable to compaction by vibration. The workability of concrete at the time of placement shall be adequate for the compaction equipment to be used. If there is considerable time gap between mixing and placing of concrete, as in the case of ready mixed concrete plants or off-site batching and mixing plants, concrete mix shall be designed to have appropriately higher workability at the time of discharge from the mixer, in order to compensate the loss of workability during transit. This is generally achieved by suitable chemical admixtures. Keeping these considerations in view, the general requirement for ready mixed concrete plants or off-site batching and mixing plants, is that concrete shall be discharged from the truck mixer within two hours of the time of loading. A longer period may be permitted if suitable retarding admixtures are used.

In wall forms, drop chutes attached to hoppers at the top should preferably be used to lower concrete to the bottom of the form. As a general guidance, the permissible free fall of concrete may not exceed 1.5 metres and under no circumstances shall it be more than 2 metres. When free fall of larger height is involved, self-compacting concrete having adequate fluidity, cohesiveness and viscosity and which uniformly and completely fills every corner of the formwork by its own weight without segregation, shall be used.

Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not more than 300 mm in all other cases.

Concrete when deposited shall have temperature of not less than 5°C and preferably not more than 30°C and in no case more than 40°C. In case of site mixing, fresh concrete shall be placed and compacted in its final position within 30 minutes of its discharge from the mixer. When the concrete is carried in properly designed agitator operating continuously, the concrete shall be placed and compacted within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete, if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

1708.6 Compaction of Concrete

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over-vibration shall be avoided to minimize the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided.

When internal vibrators are used, they shall be inserted vertically to the full depth of the layer being placed and ordinarily shall penetrate the layer below for a few centimetres. The vibrator should be kept in place until air bubbles cease escaping from the surface and then withdrawn slowly to ensure that no hole is left in the concrete, care being taken to see that it remains in continued operation while being withdrawn. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdown.

Mechanical vibrators used shall comply with IS:2502, IS:2506, IS:2514 and IS:4656.

1709 Construction Joints

Construction joints shall be avoided as far as possible. In no case shall the locations of such joints be changed or increased from those shown on the drawings except with the express approval of the Engineer.

Joints should be positioned where they are readily accessible for preparation and concreting. Construction joints should be positioned to minimize the effects of the discontinuity of the durability, structural integrity and appearance of the structure. As far as possible, joints should be provided in non-aggressive zones, but if joints in aggressive zones cannot be avoided, they should be sealed. Joints should be located away from the regions of maximum stress caused by loading; particularly where shear and bond stresses are high.

In beams and slabs joints should not be near the supports. Construction joints between slabs and ribs in composite beams, shall be avoided. For box girders, there shall be no construction joint between the soffit and webs.

Joints should be either vertical or horizontal. For a vertical construction joint, the lifts of concrete shall finish level or at right angles to the axis of the member. Concreting shall be continued right up to the joint.

Before resuming work at a construction joint when concrete has not yet fully hardened, all laitance shall be removed thoroughly. The surface shall be roughened, taking care to avoid dislodgement of coarse aggregates. Concrete shall be brushed with a stiff brush soon after casting, while the concrete has only slightly stiffened. If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed. Fully hardened concrete shall be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles. The practice of first placing a layer of mortar or grout when concreting joints, shall

be avoided. The old surface shall be soaked with water, without leaving puddles, immediately before starting concreting. The new concrete shall be thoroughly compacted against it.

Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement shall be protected. In all cases, where construction joints are made, the joint surface shall not be contaminated with release agents, dust, or sprayed curing membrane and reinforcement shall be firmly fixed in position at the correct cover.

The sequence of concreting, striking of forms and positioning of construction joints for every individual structure, shall be decided well in advance of the commencement of work.

1710 Concreting under Water

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used, shall be got approved from the Engineer before any work is started.

Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall not be less than 16°C, nor more than 30°C.

