

**Volume-III A**  
**Employer's requirement and Technical Specifications**  
**For Road Works**



**DESIGN CRITERIA**

The methodology of investigation involved the evaluation of surface rebound, through Benkelman Beam Deflection and verification of layer thickness of overlay. It has been observed that certain requirements and limit values are set out in the specifications in regard to properties of materials and workmanship to be supplied. Tests shall be conducted and measurements will be taken. As per site conditions, investigations are identified and the following quantum of investigations are carried out at field as well as in laboratory. The existing road structure is evaluated through Benkelman Beam Deflection technique and the overlay for the existing road is proposed using BBD test as per IRC81:1997 Guidelines for Strengthening of flexible road pavements. In geotechnical engineering, soil compaction is an instantaneous process in which a stress applied to a soil causes densification as air is displaced from the pores between the soil grains and always takes place in partially saturated soil (three phase system). As per provision in IRC:SP:20-2002, for pavement design, the subgrade strength is determined in terms of CBR at the most critical moisture conditions likely to occur. The CBR test is conducted on remolded samples prepared at optimum moisture content & dry density corresponding to standard proctor. [(IS:2720 (Part 7) -1980] and soaked in water for four days prior to testing. In case of existing roads requiring strengthening, the soil should be moulded at the optimum moisture content & Field density. Test pits are dug manually on random basis as per the locations selected by visually seeing the site conditions. The test pits are aligned across wheel path from edge of pavement. IS 2720-8

Guidelines for strengthening of flexible road pavements means we are referring to flexible roads, flexible pavements and these guidelines are meant for Benkelman beam deflection technique. The first version was in 1981 and the first revision what we are discussing is the 1997 revision. These guidelines are based extensively on the basis of the findings of MORTH Ministry of Road Transport and Highways, Government of India, a sponsored research project which has got the code R6 which was entitled “Development of Methods such as Benkelman Beam Deflection method for Evaluation of Structural Capacity of Existing Pavements and also for Strengthening of any Weak Pavement” this was the main objective of the research scheme, it was to develop Benkelman beam and other similar methods for evaluation of structural capacity of existing pavements. So the methodology is for evaluation of structural capacity of in service pavements and also for finding out the strengthening requirements of any weak pavements

## Road FACILITIES

### 1. Road Facilities

The Contractor shall construct the Project Facilities in accordance with the provisions of this Agreement. Such Project Facilities shall include:

Fabricating, constructing, or procuring all relevant streetscape elements and furniture, including but not limited to:

- ❖ Kerbs
- ❖ Paving Materials
- ❖ Tree Plantation
- ❖ Trench, DWC HDPE Pipes and Cable Laying
- ❖ Benches
- ❖ Dustbins
- ❖ Bus Shelters
- ❖ Signage
- ❖ Bollards
- ❖ Cycle Track and Footpath
- ❖ Additional Elements, if any, as per instructions of approving authority, and based on technical specifications as listed under Schedule D of this tender document.

### 2. Description of Project Facilities

Each of the Project Facilities is described below:

Sr. No.	Project Facility	Design Requirements
1	Recommended practice for The design and layout of cycle tracks.	IRC : 11-2015
2	Guidelines for pedestrian facilities.	IRC- 103-2012
3	Cable Trench	As per IS 456
4	Guidelines on landscaping and tree plantation	IRC SP 21 – 2009
5	Code of practice for road signs.	IRC 67-2012
6	Code of practice for road marking	IRC 35-2015

**Note:** The above-mentioned details and designs are to be read in conjunction with each

other. The contractor is expected to match the finishes and/or improve the designs to create an urban facilities and furniture family for the project site in consultation and approval by the Authority Engineer. The location and distribution of street lights and pedestrian lights are to be verified and approved for the appropriate lux level of illumination on site with relevant photometric tests and lighting standards subject to approval of the Authority Engineer.

## TECHNICAL SPECIFICATIONS FOR ROAD WORKS

### CODES AND SPECIFICATIONS

The following IS (Indian Standard) Codes and IRC (Indian Road Congress) Codes, specifications etc. shall be applicable. In all cases the latest revision of the codes and specifications shall be referred to:

Sr. No.	IS / IRC Code Nos.	Description
1	MORT&H	Specifications for Road and Bridge works, Fifth Revision, Ministry of Road Transport and Highways, New Delhi 2013
2	IRC : 35	Code of Practice for Road Markings.
3	IRC : 36	Recommended Practice for Construction of Earth Embankments and Sub-grade for road works
4	IRC : 86	Geometric Design standards for Urban roads in plans
5	IRC : 37	Guidelines for the Design of Flexible Pavements
6	IRC : 67	Code of Practice for Road Signs
7	IRC:SP:63	Guidelines for the use of Interlocking Concrete Block Pavement
8	IRC:SP:41	Guidelines on Design of At-Grade Intersections in Rural & Urban Areas
9	IRC : 94	Specification for Dense Bituminous Macadam
10	IRC : 29	Specifications for Bituminous Concrete for Road Pavement
11	IS : 73	Specifications for Paving Bitumen
12	IS : 217	Specification for cut back Bitumen
13	IS : 400	Specification for Test Sieve
14	IS : 454	Specification for Digboi type cut back Bitumen
15	IS : 456	Specifications for plain and reinforced concrete.
16	IS : 2720 : (Part 5)	Method of Test for Soils: Determination of Liquid and Plastic Limit.
17	IS : 2720 : (Part 8)	Method of Test for Soils: Determination of water content – dry density relation using Light compaction
18	IS : 2720 : (Part 16)	Method of Test for Soils: Laboratory determination of CBR
19	IS : 1124	Method of Test for determination of water Absorption, apparent specific gravity & porosity of Building stone
20	IRC: 103	Guidelines for Pedestrian Facilities
21	IRC: SP: 55	Guidelines on Traffic Management in Work Zones

**TABLE OF CONTENTS**

<b>Sr. No.</b>	<b>MORT&amp;H No.</b>	<b>Description</b>
1	-	Note
2	112	Arrangement for traffic during construction
3	201	Clearing and Grubbing
4	301	Excavation for Roadway and Drains
5	304	Excavation for Structures
6	305	Embankment Construction
7	401	Granular Sub Base
8	402	Lime Treated Soil for Improved Sub-Grade
9	406	Wet Mix Macadam
10	409	Cement Concrete Kerb
11	502	Prime Coat Over Granular Base
12	503	Tack Coat
13	505	Dense Bituminous Macadam
14	507	Bituminous Concrete
15	903	Quality Control Tests During Construction
16	800	Traffic Signs
17	900	Quality Control
18	2600	Expansion Joints
19	2700	Wearing Course
20	2900	Pipe Culvert

### NOTE

1. Relevant clauses of Ministry of Road Transport & Highways (MORT&H) Specifications for Roads and Bridge works relevant to this tender only are reproduced.
2. In case of any variation between the reproduced specification and the original specification of MORT&H Publication, the reproduce publication shall prevail and shall be construed accordingly.
3. If MORT&H clauses referred to in the reproduced specifications herein are not included in the latter, the same shall be read from MORT&H specifications.

### Topographic Survey, & Geotechnical investigation

Contractor to conduct detail topographical site survey and Geotechnical investigation before execution of work and submit the same to the Engineer in charge for approval

## **TRAFFIC REGULATION**

### **Traffic regulation by the Contractor**

The Contractor shall take all the required measures and make arrangements for the safety of Users during the construction and maintenance of the Smart Road or a Section thereof in accordance with the provisions of MORTH Specifications. It shall provide, erect and maintain all such barricades, signs, markings, flags, and lights as may be required by Good Industry Practice for the safety of the traffic passing through the Section under construction or maintenance.

All works shall be carried out in a manner creating least interference to traffic passing through the Smart Road or a Section thereof. In stretches where construction or maintenance works on the carriageway are taken up, the Contractor shall ensure that proper passage is provided for the traffic. Where it is not possible or safe to allow traffic on part width of the carriageway, a temporary diversion of proper specifications shall be constructed by the Contractor at its own cost. The Contractor shall take prior approval of the Authority's Engineer for any proposed arrangement for traffic regulation during Construction and Maintenance, which approval shall not be unreasonably withheld.

## 112. ARRANGEMENT FOR TRAFFIC DURING CONSTRUCTION

### 112.1. General

The Contractor shall at all times carry out work on the highway in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing highway, the Contractor shall, in accordance with the directives of the Engineer, provide and maintain, during execution of the



work, a passage for traffic either along a part of the existing carriageway under improvement, or along a temporary diversion constructed close to the highway. The Contractor shall take prior approval of the Engineer regarding traffic arrangements during construction.