Coffer dams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 m per minute through the space into which concrete is to be deposited. Coffer dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To minimise the formation of laitance, care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

All under water concreting shall be carried out by tremie method only. The number and spacing of the tremies should be worked out to ensure proper concreting. However, it is necessary to have a minimum number of 2 tremies for any concreting operation, so that even if one of the tremies goes out of commission during concreting, the other one can be used to complete the work. The tremie concreting when started, should continue without interruption for the full height of the member being concreted. The capacity of the concrete production and placement equipment should be sufficient to enable the underwater concreting to be completed uninterrupted within the stipulated time.

The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket, as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise the tremie slowly in order to allow a uniform flow of concrete. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the plastic concrete and shall not be taken out of concrete. This will cause the concrete to build up from below instead of flowing out over the surface and thus avoid formation of layers of laitance. It is advisable to use retarders or suitable superplasticizers to retard the setting time of concrete, which shall be established before the commencement of work.

1711 Concreting in extreme Weather 1711.1 Concreting in Cold Weather

Where concrete is to be deposited at or near freezing temperature, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5°C and that the temperature shall be maintained above 4°C until the concrete has hardened. When necessary, concrete ingredients shall be heated before mixing but cement shall not be heated artificially other than by the heat transmitted to it from other ingredients of the concrete. Stock- piled aggregate may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or on sheet metal over fire. In general, the temperature of aggregates or water shall not exceed 65°C. Salt or other chemicals shall not be used for the prevention of freezing. No frozen material or materials containing ice shall be used. All concrete damaged by frost shall be removed. Concrete exposed to freezing weather shall have entrained air and the water content of the mix shall not exceed 30 litres per 50 kg of cement. To counter slower setting of concrete, accelerators can be used with the approval of the Engineer. However, accelerators containing chloride shall not be used.

1711.2 Concreting in Hot Weather

When depositing concrete in hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 30°C while placing. This shall be achieved by using chilled mixing water, using crushed ice as a part of mixing water, shading stock piles of aggregates from direct rays of the sun, sprinkling the stock piles of coarse aggregate with water to keep them moist, limiting temperature of cement below 30°C at the time of use, starting curing before concrete dries out and restricting time of concreting as far as possible to early mornings and late evenings. When ice is used to cool mixing water, it will be considered as part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted. The Contractor will be required to state his methodology for the Engineer's approval when temperatures of concrete are likely to exceed 30°C during the work.

1712 Protection and Curing

1712.1 General

Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor. Curing and protection of concrete shall start immediately after compaction of the concrete.

The concrete shall be protected from:

- a) Premature drying out particularly by solar radiation and wind
- b) High internal thermal gradients
- c) Leaching out by rain and flowing water
- d) Rapid cooling during the first few days after placing
- e) Low temperature or frost
- f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.
- g) Vibration caused by traffic including construction traffic.

Concrete shall be protected, without allowing ingress of external water, by means of wet (not dripping) gunny bags, hessian etc. Once the concrete has attained some degree of hardening (approximate 12 hrs after mixing), moist curing shall commence and be continued through the requisite period. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

1712.2 Water Curing

Water for curing shall be as specified in section 1000 of these specifications.

Sea water shall not be used for curing. Sea water shall not come into contact with concrete members before they have attained adequate strength.

The concrete should be kept constantly wet by ponding or covering or use of sprinklers/ perforated pipes for a minimum period of 14 days after concreting, except in the case of concrete with rapid hardening cement, where it can be reduced to 5 days. Water should be applied on surfaces after the final set. Curing through watering shall not be done on green concrete. On formed surfaces, curing shall start immediately after the forms are stripped. The concrete shall be kept constantly wet with a layer of sacking, canvas, hessian or similar absorbent material.