#### 112.2. Passage of Traffic along a part of the Existing Carriageway under Improvement

For widening/strengthening existing carriageway where part width of the existing carriageway is proposed to be used for passage of traffic, treated shoulders shall be provided on the side on which work is not in progress. The treatment to the shoulder shall consist of providing atleast 150 mm thick granular base course covered with bituminous surface dressing in a width of atleast 1.5 m and the surface shall be maintained throughout the period during which traffic uses the same to the satisfaction of the Engineer. The continuous length in which such work shall be carried out, would be limited normally to 500 m at a place. However, where work is allowed by the Engineer in longer stretches passing places atleast 20 m long with additional paved width of 2.5 m shall be provided at every 0.5 km interval.

In case of widening existing two-lane to four-lane, the additional two lanes would be constructed first and the traffic diverted to it and only thereafter the required treatment to the existing carriageway would be carried out. However, in case where on the request of the Contractor, work on existing two-lane carriageway is allowed by the Engineer with traffic using part of the existing carriageway, stipulations as in para above shall apply.

After obtaining permission of the Engineer, the treated shoulder shall be dismantled, the debris disposed of and the area cleared as per the direction of the Engineer.

#### 112.3. Passage of Traffic along a Temporary Diversion

In stretches where it is not possible to pass the traffic on part width of the carriageway, a temporary diversion shall be constructed with 7 m carriageway and 2.5 m earthen shoulders on each side (total width of roadway 12 m) with the following provision for road crust in the 7 m width:

- i) 200 mm (compacted) granular sub base;
- ii) 225 mm (compacted) granular base course; and
- iii) Premix carpet with Seal Coat/Mix Seal Surfacing.

The alignment and longitudinal section of diversion including junctions and temporary cross drainage provision shall be as approved by the Engineer.

#### 112.4. Traffic Safety and Control

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 programme 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 120 m away. The signs shall be of approved design and of reflectory type, if so directed by the Engineer.

#### 112.5. Maintenance of Diversions and Traffic Control Devices

Signs, lights, barriers and other traffic control devices, as well as the riding surface of diversions shall be maintained in a satisfactory condition till such time they are required as directed by the Engineer. The temporary traveled way shall be kept free of dust by frequent applications of water, if necessary.

#### 112.6. Measurements for Payment and Rate

All arrangements for traffic during construction including provision of temporary cross drainage structures, if required, and treated shoulder as described in Clause 112.2 including their maintenance, dismantling and clearing debris, where necessary, shall be considered as incidental to the works and shall be the Contractor's responsibility.

The construction of temporary diversion including temporary cross drainage structures as described in Clause 112.3, shall be measured in linear metre and the unit contract rate shall be inclusive of full compensation for construction (including supply of material, labour, tools etc.), maintenance, final dismantling, and disposal.

#### Earthworks:

Earthworks shall involve of Clearing and Grubbing and excavation for roadway and drains, excavation for structures and embankment Construction for Road.

#### 201.0 CLEARING AND GRUBBING

#### 201.1 SCOPE

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 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 in advance of earthwork operations and in accordance with the requirements of these Specifications.

#### 201.2 PRESERVATION OF PROPERTY/AMENITIES

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

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc. and where required undertake additional works to that effect vide As per MoRT&H 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 As per MoRT&H clause 306.3.

#### 201.3 METHODS, TOOLS AND EQUIPMENT

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 tyre 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 500mm of the sub-grade bottom. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/sub-grade 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 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 areas.

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

#### 201.4 DISPOSAL OF MATERIALS

All materials arising from clearing and grubbing operations shall be taken over and shall be disposed of by the Contractor at suitable disposal sites with all leads and lifts. The disposal shall be in accordance with local, State and Central regulations.

#### 301. EXCAVATION FOR ROADWAY AND DRAINS

##### 301.1 SCOPE

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and waterways, in accordance with requirements of these specifications and the lines, grades and cross-section shown in the

drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and sub-grade construction, suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner, with all leads and lifts, reuse of cut materials as may be deemed fit, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

Excavated material shall be stacked off in the manner indicated at the site including stacking of excavated material up to any lead and lift. The rate shall only cover the cost of excavation, stacking and/or spreading of the material, if required at the site.

### 301.2 CLASSIFICATION OF EXCAVATED MATERIAL

#### 301.2.1 Classification.

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

a) Soil:

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

b) Ordinary Rock (not requiring blasting) :

This shall include:

- i) rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone etc., which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting.
- ii) macadam surfaces such as water bound and bitumen/tar bound; soling of roads, cement concrete pavement, cobble stone, etc, compacted moorum or stabilized soilpaths, etc. and hard core; compact moorum or stabilised soil requiring use of pick axe or shovel or both.
- iii) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and
- iv) boulders which do not require blasting found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

c) Hard Rock (requiring blasting) :

This shall comprise:

- i) Any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required.
- ii) Reinforced cement concrete below ground level and in bridge/ROB/RUB/flyover piers and abutments.

iii) boulders requiring blasting

d) Hard Rock (using controlled blasting)

Hard rock requiring blasting as described under (c) but where controlled blasting is to be carried out in locations where built-up area, huts, and are situated at within 200m of the blast site.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason like people living within 20 m of blast sites etc, and excavation has to be carried out by chiselling, wedging of any other agreed method.

f) Marshy Soil

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

### 301.2.2 Authority for Classification

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

## 301.3 CONSTRUCTION OPERATIONS

### 301.3.1 Setting Out:

After the site has been cleared as per As per MoRT&H clause 201, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. As per MoRT&H clause 109 shall be applicable for setting out operations.

### 301.3.2 Stripping and Storing Top Soil

When so directed by the Engineer, the top soil existing over the sites of excavation shall be stripped to specified depths and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired in accordance with As per MoRT&H clause 305.3.3. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots with approval of the Engineer.

### 301.3.3 Excavation - General

All excavations shall be carried out in conformity with the directions laid herein under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as deemed fit or as approved by the Engineer.

While planning or executing excavations, the Contractor shall take all-adequate precautions against soil erosion, water pollution etc. as per As per MoRT&H clause 306, and take appropriate drainage measures to keep the site free of water in accordance with As per MoRT&H clause 311.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed by the Engineer. The Contractor shall not excavate outside the slopes or below the established grades or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels on the road shall be made good at the cost of the Contractor with suitable material of similar characteristics to that removed and compacted to the requirements of As per

MoRT&H clause 305.

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

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place.

#### 301.3.4 Methods, Tools and Equipment:

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

#### 301.3.5 Rock Excavation:

Rock, when encountered in road excavation, shall be removed up to the sub-grade top level or as otherwise indicated on the drawings. Where, however, unstable shales or other similar materials are intersected at the sub-grade top level, these shall be excavated to the extent of 500 mm below the formation level or as otherwise specified. In all cases, the excavation operations shall be so carried out that at no point on cut formations the rock protrudes above the specified levels. Rocks and boulders which are likely to cause differential settlement and also local drainage problems should be removed to the extent of 500 mm below the formation level in the formation width including side drains.

Where excavation is done to levels lower than those specified, the excess excavation shall be made good as per As per MoRT&H clauses 301.3.3 and 301.6 to the satisfaction of the Engineer.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when pierced by a crowbar shall be removed.

Where blasting is to be resorted to, the same shall be carried out to As per MoRT&H clause 302 and all precautions indicated therein observed.

Where pre-splitting is prescribed to be done for the establishment of a specified slope in rock excavation, the same shall be carried out as per As per MoRT&H clause 303.

#### 301.3.6 Marsh Excavation

The excavation of marshes/swamps shall be carried out as per the programme approved by the Engineer.

Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of back filling. The method and sequence of excavating and back-filling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits indicated on the drawings or as staked by the Engineer.

#### 301.3.7 Excavation of Road Shoulders/Verge/Median for Widening of Pavement or providing treated shoulders:

In the works involving widening of existing pavements or providing paved shoulders, the existing shoulder/verge/median shall be removed to its full width and upto top of the subgrade. The subgrade material within 500 mm from the bottom of the pavement for the widened portion or paved shoulders shall be loosened and recompacted as per As per

MoRT&H clause 305. Any unsuitable material found in this portion shall be removed and replaced with the suitable material. While doing so, care shall be taken to see that no portion of the existing pavement designated for retention is loosened or disturbed. If the existing pavement gets disturbed or loosened, it shall be dismantled and cut to a regular shape with sides vertical and the disturbed/loosed portion removed completely and re-laid as directed by the Engineer, at the cost of the Contractor.