1712.3 steam Curing

Where steam curing is adopted, it shall be ensured that it is done in suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete. Steam curing is applied in enclosures or tunnels through which concrete members are transported on a conveying system. Alternatively, portable enclosures or plastic covers are placed over precast members and steam is supplied to the enclosures. The rate of increase or decrease of temperature should not be more than 10°C to 20°C per hour and the maximum temperature shall be about 70°C. The maximum temperature shall be maintained until the concrete has attained the desired strength required at the end of steam curing period and shall be decided by prior trials. When steam curing is discontinued, the air temperature shall not drop at a rate exceeding 10°C per hour, until a temperature of about 10°C above the ambient temperature outside has been reached. Steam curing of concrete shall be followed by water curing for at least 7 days. The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

1712.4 Curing Compound

Membrane forming curing compounds consisting of waxes, resins, chlorinated rubbers etc. may be permitted by the Engineer in special circumstances. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist cured and no curing compound shall be permitted in locations where concrete surfaces are required to be bonded together.

Liquid membrane forming compounds shall conform to ASTM C 309 and the curing efficiency shall be as per ASTM C 156.

Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately

after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking. The membrane formed shall be stripped off after 14 days, when curing is complete. Impermeable membranes, such as sheet materials for curing concrete conforming to ASTM C 171 or polyethylene sheeting covering closely the concrete surface, may also be used to provide effective barrier against evaporation.

1713 Finishing

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar. The mortar shall be of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as possible. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance of the member, shall be rejected. Surface defects of a minor nature may be accepted. On acceptance of such work, the same shall be rectified as directed by the Engineer.

1715.2 Materials

Cement, mineral admixtures, chemical admixtures, aggregates and water shall conform to section 1000 of these Specifications and this Section.

Fly-ash when used, shall neither be less than 20 percent nor shall be greater than 35 percent of the total by mass of ordinary Portland cement and fly-ash and shall conform to grade-1 of IS:3812.

Ground granulated blast furnace (GGBS) slag when used, shall neither be less than 50 percent nor greater than 70 percent of the total mass of ordinary Portland cement and GGBS and shall conform to IS:12089.

Silica fume conforming to IS:15388 shall be used.

The cement content of concrete inclusive of any mineral admixtures shall not be less than 380 kg/m³. The cement content excluding any mineral admixtures (Portland cement content alone) shall not exceed 450 kg/m³. The water/cement (cement plus all cementitious materials) ratio should generally not exceed 0.33 but in no case shall be more than 0.40.

1715.3 Compatibility of admixtures

Compatibility of the super plasticizer and admixtures with the cement and any other Pozzolanic or hydraulic dilutes shall be ensured by trials as outlined under Clause 1705.

1715.4 Characteristic strength and target Mean strength

Characteristic strength and the initial target mean strength of concrete, shall be as given in

table 1700-8.

The target mean strength shall be calculated as per Clause 1704.2 after obtaining data on standard deviation from sufficient samples.

table 1700-8 : Characteristic Compressive strength and target Mean strength

Grade designation	Specified Compressive strength at 28 days (MPa)	Characteristic target Mean strength (MPa)
M 40	40	52
M 45	45	58
M 50	50	63
M 55	55	69
M 60	60	74
M 65	65	80
M 70	70	85
M 75	75	90
M 80	80	95
M85	85	101
M90	90	106

1715.5 Workability and other Requirements

Workability, concrete mix design, field trial mixes, chloride and sulphate contents shall be as laid down in other Sections of these Specifications.

1715.6 Mixing of Concrete

The concreting plant and means of transportation employed to make trial mixes and to transport them to representative distances shall be similar to the corresponding plant and

transport to be used in the works. The optimum sequence of mixing of ingredients shall be established by trials. Mixing time may be longer than in normal grade concrete mixes.

The temperature of concrete at the time of placement shall not exceed 25°C. The temperature of concrete at the mixing stage should be lower, to allow for rise in temperature during transport. When considerable distance of transport is involved, particular attention should be paid to ensure retention of slump as targeted for placement.

1715.7 Prototype testing

Mock-up trials or prototype testing may be carried out to ensure that the concrete can be satisfactorily placed and compacted, taking into account the location of placement and provision of reinforcement, and required adjustments made in concrete mix design and/or detailing of reinforcement.