#### 301.3.8 Excavation for Surface/Sub-surface Drains

Where the Contract provides for construction of surface/sub-surface drains to As per MoRT&H clause 309, excavation for these shall be carried out in proper sequence with other works as approved by the Engineer.

#### 301.3.9 Slides:

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

#### 301.3.10 De-watering:

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

#### 301.3.11 Use and Disposal of Excavated Materials:

All the excavated materials shall either be reused with the approval of the Engineer or disposed off with all leads and lifts as directed by the Engineer.

#### 301.3.12 Back-filling :

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

#### 301.4 PLYING OF CONSTRUCTION TRAFFIC

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

#### 301.5 PRESERVATION OF PROPERTY

The Contractor shall undertake all reasonable precautions for the protection and

preservation of any or all existing roadside trees, drains, sewers or other sub-surface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which in the opinion of the Engineer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect, shall be got approved by him from the Engineer. 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 cost. If the Contractor fails to do so, within the required time as directed by the Engineer or if, in the opinion of Engineer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Engineer shall arrange the replacement/restoration directly through any other agency at the risk and cost of the Contractor after issuing a prior notice to the effect.

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

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

Where the material, in the sub-grade has a density less than specified in Table 300-1, the same shall be loosened to a depth of 500 mm. and compacted in layers in accordance with the requirements of As per MoRT&H clause 305 adding fresh material, if any required, to maintain the formation level as shown in the drawings. Any unsuitable material encountered in the sub-grade shall be removed as directed by the Engineer, replaced with suitable material compacted in accordance with As per MoRT&H clause 305.

In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular base material as directed by the Engineer, laid and compacted in accordance with the respective specifications for these materials. The unsuitable material shall be disposed of in accordance with As per MoRT&H clause 301.3.11. After satisfying the density requirements, the cut formation shall be prepared to receive the sub-base/base-course in accordance with As per MoRT&H clause 310 and 311.

#### **301.7    FINISHING OPERATIONS**

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces.

When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm. measured at right angles to the slope, except where excavation is in rock (hard or soft) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in As per MoRT&H clause 902.

Where directed, the topsoil removed earlier and conserved (As per MoRT&H clauses 301.3.1 and 305.3.3) shall be spread over cut slopes, shoulders and other disturbed areas. Slopes may be roughened and moistened slightly, prior to the application of topsoil, in order to provide satisfactory bond. The depth of topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 to 100 mm.

#### **304       EXCAVATION FOR STRUCTURES**

##### **304.1    SCOPE**

Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, head-walls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements of these Specifications and the lines and dimensions shown on the



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

#### 304.2 CLASSIFICATION OF EXCAVATION

All materials involved in excavation shall be classified in accordance with As per MoRT&H clause 301.2.

#### 304.3 CONSTRUCTION OPERATIONS

##### 304.3.1 Setting out:

After the site has been cleared to As per MoRT&H clause 201, the limits of excavation shall be set out true to lines curves and slopes to As per MoRT&H clause 301.3.1.

##### 304.3.2 Excavation:

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

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

Where blasting is to be resorted to, the same shall be carried out to As per MoRT&H clause 302 and all pre -cautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

##### 304.3.3 Dewatering and Protection:

Normally, open foundation shall be laid dry. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, cofferdams and other necessary works to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the

adequacy of dewatering and protection arrangements and for the quality and safety of the Works.

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

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

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

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

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

#### 304.3.4 Preparation of Foundation:

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation at the cost of the Contractor as per As per MoRT&H clause 2104.1 Ordinary filling shall not be used for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed or all soft and loose material, cleaned and cut to a firm surface either level, stepped or serrated as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 up to the top level of rock.

If the depth of fill required is more than 1.5 m in soft rock or 0.6 m in hard rock above the foundation level, the filling up to this level shall be done with M-15 concrete and portion above shall be filled by concrete or by boulders grouted with cement.

When foundation piles are used, the excavation for pile cap shall be done after driving/casting of all piles forming the group. After pile driving operations in a given

pit are completed, all loose and displaced materials therein shall be removed to the level of the bottom of the pile cap.

**304.3.5 Slips and Blows:**

If there are any slips or blows in the excavation, these shall be removed by the Contractor at his own cost.

**304.3.6 Public Safety:**

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

**304.3.7 Back Filling:**

Back filling shall be done with approved material after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface in layers not exceeding 150 mm compacted thicknesses. The compaction shall be done with the help of suitable equipment such as mechanical tamper, rammer, plate vibrator etc. after necessary watering, so as to achieve the maximum dry density.

**304.3.8 Disposal of Surplus Excavated Materials:**

As per MoRT&H clause 301.3.11 shall apply.

**305 EMBANKMENT CONSTRUCTION**

**305.1 GENERAL**

**305.1.1 Description:**

These specifications shall apply to the construction of embankments, sub-grades, earthen shoulders and miscellaneous back fills with approved material obtained either from excavation for road construction, borrow pits or other sources. All embankments and sub-grades shall be constructed to 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.

**305.2 MATERIALS AND GENERAL REQUIREMENTS**

**305.2.1 Physical Requirements:**

**305.2.1.1** The materials used in embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, reclaimed material from pavement, fly ash, pond ash, a mixture of these or any other material as approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment.

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

- a) Material from swamps, marshes or bogs
- b) Peat, log, stump or perishable material; any soil classifies as OL, OI, OLL or Pt in accordance with IS: 1498.
- c) Material susceptible to spontaneous combustions
- d) Material in a frozen condition
- e) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and
- f) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 per cent when tested as per IS: 2720 – Part 40) shall not be used as a fill material. Where an expansive clay having "free swelling index" value less than 50 percent is used as a fill material, sub-grade and top 500mm portion of the embankment just below sub-grade shall be non-expansive in nature.

305.2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO<sub>3</sub>) per litre when tested in accordance with BS: 1377, Part 3, but using a 2:1 water-soil ratio shall not be deposited within 500mm distance (or any other distance described in the Contract), of permanent works constructed out of concrete, cement bound materials or other cementitious material.

Material with a total sulphate content (expressed as SO<sub>3</sub>) exceeding 0.5 percent by mass, when tested in accordance with BS:1377, Part 3 shall not be deposited within 500 mm, or other distances described in the Contract, or metallic items forming part of the Permanent Works.

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

305.2.1.5 Ordinarily, only the materials satisfying the density requirements given in Table 300.1 shall be employed for the construction of the embankment and the sub-grade.

TABLE 300.1 DENSITY REQUIREMENTS OF EMBANKMENT AND SUB-GRADE MATERIALS

Sl. No	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part 8)
1.	Embankments up to 3 m height, not subjected to extensive flooding.	Not less than 15.2 KN/cu.m

Sl. No	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part 8)
2.	Embankments exceeding 3 metre height or embankments of any height subject to long periods of inundation.	Not less than 16 KN/cu.m
3.	Sub-grade and earthen shoulders /verge/backfill	Not less than 17.5 KN/cu.m

Note:

- 1) This table is not applicable for lightweight fill material e.g. cinder, fly ash etc.
- 2) The material to be used in subgrade shall be non-expansive and shall satisfy design CBR at the specified dry density and moisture content. In case the available materials fail to meet the requirement of CBR, use of stabilization methods in accordance with As per MoRT&H clauses 403 and 404 or by any stabilization method approved by the Engineer shall be followed.

305.2.1.6 The material to be used in subgrade shall confirm to the design CBR value at the specified dry density and moisture content of the test specimen. In case the available materials fails to meet the requirement of CBR, use of stabilization methods in accordance with As per MoRT&H clauses 403 and 404 or by any stabilization method approved by the Engineer or by the IRC Accreditation Committee shall be followed.

305.2.1.7 The material to be used in high embankment construction shall satisfy the specified requirements of strength parameters.

305.2.2 General Requirements:

305.2.2.1 The materials for embankment shall be obtained from approved sources with preference given to acceptable materials becoming available from nearby roadway excavation under the same contract.