1715.8 Curing of Concrete

High performance concrete containing silica fume is more cohesive than normal mixes hence, there is a little or no bleeding and no bleed water to rise to the surface to offset water loss due to evaporation. Plastic shrinkage cracking is possible, if curing is not proper. Initial curing should commence soon after initial setting of concrete. Concrete should be covered with moist covers, opaque colour plastic sheets or suitable curing compound. Final moist curing should commence after final setting of concrete and continue for at least 14 days.

1715.9 additional tests for Concrete

Apart from the strength tests prescribed in other Sections of these Specifications, the additional tests as specified under Clause 1714.3, shall also be carried out.

1716 tolerances

Tolerances for dimensions/shape of various components shall be as indicated in these Specifications or shown on the drawings or as directed by the Engineer.

1717 tests and standards of acceptance

1717.1 Concrete shall conform to the surface finish and tolerance as prescribed in these Specifications for respective components.

1717.2 Random sampling and lot by lot acceptance inspection, shall be made for the 28 days cube strength of concrete.

1717.3 Concrete under acceptance, shall be notionally divided into lots for the purpose of sampling before commencement of work. The basis of delimitation of lots shall be as follows:

- i) No individual lot shall be more than 30 cu.m in volume
- ii) Different grades of mixes of concrete shall be divided into separate lots.
- iii) Concrete of a lot shall be used in the same identifiable component of the bridge.

1717.4 sampling and testing

Concrete for preparing 3 test cubes shall be taken from a batch of concrete at point of delivery for construction, according to procedure laid down in IS:1199.

A random sampling procedure shall be adopted which ensures that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes.

150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28 day test strength result for each cube shall form an item of the sample. Tests at other age shall also be performed, if specified.

Where automated batching plant/Ready Mixed Concrete Plant is located away from the place of use and the time gap between production and placement is more than the initial setting time or where any ingredients are added subsequent to mixing, separate sets of samples shall be collected and tested at batching plant and at location of placement. The results shall be compared and used to make suitable adjustment at batching plants so that properties of concrete at placement are as per the requirements.

1717.5 test specimen and sample strength

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

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than ± 15 percent of the average. If variation is more, the test results of the sample are invalid.

1717.6 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 1700-9.

table 1700-9 : Minimum Frequency of sampling

Quantity of Concrete in Work, m ³	no. of samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 and above	4 plus one additional sample for each additional 50 m ³ or part thereof

1717.7 acceptance criteria

1717.7.1 Compressive strength

1) Cubes

The concrete shall be taken as having the specified strength when both the following conditions are met: compressive

a) The mean strength determined from any group of four consecutive non-overlapping samples exceeds the specified characteristic compressive strength by 3 MPa.

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

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

2) Cores

When the concrete does not satisfy both the conditions given in (1) above, representative cores shall be extracted from the hardened concrete for compression test in accordance with the method described in IS:1199 and tested to establish whether the concrete satisfies the requirement of compressive strength.

Evaluation of compressive strength by taking cores may also be done in case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength tests.

The locations from which core samples are to be taken and their number shall be decided so as to be representative of the whole of the concrete under consideration. However, in no case shall fewer than three cores be tested. Cores shall be prepared and tested as described in 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 of the grade of concrete specified for the corresponding age and no individual core has strength less than 75 percent of the specified strength.

1717.7.2 Chloride and sulphate Content

The total chloride and sulphuric anhydride (SO₃) content of all the constituents of concrete as a percentage of mass of cement in the mix, shall not exceed the values given in this Section.