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

305.2.2.2 Borrow Materials:

The arrangement for the source of supply of the material for embankment and sub-grade and compliance with the guidelines, and environment requirements, in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from

the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

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

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

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

### 305.2.2.3 Fly Ash

Use of fly ash shall conform to the Ministry of Environment and Forest guidelines. Where fly-ash is used the embankment construction shall conform to the physical and chemical properties and requirements of IRC: SP: 38-2001, "Guidelines for Use of Fly ash in Road Construction". The term fly ash shall cover all types of coal ash such as pond ash, bottom ash or mound ash.

Embankment constructed out of fly ash shall be properly designed to ensure stability and protection against erosion in accordance with IRC guidelines. A suitable thick cover may preferably be provided at intervening layers of pond ash for this purpose. A thick soil cover shall bind the edge of the embankment to protect it against erosion. Minimum thickness of such soil cover shall be 500 mm.

### 305.2.2.4 Compaction Requirements

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub-grade material when compacted to the density requirements as in Table 300.2 shall yield the specified design CBR value of the sub-grade.

TABLE: 300.2 COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE

Sl. No	Type of Work/ Material	Relative compaction as percentage of max. laboratory dry density as per IS : 2720 (Part 8)
1.	Sub-grade and earthen shoulders	Not less than 97%
2.	Embankment	Not less than 95%
3.	Expansive clays	

Sl. No	Type of Work/ Material	Relative compaction as percentage of max. laboratory dry density as per IS : 2720 (Part 8)
	a) Sub-grade and 500mm. portion just below	Not allowed
	b) Remaining portion of embankment	90 -95%

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

- a) The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 8), appropriate for each of the fill materials he intends to use.
- b) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

The maximum dry density and optimum moisture content approved by the Engineer shall form the basis for compaction.

### 305.3 CONSTRUCTION OPERATIONS

#### 305.3.1 Setting Out:

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

#### 305.3.2 Dewatering:

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water, As per MoRT&H clause 305.4.6 shall apply.

#### 305.3.3 Stripping and Storing Top Soil:

When so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to

specified depths not less than 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily subjected to traffic either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

#### 305.3.4 Compacting Ground Supporting Embankment/Sub-grade

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

In a case where the difference between the sub grade level (top of the sub-grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 percent relative compaction with respect to the dry density (as given in Table 300-2), the ground shall be loosened up to a level 0.5 m below the sub-grade level, watered and compacted in layers in accordance with As per MoRT&H clauses 305.3.5 and 305.3.6 to achieve dry density not less than 97 percent relative compaction as given in Table 300-2.

Where so directed by the Engineer any unsuitable material occurring in the embankment foundation (500 mm portion just below the sub-grade) shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

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

#### 305.3.5 Spreading material in layers and bringing to appropriate moisture content.

305.3.5.1 The embankment and sub-grade material shall be spread in layers of uniform thickness in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250 mm when vibratory roller/vibratory soil compactor is used and not more than 200 mm when 80-100 KN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300.2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in



soil by blading, using disc harrow until a uniform moisture content is obtained throughout the depth of the layer.

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

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

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

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

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

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

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

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

305.3.6 Compaction:

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Static three wheeled roller, self propelled single drum vibratory roller, tandem vibratory roller, pneumatic tyre roller, pad foot roller etc, of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of self-propelled single drum vibratory roller or pad foot vibratory roller of 80 to 100 KN static weight or heavy pneumatic tyre roller of adequate capacity capable of achieving the required compaction. The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

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

Each layer of the material shall be thoroughly compacted to the densities specified in Table 302-2. Subsequent layers shall be placed only after the finalised layer has been tested according to As per MoRT&H clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS:2720 (Part 28). A record of the same shall be maintained by the Contractor.

Where density measurements reveal any soft areas in the embankment/sub-grade/earthen shoulder, further compaction shall be carried out as directed by the Engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

#### 305.3.7 Drainage:

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

#### 305.3.8 Repairing of damages caused by rain/spillage of water

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with As per MoRT&H clause 305.3.6. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor

at his own cost, including the arranging of machinery/equipment for the purpose.

#### 305.3.9 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders/verge road bed and side slopes to conform to the alignment, levels, cross -sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerances described in As per MoRT&H clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The top soil, removed and conserved earlier (As per MoRT&H clauses 301.3.2 and 305.3.2) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75mm to 150mm.

Where directed, the slopes shall be turfed with sods in accordance with As per MoRT&H clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of As per MoRT&H clause 308.

When earthwork operations have been substantially completed the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

#### 305.4 CONSTRUCTION OF EMBANKMENT AND SUB-GRADE UNDER SPECIAL CONDITIONS

##### 305.4.1 Earthwork for Widening Existing Road Embankment:

When an existing embankment and/or sub-grade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300mm. wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment /sub-grade material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment/sub-grade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of usual wider rollers, compaction shall be carried out with the help of tandem sheep's foot rollers, mechanical tampers or other approved equipment. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances, when the extra width is too narrow to permit the movement of any other types of hauling equipment.

##### 305.4.2 Earthwork for Embankment and Sub-grade to be Placed against Sloping Ground:

Where an embankment/sub-grade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in As per MoRT&H clause 305.4.1, before placing the embankment/sub-grade material.

Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings before the fill is placed against sloping ground.

Where the contract requires construction of transverse sub-surface drain at the cut-fill interface, work on the same shall be carried out to As per MoRT&H clause-309 in proper sequence with the embankment and sub-grade work as approved by the Engineer.

#### 305.4.3 Earthwork over Existing Road Surface:

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

- i) If the existing road surface is of granular or bituminous type and lies within 1m of the new formation levels, it shall be scarified to a depth of 50mm. or as directed so as to provide ample bond between the old and new material ensuring that at least 500mm. portion below the top of new sub-grade level is compacted to the desired density.
- ii) If the existing road surface is of bituminous type or cement concrete and lies within 1m of the new formation level, the bituminous or cement concrete layer shall be removed completely.
- iii) If the level difference between the existing road surface and the new sub-grade level is more than 1m the existing surface shall be roughened after ensuring that the maximum thickness of 500 mm of sub grade is available.

#### 305.4.4 Embankment and Sub-grade around Structures:

To avoid interference with the construction abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankments forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and sub-grade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS : 2720 (Part-5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in IRC: 78-1983 The fill

material shall be deposited in horizontal layers not exceeding 150mm in loose thickness and compacted thoroughly to the requirements of Table 300-2.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in As per MoRT&H clause 2504 unless otherwise specified in the contract.

Where it may be impracticable to use power rollers or other heavy equipment, mechanical tampers shall carry out the compaction or other methods approved by the Engineer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

#### 305.4.5 Construction of embankment over ground incapable of supporting construction equipment.

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geo-synthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contractor will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in As per MoRT&H clause 305.3.

#### 305.4.6 Embankment Construction under Water and Waterlogged Areas

##### 305.4.6.1 Embankment construction under Water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall be of GW, SW, GP, SP as per IS: 1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75mm. The material should be non-plastic having uniformity coefficient of not less than 10. The placed in open water shall be deposited by end tipping without compaction.

##### 305.4.6.2 Embankment construction in Waterlogged and Marshy Areas

The work shall be done as per IRC:34

#### 305.4.7 Earthwork for high embankment

The material for high embankment construction shall conform to As per MoRT&H clause 305.2.1.7. In the case of high embankments (more than 6 m), the

Contractor shall normally use fly ash in conformity with As per MoRT&H clause 305.2.1.1 or the material from the approved borrow area.

Where provided, stage construction of embankment and controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the contract. If settlement of surcharged fill results the Contractor shall bring the resultant level up to formation level with acceptable material for use in fill.

#### 305.4.8 Settlement Period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wing wall, retaining wall, footings, etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the contract or as directed by the Engineer.

#### 305.5 PLYING OF TRAFFIC

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

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

The surface finish of construction of sub-grade shall conform to the requirements of As per MoRT&H clause 902. Control on the quality of materials and works shall be exercised in accordance with As per MoRT&H clause 903.

#### 305.7 SUB-GRADE STRENGTH

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

305.7.2 Sub-grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed sub-grade shall be determined on remoulded samples, compacted to the field density at the field moisture content and tested for soaked/unsoaked condition as specified in the Contract.

**401 GRANULAR SUB-BASE****401.1 SCOPE**

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

**401.2 MATERIALS**

- 401.2.1 The material to be used for the work shall be natural sand, murum, gravel, crushed stone, crushed slag, or combinations thereof depending upon the grading required. Use of materials like brick metal, kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table 400-1 and physical requirements given in Table 400-2. Gradings III and IV shall preferably be used in lower sub-base. Gradings V and VI shall be used as a sub-base cum drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.
- 401.2.2 If the water absorption of the aggregates determined as per IS:2386 (Part 3) is greater than 2 percent, the aggregates shall be tested for Wet Aggregate Impact Value (AIV) (IS:5640). Soft aggregates like kankar, brick ballast and laterite shall also be tested for Wet AIV (IS:5640).

TABLE 400-1

GRADING FOR GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0mm.	100	--	--		100	
53.0 mm.	80-100	100	100	100	80-100	100
26.5.5mm	55-90	70-100	55-75	55-80	55-90	75-100
9.50mm.	35-65	50-80	--	--	35-65	55-75
4.75mm.	25-55	40-65	10-30	15-35	25-50	30-55
2.36mm.	20-40	30-50	--	--	10-20	10-25
0.85mm.	--	--	--	--	2-10	--
0.425mm.	10-15	10-15	--	--	0-5	0-8
0.075mm.	<5	<5	<5	<5	--	0-3

TABLE 400-2

PHYSICAL REQUIREMENTS FOR MATERIALS FOR GRANULAR SUB-BASE

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

#### 401.3 CONSTRUCTION OPERATIONS

##### 401.3.1 Preparation of Sub-grade:

Immediately prior to the laying of sub-base, the sub-grade already finished to Section 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 80-100 kN smooth wheeled roller.

##### 401.3.2 Spread and Compacting:

The sub-base material of grading specified in the Contract shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and maintain 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 As per MoRT&H clause 401.2.1, mixing shall be done mechanically by the mix-in-place method.

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 percent above to 2 percent 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 if so directed by the Engineer until the layer is uniformly wet.

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



carriageway having crossfall on both sides, rolling shall commence at the edges and progress towards the crown.

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

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

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

The surface finish of construction shall conform to the requirements of As per MoRT&H clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance With Section 900.

#### 401.5 ARRANGEMENT FOR TRAFFIC

During the period of construction arrangement of traffic shall be maintained in accordance with As per MoRT&H clause 112.

### 402 LIME TREATED SOIL FOR IMPROVED SUBGRADE

#### 402.1 SCOPE

This work shall consist of laying and compacting an improved sub-grade/lower sub-base of soil treated with lime on prepared sub-grade 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. Lime treatment is generally effective for soils, which contain a relatively high percentage of clay and silty clay.

#### 402.2 Materials

##### 402.2.1 Soil:

Except when otherwise specified, the soil used for stabilisation shall be the local clayey soil having a plasticity index greater than 8.

##### 402.2.2 Lime:

Lime for lime-soil stabilisation work shall be commercial dry lime slaked at site or pre-slaked lime delivered to the site in suitable packing. Unless otherwise permitted by the Engineer, the lime shall have purity of not less than 70 per cent by weight of Quicklime (CaO) when tested in accordance with IS: 1514. Lime shall be properly stored to avoid prolonged exposure to the atmosphere and consequent carbonation, which would reduce its binding properties.

##### 402.2.3 Quantity of Lime in stabilised mix:

Quality of lime to be added as percentage by weight of the dry soil shall be as specified in the Contract. The quantity of lime used shall be related to its calcium oxide content, which shall be specified. Where the lime of different calcium oxide content is to be used, its quantity shall be suitably adjusted to the approval of the Engineer so that equivalent calcium oxide is incorporated in the work. The mix design shall be done to arrive at the appropriate quantity of lime to be added, having due regard to the purity of lime, the type of soil, the moisture-density relationship, and the design CBR/Unconfined Compressive Strength (UCS) value specified in the Contract. The laboratory CBR/UCS value shall be at least 1.5 times the minimum field value of CBR/UCS stipulated in the Contract.

#### 402.2.4 Water:

The water to be used for lime stabilisation shall be clean and free from injurious substances. Potable water shall be preferred.

### 402.3 Construction Operations

#### 402.3.1 Weather limitations:

Lime-soil stabilisation shall not be done when the air temperature in the shade is less than 10 C.

#### 402.3.2 Degree of pulverisation:

For lime-soil stabilisation, the soil before addition of stabiliser, shall be pulverised using agricultural implements like disc harrows (only for low volume roads) and rotavators to the extent that it passes the requirements set out in Table 400-3 when tested in accordance with the method described in Appendix -3, "Method of Sieving for wet soils to determine the degree of pulverisation".

TABLE 400-3.

SOIL PULVERISATION REQUIREMENTS FOR LIME STABILISATION

IS Sieve Designation	Minimum Percent by weight passing the IS Sieve
26.5mm	100
5.6mm	80

#### 402.3.3 Equipment for Construction:

Stabilised soil sub-bases shall be constructed by mix-in-place method of construction or as otherwise approved by the Engineer. 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 mix-in-place construction shall be rotavator or similar approved equipment capable of pulverising and mixing the soil with additive and water to specified degree to the full thickness of the layer being processed, and of achieving the desired degree of mixing and uniformity of the stabilised material. If

so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for work.

The thickness of any layer to be stabilised shall be not less than 100 mm when compacted. The maximum thickness shall be 200 mm, provided the plant used is accepted by the Engineer.

#### 402.3.4 Mix-in-place method of construction:

Before deploying the equipment, the soil after it is made free of undesirable vegetation or other deleterious matters shall be spread uniformly on the prepared sub-grade in a quantity sufficient to achieve the desired compacted thickness of the stabilised layer. Where single-pass equipment is to be employed, the soil shall be lightly rolled at the discretion of the Engineer.

The Equipment used shall either be of single-pass or multiple pass type. The mixers shall be equipped with an appropriate device for controlling the depth of processing and the mixing blades shall be maintained or reset periodically so that the correct depth of mixing is obtained at all times.

With single-pass equipment the forward speed of the machine shall be so selected in relation to the rotor speed that the required degree of mixing, pulverisation and depth of processing is obtained. In multiple-pass processing, the prepared sub-grade shall be pulverised to the required depth with successive passes of the equipment and the moisture content adjusted to be within prescribed limits mentioned hereinafter. The blending or stabilising material shall then be spread uniformly and mixing continued with successive passes until the required depth and uniformity of processing have been obtained.

The mixing equipment shall be so set that it cuts slightly into the edge of the adjoining lane processed previously so as to ensure that all the material forming a layer has been properly processed for the full width.

#### 402.3.5 Construction with manual means:

Where manual mixing is permitted, the soil from borrow areas shall first be freed of all vegetation and other deleterious matter and placed on the prepared sub-grade. The soil shall then be pulverised by means of crow-bars, pick axes or other means approved by the Engineer.

Water in requisite quantities may be sprinkled on the soil for aiding pulverisation. On the pulverised soil, the blending materials(s) in requisite quantities shall be spread uniformly and mixed thoroughly by working with spades or other similar implement till the whole mass is uniform. After adjusting the moisture content to be within the limits mentioned later, the mixed material shall be levelled up to the required thickness so that it is ready to be rolled.

#### 402.3.6 Addition of Lime :

Lime may be mixed with the prepared material either in slurry form or dry state at the option of the Contractor with the approval of the Engineer.

Dry lime shall be prevented from blowing by adding water to the lime or other suitable means selected by the Contractor, with the approval of the Engineer.

The tops of windrowed material may be flattened or slightly trenched to receive the lime. The distance to which lime may spread upon the prepared material ahead of the mixing operation shall be determined by the Engineer.

No traffic other than the mixing equipment shall be allowed to pass over the spread lime until after completion of mixing.

Mixing or re-mixing operations, regardless of equipment used, shall continue until the material is free of any white streaks or pockets of lime and the mixture is uniform.

Non-uniformity of colour reaction, when the treated material is tested with the standard phenolphthalein alcohol indicator, will be considered evidence of inadequate mixing.

#### 402.3.7 Moisture content for compaction:

The moisture content at compaction checked vide IS: 2720 (Part 2) shall neither be less than the optimum moisture content corresponding to IS: 2720 (Part 8) nor more than 2 per cent above it.

#### 402.3.8 Rolling:

Immediately after spreading, grading and levelling of the mixed material, compaction shall be carried out with approved equipment preceded by a few passes of lighter rollers if necessary. Rolling shall commence at edges and progress towards centre, except at super elevated portions where it shall commence at the inner edge and progress towards outer edge. During rolling the surface shall be frequently checked for grade and cross-fall (camber) and any irregularities corrected by loosing the material and removing/adding fresh material. Compaction shall continue until the density achieved is at least 98 per cent of the maximum dry density for the material determined in accordance with IS: 2720 (Part 8).