1717.7.3 density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1717.7.4 density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1717.7.5 Permeability test

Water permeability test as per DIN:1048 Part 5–1991 shall be carried out as described below :

- i) A cylindrical test specimen 150 mm dia and 160 mm high shall be prepared.
- ii) After 28 days of curing, the test will be conducted between 28 and 35 days. The test specimen shall be fitted in a machine such that specimen can be subjected to a water pressure of up to 7 bars. A typical machine is shown in Appendix-1700/1.
- iii) The concrete specimen shall be subjected to a water pressure of 0.5 N/mm² from the top for a period of 3 days. The pressure shall be maintained constant throughout the test period. If the water penetrates through to the underside of the specimen, the test may be terminated and the specimen rejected as failed.
- iv) After 3 days, the pressure shall be released and the sample shall be taken out. The specimen shall be split in the middle by compression applied on two round bars on opposite sides above and below.
- v) When the split faces show signs of drying (after 5 to 10 minutes), the maximum depth of penetration in the direction of height shall be measured with the scale and extent of water penetration established.
- vi) The mean of maximum depth of penetration obtained from three specimens thus tested, shall be taken as the test result and it shall not exceed 25 mm.

1717.7.6 If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance, shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable even after investigation, the Contractor shall remove the rejected concrete forthwith.

1717.7.7 When durability of concrete is desired the rapid chloride ion permeability test as stated under Clause 1714.3.1 shall also be performed in addition to above tests.

1718 Measurements for Payment

Structural concrete shall be measured in cubic meters. In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

1719 Rate

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. Unless mentioned separately as an item in the contract, the contract unit rate

for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per section 1500 of these Specifications.

If the concrete is found to be acceptable by the Engineer as sub-standard work, the Contractor shall be subjected to reduction in his contact unit rate. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under:

$$\text{Percentage reduction in rate} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

Item No.: 26:

Providing Epoxy coated Treated bars FE - 500D for RCC work including cutting, bending, binding, hooking, tying and placing in position as per detailed drawings incl. cost of binding wire etc. complete at all levels.

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, the reinforcement/untensioned steel as the case may be, shall consist of the following grades of reinforcing bars.

Table 1000-3 : Grades of Reinforcing Bars

Grade Designation	Bar Type Conforming to Governing Specifications	IS Characteristic Strength f_y MPa	Elastic Modulus GP
Fe240	IS:432 Part I Mild Steel	240	200
Fe 415	IS:1786 High Strength Deformed Steel Bars (HSD)	415	200
Fe 500 or Fe 500D	IS:1786 High Strength Deformed Steel Bars (HSD)	500	200
Fe 550 or Fe 550D	IS:1786 High Strength Deformed Steel Bars (HSD)	550	200
Fe 600	IS:1786 High Strength Deformed Steel Bars (HSD)	600	200

Note: If any grade of steel given in the above table is not available steel of next higher grade may be used.

All steel shall be procured from 'Original producers' who manufacture billets directly from iron ores and roll the billets to produce steel conforming to IS:1786. No re-rolled steel shall be incorporated in the works. However, in case the original producers give certificate that they are unable to supply the steel within the required time period or that they are not producing bars of the required diameter, the Engineer may allow the procurement of steel

from other suppliers, provided that the reinforcement is manufactured from billets procured from the original producers. In such cases, the manufacturer's certificate alone shall not be considered as sufficient and the steel shall be got tested by the Engineer in the NABL accredited laboratories only, as a third party check. It shall be ensured that all the test results conform to IS:1786 requirements.

Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bars shall be discarded. Bars with cracked ends shall be discarded.

For the steel procured from original producers also, the Engineer / Employer may carry out occasional checks on materials through third party as mentioned above, for confirming the test results shown in the certificates, in case of any doubt regarding the quality of steel supplied.

1009.3.2 Coating of Reinforcing Bars

1009.3.2.1 Fusion Bonded Epoxy Coated Reinforcement

Fusion bonded epoxy coated reinforcement shall conform to IS:13620 or other international standards as approved by Engineer. The location of the source of supply of the coated bars shall be such as to ensure that the bars are not transported for a distance of more than 300 Km.