Care shall be taken to see that the compaction of lime stabilised material is completed within three hours of its mixing or such shorter period as may be found necessary in dry weather.

During rolling it shall be ensured that roller does not bear directly on hardened or partially hardened treated material previously laid other than what may be necessary for achieving the specified compaction at the joint. The final surface shall be well closed, free from movement under compaction planes, ridges, cracks or loose material. All loose or segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

#### 402.3.9 Curing:

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

#### 402.4 Surface Finish and Quality Control of Work

The surface finish of construction shall confirm to the requirements of As per MoRT&H clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

#### 402.5 Strength

When lime is used for improving the sub-grade, the soil-lime mix shall be tested for its CBR value. When lime stabilised soil is used in a sub-base, it shall be tested for unconfined compressive strength (UCS) at 7 days. In case of variation from the design CBR/UCS, in situ value being lower, the pavement design shall be reviewed based on the actual CBR/UCS value shall be constructed by the Contractor at his own cost.

#### 402.6 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be provided and maintained in accordance with As per MoRT&H clause 112.

### 406. WET MIX MACADAM SUB-BASE / BASE

#### 406.1. SCOPE

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

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 upto 200 mm with the approval of the Engineer.

#### 406.2. MATERIALS

##### 406.2.1. Aggregates

##### 406.2.1.1. Physical requirements:

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

TABLE 400-12 PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB-BASE/BASE COURSES

Test		Test Method	Requirements
1.	• Los Angeles Abrasion Value*	IS : 2386 (Part – 4)	40 per cent (Max)
	Or • Aggregate Impact Value*	IS : 2386 (Part – 4) or IS:5640 **	30 per cent (Max)

Test		Test Method	Requirements
2.	Combined Flakiness and Elongation Indices (Total)	IS : 2386 (Part – 1)	30 per cent (Max)**

\* Aggregate may satisfy requirements of either of the two tests.

\*\* To determine this combined proportion, the flaky stone from a Representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The 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 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part- 5).

#### 406.2.1.2. Grading Requirements

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

TABLE 400-13. GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per Cent by Weight Passing IS Sieve
53 mm	100
45 mm	95-100
26.50 mm	-
22.4 mm	60-80
11.2 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600 micron	8-22
75 micron	0-5

Materials 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 sieve or vice versa.

### 406.3. CONSTRUCTION OPERATIONS

#### 406.3.1. Preparation of base:

As per MoRT&H clause 404.3.1 shall apply.

#### 406.3.2. Provision of lateral confinement of aggregates:

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

operations described in As per MoRT&H clause 404.3.3.

#### 406.3.3. Preparation of mix:

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

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

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

#### 406.3.4. Spreading of mix:

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

The mix may be spread either by a paver finisher or motor grader. The paver finisher shall be self-propelled, having the following features:

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

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

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

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

#### 406.3.5. Compaction:

After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, 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 centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

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

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

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching 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 subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 meter 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 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges,



cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompact.

#### 406.3.6. Setting and drying

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

#### 406.4. OPENING TO TRAFFIC

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

#### 406.5. SURFACE FINISH AND QUALITY CONTROL OF WORK

406.5.1. The surface finish of construction shall confirm to the requirements of As per MoRT&H clause 902.

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

### 409 CEMENT CONCRETE KERB

#### 408.1 SCOPE

This work shall consist of constructing cement concrete kerbs along the Footpath in conformity with the lines, levels and dimensions as specified in the drawings or as directed by the Engineer.

#### 408.2 MATERIALS

Kerbs shall be provided in cement concrete of grade M20 in accordance with as per MoRT&H clause 1700 of these specifications.

#### 408.3 TYPE OF CONSTRUCTION

These shall be cast-in-situ construction with suitable kerb casting machine in all situations except at locations where continuous casting with equipment is not practicable. In those situations pre-cast concrete blocks shall be used.

#### 408.4 EQUIPMENT

A continuous kerb casting equipment of adequate capacity and controls, capable of laying the kerbs in required cross-sections and procuring a well-compacted mass of concrete free of voids and honeycombs, shall be used.

#### 408.5 CONSTRUCTION OPERATION

408.5.1 Kerbs shall be laid on firm foundation of minimum 150mm concrete of M15 grade cast in situ or on extended width of pavement; the foundation shall have a projection of 50mm beyond the kerb stone. Before laying the foundation of lean concrete, the base shall be levelled and slightly watered to make it damp.

408.5.2 In the median portions in the straight reaches, the kerb shall be cast in continuous lengths. In the portions where footpath is provided and/or the slope of the carriageway is towards median (as in case of super elevated portions), there shall be sufficient gap/recess left in the kerb to facilitate drainage openings.

408.5.3 After laying the kerbs and just prior to hardening of the concrete, saw-cut grooves shall be provided at 5m intervals or as specified by the Engineer.

408.5.4 Kerbs on the drainage ends such as along the footpath or the median in super elevated portions shall be cast with monolithic concrete channels as indicated in drawings. The slope of the channel towards drainage pipes shall be ensured for efficient drainage of the road surface.

408.5.5 Vertical and horizontal tolerance with respect to true line and level shall be  $\pm 6\text{mm}$ .

#### FOOTPATHS AND SEPARATORS

##### 408.6 Scope

The work shall consist of constructing footpaths and/or separators at locations as specified in the drawings or as directed by the Engineer.

The lines, levels and dimensions shall be as per the drawings. The scope of the work shall include provision of all drainage arrangements as shown in the drawings or as directed by the Engineer.

##### 408.7 Materials

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

a) Cast-in-situ cement concrete of Grade M 20 as per Section 1700 of the Specifications. The minimum size of the panels shall be as specified in the drawings.

b) Precast cement concrete blocks and interlocking blocks/tiles of grade not less than M 30 as per Section 1700 of the Specifications. The thickness and size of the cement concrete blocks or interlocking blocks/ tiles shall be as specified in the drawings.

c) Natural stone slab cut and dressed from stone of good and sound quality, uniform in texture, free from defects and at least equal to a sample submitted by the Contractor and approved by the Engineer.

The thickness and size of the natural stone slab shall be as specified in the drawings.

##### 408.8 Construction Operations

###### 408.8.1 Drainage pipes below the footpath originating from the kerbs shall be first

laid in the required slope and connected to the drains/sumps/storm water drain/drainage

chutes as per provisions of the drawings, or as specified.

###### 408.8.2 Portion on back side of kerbs shall be filled and compacted with granular

sub-base material as per As per MoRT&H clause 401 of the Specifications in specified thickness.

408.8.3 The base for cast-in-situ cement concrete panels/ tiles/ nature stone slab shall be prepared and finished to the required lines, levels and dimensions as indicated in the drawings. Over the prepared base, precast concrete interlocking blocks/tiles/natural stone slabs and/or cast-in- situ slab shall be set/laid as described in As per MoRT&H clauses 410.3.4 and 410.3.5.

#### 408.8.4 Tiles/Natural Stone Slabs

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

#### 408.8.5 Cast-in-5itu Cement Concrete

The panels of specified size shall be cast on the prepared base in panels of specified size in a staggered manner. Construction joints shall be provided as per Section 1700 of the Specifications.

#### 408.8.6 Precast Concrete Blocks and Interlocking Concrete Block Pavements)

The precast concrete blocks and interlocking concrete block pavement shall be laid on a bedding of sand of thickness specified in the drawing. The grading of the sand layer shall be as in Table 400-16.

Table 400-16

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

The joints shall be filled with sand passing a 2.35 mm size with the grading as in

Table 400-17.

IS Sieve Size	Percent Passing
2.36 mm	100
1.18 mm	90–100
600 micron	60–90
300 micron	30–60
150 micron	15–30
75 micron	0–10

The bedding sand slightly moist, the moisture content being about 4 percent. The bedding sand shall be compacted by vibratory plate compactor.

The blocks shall be laid to the levels indicated on the drawings and to the pattern directed by the Engineer. The surface tolerance shall be  $\pm 10$  mm with respect to the design level. The blocks shall be embedded using a hammer.

## 501. GENERAL REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

### 501.1. General

Bituminous pavement courses shall be made using the materials described in the following Specifications.

The use of machinery and equipment mentioned in various As per MoRT&H clauses of these Specifications is mandatory. Details of the machinery and equipment are available in the Manual for Construction and Supervision of Bituminous Works. Equipment mandatory for any particular project shall be in accordance with the Contract Specification for that project.

### 501.2. Materials

501.2.1. Binder: The binder shall be an appropriate type of bituminous material complying with the relevant Indian Standard (IS), as defined in the appropriate As per MoRT&H clauses of these Specifications, or as otherwise specified herein. The choice of binder shall be stipulated in the Contract or by the Engineer. Where penetration grades of bitumen are specified, they are referred to by a single-figure designation in accordance with IS:73. Thus bitumen grade 35 refers to a bitumen in the penetration range 30 to 40. Where Modified Binder is specified, the As per MoRT&H clause 521 of these Specifications shall apply.

501.2.2. 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 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 aggregates shall be tested for stripping.

The aggregates shall satisfy the physical requirements set forth in the individual relevant as per MoRT&H clause for the material in question.

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.

501.2.3. Fine Aggregates: Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 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.

501.2.4. Source of material: The source of all materials to be used on the project must be tested to the satisfaction of and be expressly approved by the Engineer. The Engineer may

from time to time withdraw approval of a specific source, or attach conditions to the existing approval. Any change in aggregate source for bituminous mixes, will require a new mix design, and laying trials, where the mix is based on a job mix design. Stockpiles from different sources, approved or otherwise, shall be kept separate, such that there is no contamination between one material and another. Each source submitted for approval shall contain sufficient material for at least 5 days work.

#### 501.3. 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.

#### 501.4. 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.

#### 501.5. Laying

501.5.1. 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.

501.5.2. Cleaning of surface: The surface on which the bituminous work is to be laid shall be cleaned of all loose and extraneous matter by means of a mechanical broom or any other approved equipment / method as specified in the contract. The use of a high-pressure air jet from a compressor to remove dust or loose matter shall be available full time on the site, unless otherwise specified in the Contract.

501.5.3. 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:

- i) For laying regulating courses of irregular shape and varying thickness.
- ii) In confined spaces where it is impracticable for a paver to operate.
- iii) For footways.
- iv) At the approaches to expansion joints at bridges, viaducts or other structures.
- v) For laying mastic asphalt in accordance with As per MoRT&H clause 515.
- vi) For filling of potholes.
- vii) 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:

- i) At the edges of the layers of material and at gullies and manholes.
- ii) At the approaches to expansion joints at bridges, viaducts or other structures.
- iii) As directed by the Engineer.

501.5.4. 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 As per MoRT&H 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.

#### 501.6. Compaction

Bituminous materials shall be laid and compacted in layers, which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling 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/sqcm. 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 rear 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.

#### 501.7. Joints

Where longitudinal joints are made in pre-mixed bituminous materials, the materials shall be fully compacted and the joint made flush in one of the following ways; only method (iii) shall be used for transverse joints:

- i) by heating the joints with an approved joint heater when the adjacent width is being laid, but without cutting back or coating with binder. The heater shall raise the temperature of the full depth of material, to within the specified range of minimum rolling temperature and maximum temperature at any stage for the material, for a width not less than 75 mm. The Contractor shall have equipment available, for use in the event of a heater breakdown, to form joints by method (iii);
- ii) by using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling;
- iii) by cutting back the exposed joint, for a distance equal to the specified layer thickness, to a vertical face, discarding all loosened material and coating the vertical face completely with 80/100 penetration grade hot bitumen, or cold-applied bitumen, or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm, before the adjacent width is laid.

All joints shall be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, which ever is appropriate.



Longitudinal joints shall not be situated in wheel track zones.

#### 501.8. Preparation of Surface

501.8.1. Scope : This work shall consist of preparing an existing granular or black-topped surface bituminous course. The work shall be performed on such widths and lengths as shown on the drawings or as instructed by the Engineer. The existing surface shall be firm and clean, and treated with Prime or Tack coat as shown on the drawings as otherwise stated in the Contract.

#### 501.8.2. Materials

501.8.2.1. For scarifying and re-laying the granular surface: The material used shall be coarse aggregate salvaged from the scarification of the existing granular base course supplemented by fresh coarse aggregate and screenings so that aggregates and screenings thus supplemented correspond to As per MoRT&H clause 404: Water Bound Macadam or As per MoRT&H clause 406: Wet Mix Macadam.

501.8.2.2. For patching potholes and sealing cracks: Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with As per MoRT&H clauses 3004.2 and 3004.3, or as directed by the Engineer.

501.8.2.3. For profile corrective course: A profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the Drawings, or as indicated in the Contract Documents. The profile corrective course shall be laid to tolerances and densities as specified for wearing course if a single layer, or base course, if it is to be covered with a wearing course layer.

501.8.2.4. Profile corrective course and its application: The type of material for use as profile corrective course shall be as shown on the drawings or as directed by the Engineer. Where it is to be laid as part of the overlay/strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/strengthening course. However, if provided as a separate layer, it shall be of the specification and details given in the contract drawings.

- i) Any high spots in the existing surface shall be removed by a milling machine or other approved method, and all loose material shall be removed to the satisfaction of the Engineer.
- ii) Where the maximum thickness of profile corrective course will be not more than 40 mm, the profile corrective course shall be constructed as an integral part of the overlay course. In other cases, the profile corrective course shall be constructed as a separate layer, adopting such construction procedures and using such equipment as approved, by the Engineer, to lay the specified

type of material, to thickness and tolerance as specified, for the course, to be provided.

#### 501.8.3. Construction Operations

501.8.3.1. Preparing existing granular surface: Where the existing surface is granular, all loose materials shall be removed, and the surface lightly watered where the profile corrective course to be provided as a separate layer is also granular. Where the profile corrective course of bituminous material is to be laid over the existing granular surface, the latter shall, after removal of all loose material, be primed in accordance with As per MoRT&H clause 502.

The surface finish of all granular layers on which bituminous works are to be placed, shall, unless otherwise specifically instructed by the Engineer, be free from dust. All such layers must be capable of being swept, after the removal of any non-integral loose material, by means of a mechanical broom, without shedding significant quantities of material and dust removed by air jet, washing, or other means approved by the Engineer.

After cleaning the surface shall be correct to line and level, within the tolerances specified for base course.

501.8.3.2. Scarifying existing bituminous surface: Where specified or shown on the drawings, the existing bituminous layer in the specified width shall be removed with care and without causing undue disturbance to the underlying layer, by a suitable method approved by the Engineer. After removal, all loose and disintegrated material, the underlying layers, which might have been disturbed, should be suitably reworked and compacted to line and level. After supplementing the base material as necessary with suitable fresh stone, the compacted finished surface shall be primed in accordance with As per MoRT&H clause 502. Reusable materials shall be stacked as directed by the Engineer within 1000 m of their origin.

501.8.3.3. Patching of potholes and sealing of cracks: Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with as per MoRT&H clauses 3004.2 and 3004.3, or as directed by the Engineer.

#### 501.8.3.4. Laying the profile corrective course

501.8.3.4.1. Laying on granular base: After preparing the granular surface in accordance with As per MoRT&H clauses 501.8.3.1 and 501.8.3.2, the profile corrective course shall be laid using material as described in As per MoRT&H clauses 501.8.2.3 and 501.8.2.4, or as otherwise described in the Contract, and compacted to the requirements of the particular Specification.

501.8.3.4.2. Laying on existing bituminous surface: The existing bituminous surface shall be prepared in accordance with As per MoRT&H clause 501.8.3.3, and after applying a tack coat conforming to As per MoRT&H clause 503, the bituminous profile corrective course

shall be laid and compacted to the requirements of the particular Specification.

501.8.3.4.3. Correction of local depressions: Where local sags or depressions occur in the existing pavement, a specific filling operation shall be instructed by the Engineer, which should be laid in accordance with Figure 500-1. Normally, the maximum layer thickness at any point should not exceed 100 mm. In placing multiple lifts, they should be arranged according to the correct method as illustrated.

For correction of camber or super-elevation of the existing carriageway, the method shown in Figure. 500-2 shall be adopted, depending on the profile of the existing carriageway.

501.8.3.5. Covering the profile corrective courses: Profile corrective course particularly shall be so planned that the layer shall be covered by the designed base/wearing course at the earliest opportunity, before opening to regular traffic.