Additional requirements for the use of such reinforcement bars are given below:

- a) Patch up materials shall be procured in sealed containers with certificates from the agency who has supplied the fusion bonded epoxy bars.
- b) PVC coated G.I. binding wires of 18G shall only be used in conjunction with fusion bonded epoxy bars.
- c) Chairs for supporting the reinforcement shall also be of fusion bonded epoxy coated bars.
- d) The cut ends and damaged portions shall be touched up with repair patch up material.
- e) The bars shall be cut by saw-cutting and not by flame cutting.
- f) While bending the bars, the pins of work benches shall be provided with PVC or plastic sleeves.
- g) The coated steel shall not be directly exposed to sun rays or rains and shall be protected with opaque polyethylene sheets or such other approved materials.
- h) While concreting, the workmen or trolley shall not move directly on coated bars but shall move only on wooden planks placed on the bars.

Mode of measurement: This item shall be measured and paid in kg of steel use in different structure.

Item No.: 27:

Providing, supplyaing and spreading blindage of Hard murram for side including leveling to camber and gradient with rolling and consolidation of hard murram as per site condition as directed by the Engineer incl. leveling the ground to the required line, grade & profile by suitable means, watering and compacting with vibratory power roller to achieve the desired compaction etc. complete as directed.

Scope

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

Materials

Shoulder on either side of the road may be of selected earth/granular material/paved conforming to the requirements of Clause 305/401 and the median may be of selected earth conforming to the requirements of Clause 305.

Median/Traffic islands shall be raised and kerbed at the perimeter and the enclosed area filled with earth and suitably covered with grass turf/shrubs as per Clause 307 and/or paved as per Clauses 410.3.4 or 410.3.5.

Paved shoulders shall consist of sub-base, base and surfacing courses, as shown in the drawings and materials for the same shall conform to relevant Specifications of the corresponding items. Where paved or hard shoulders are not provided, the pavement shall be provided with brick/stone block edgings as shown in the drawings. The brick shall conform to Clause 1003 of these Specifications. Stone blocks shall conform to Clause 1004 of these Specifications and shall be of size 225 mm x 110 mm x 75 mm.

Size of Shoulders/Medians/Islands

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

Construction Operations**Shoulders**

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

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

shoulder layer. The adjacent layers having same material shall be laid and compacted together.

In all cases where paved shoulders have to be provided along side of existing carriageway, the existing shoulders shall be excavated in full width and to the required depth as per Clause 301.3.7. Under no circumstances, box cutting shall be done for construction of shoulders.

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

During all stages of shoulder construction, the required cross fall shall be maintained to drain off surface water.

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

Median and Islands

Median and islands shall be constructed in a manner similar to shoulder up to the road level. Thereafter, the median and islands, if raised, shall be raised at least 300 mm by using kerb stones of approved material and dimensions and suitably finished and painted as directed by the Engineer. If not raised, the median and islands shall be differentiated from the shoulder/ pavement as the case may be, as directed by the Engineer. The confined area of the median and islands shall be filled with local earth or granular material or any other approved material and compacted by plate compactor/power rammer. The confined area after filling with earth shall be turfed with grass or planted with shrubs, or finished with tiles/slabs as provided in the drawings.

Brick/Stone Block Edging

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

Surface Finish and Quality Control of Works

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.

Measurements for Payment

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

- i) For excavation in cu.m.
- ii) For earthwork/granular fill in cu.m.
- iii) For sub-base, base, surfacing courses in units as for respective items

iv) For kerb in running metre; length of kerb for median shall be measured for each side separately.

v) Forturfing, shrubs and tile/slab finish in sq.m.

vi) For brick/stone block edging in running metre, the length for brick/ stone block edging for median edging shall be measured for each side separately.

Rate

The Contract unit rate for shoulder (Hard murrum/paved/earthen with brick or stone block edging), island and median construction 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) as applicable. The rate for this item shall be in Cu.Mt. and include the cost of Hard Murrum, spreading, leveling, rolling & consolidation.