501.8.4. Surface finish and quality control of work: The relevant provisions of Section 900 shall apply.

501.8.5. Arrangements for traffic: During construction operations, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

501.8.6. Environmental protection: The provisions of As per MoRT&H clause 111 and the provision of Annexure A to As per MoRT&H clause 501 shall apply.

501.8.7. Measurement for payment

501.8.7.1. Potholes and cracks: The work of filling potholes shall be measured separately and be paid for in square metres.

The work of filling cracks by applying fog spray or emulsion slurry seal shall be measured in square metres, for the area covered by the spray.

The work in filling cracks larger than 3mm in width shall be measured and paid for on a linear metre basis.

501.8.7.2. Scarifying: Scarifying the existing bituminous surface shall be measured on a square metre basis.

501.8.7.3. Profile corrective course: Profile corrective course shall be measured as the volume instructed and compacted in position and measured in cubic metres, or in tonnage, as stipulated in the Contract. The volume shall be calculated by plotting the exact profile of profile corrective course as required, and laid, superimposed on the existing pavement profile. Cross-sectional areas of the profile corrective course shall be measured at intervals as used in the design, or as determined by the Engineer, and the volume shall be calculated

using the method of end areas.

501.8.7.4 Prime coat: Prime coat is to be measured and paid for on a per square metre basis.

501.8.7.5 Tack coat: This is to be a PROVISIONAL item, which may be used in-part or not at all, at the Engineers direction, and is to be measured and paid for, if used, on a square metre basis.

#### 501.8.8. Rates

501.8.8.1. Rate for scarifying: The contract unit rate for scarifying existing bituminous surfaces, including repairing / reworking disturbed underlying layers and removing and stacking reusable / unusable materials, shall include for but not necessarily be limited to, the cost of all labour, supply of materials needed for repair / reworking, hire charges of tools and plant, and transportation of scarified materials within 1000 m of their origin.

501.8.8.2. Rate for premixed bituminous material: The contract unit rate for premixed bituminous material shall be payment in full for carrying out the required operations including full compensation for, but not necessarily limited to:

- i) Making arrangements for traffic to As per MoRT&H clause 112 except for initial treatment to verge, shoulders and construction of diversions;
- ii) Preparation of the surface to receive the material.
- iii) 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;
- iv) Mixing, transporting, laying and compacting the mix, as specified.
- v) All labour, tools, equipment, plant including installation of hot mix plant, power supply units and all machinery, incidental to complete the work to these Specifications;
- vi) Carrying out the work in part widths of the road where directed;
- vii) Carrying out all tests for control of quality; and
- viii) 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.

- ix) The rates for premixed material are to include for all wastage in cutting of joints etc.
- x) 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.
- xi) 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 material.

501.8.8.3. Rate for potholes and crack sealing: The rate for patching potholes shall include for breaking out, trimming edges, cleaning out, painting edges and bottom with bitumen, and filling and compacting the excavation with the specified material. The rate should be inclusive of all plant, tools, labour and materials, transport, and disposal of surplus material,

The contract unit rate for sealing cracks by applying fog spray shall be inclusive of providing all materials, tools, labour and plant and carrying out the work. The contract unit rate for sealing cracks by providing emulsion slurry seal shall be as set forth in As per MoRT&H clause 516.9.

The contract unit rate for crack sealing 3mm to 6mm cracks with straight run or other specified bitumen, shall be based on either a square metre basis, or linear metre of cracks as measured, as stipulated by the Contract.

The contract unit rate for cracks between 6mm and 15mm is to be measured on a linear metre basis, and the rate is to include for all materials, tools, plant, labour, and transport.

Annexure 'A' to As per MoRT&H clause 501

Annexure 'A'

## PROTECTION OF THE ENVIRONMENT

### 1. General

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

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

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

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

## 2. Water Quality.

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

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

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

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

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

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

## 3. Air Quality

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

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

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

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

#### 4. Noise

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

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

#### 5. Control of Wastes

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

#### 6. Emergency Response

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

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

## 7. Measurement

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

### 502. PRIME COAT OVER GRANULAR BASE

#### 502.1. Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

#### 502.2. Materials

502.2.1. Primer: The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. These are:

- i) Surface of low porosity; such as wet mix macadam and water bound macadam,
- ii) Surfaces of medium porosity; such as cement stabilized soil base,
- iii) Surfaces of high porosity; such as a gravel base.

502.2.2. 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 these 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 60°C  (Centistokes)	Quantity of Liquid Bituminous Material per 10 Sq.m. (kg)
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Low porosity	30-60	6 to 9
Medium porosity	70-140	9 to 12
High porosity	250-500	12 to 15

502.2.3. Choice of primer: 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.

### 502.3. 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 10°C. Surfaces which are 155 to receive emulsion primer should be damp, but no free or standing water shall be present.

### 502.4. Construction

502.4.1. Equipment: The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

502.4.2. Preparation of road surface: The surface to be primed shall be prepared in accordance with As per MoRT&H clauses 501.8. and 902 as appropriate. 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 interlocked 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.

502.4.3. Application of bituminous primer: The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. Where a geosynthetic is proposed for use, the requirements of As per MoRT&H clauses 703.3.2 and 703.4 shall apply. The bituminous primer shall be sprayed uniformly in accordance with As per MoRT&H 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.

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

course. 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.

502.4.5. Tack coat: Over the primed surface, a tack coat should be applied in accordance with As per MoRT&H clause 503.

#### 502.5. Quality Control of Work

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

#### 502.6. Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 502.7. Measurement for Payment

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

#### 502.8. Rate

The contract unit rate for prime coat with adjustments as described in As per MoRT&H clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of 0.6 kg per square metre, 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 As per MoRT&H clause 502.4.3.

### 503. TACK COAT

#### 503.1. Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or instructed by the Engineer.

#### 503.2. Materials

503.2.1. Binder: 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 temperatures or for emergency applications as directed by the Engineer.

#### 503.3. 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. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

#### 503.4. Construction

503.4.1. Equipment: The tack coat distributor 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, or in narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

503.4.2. Preparation of base: The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of As per MoRT&H clauses 501.8 and 902 as appropriate. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

503.4.3. Application of tack coat: The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in Table 500-2. The normal range of spraying

Type of Surface	Quantity of Liquid bituminous material in Kg per sq.m.area
i) Normal bituminous surfaces	0.20 to 0.25
ii) Dry and hungry bituminous surfaces	0.25 to 0.30
iii) Granular surfaces treated with primer	0.25 to 0.30
iv) Non bituminous surfaces	
Granular base (not primed)	0.35 to 0.40
Cement concrete pavement	0.30 to 0.35

temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C if RC-70/MC-70 is used. Where a geosynthetic is proposed for use, the provisions of As per MoRT&H clauses 703.3.2 and 703.4.4 shall apply. 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 at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray,

within the tolerances specified.

Where the material to receive an overlay is a freshly laid bituminous layer, that has not been subjected to traffic, or contaminated by dust, a tack coat is not mandatory where the overlay is completed within two days.

503.4.4. Curing of tack coat : The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

#### 503.5. Quality Control of Work

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

#### 503.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112

#### 503.7. Measurement for Payment

Tack coat shall be measured in terms of surface area or application in square metres.

#### 503.8. Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components listed in As per MoRT&H clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. The rate shall cover the provision of tack coat at 0.2 kg per square metre, with the provision that the variance in actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

### 504. BITUMINOUS MACADAM

#### 504.1. Scope

This work shall consist of construction in a single course having 50mm to 100mm thickness or in multiple courses of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of these Specifications. Bituminous macadam is more open graded than the dense graded bituminous materials described in As per MoRT&H clauses 507, 508 and 509.

#### 504.2. Materials

504.2.1. 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 500-4.

504.2.2. 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 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 ami-stripping agents, 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 set forth in Table 500-3.

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.

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

Property	Test	Specification
Cleanliness	Grain size analysis <sup>1</sup>	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index <sup>2</sup>	Max 30%
Strength	Los Angeles Abrasion Value <sup>3</sup>	Max 40%
Durability	Soundness: <sup>4</sup>	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption <sup>5</sup>	Max 2%
Stripping	Coating and stripping of Bitumen Aggregate Mixtures <sup>6</sup>	Minimum retained coating 95%
Water	Retained Tensile Strength	Min 80%

Sensitivity<sup>7</sup>

- 
- |           |   |    |                 |
|-----------|---|----|-----------------|
| Notes: 1. | IS: 2386 Part 1   | 4. | IS: 2386 Part 5 |
| 2.        | IS: 2386 Part 1.<br>(the elongation test to be done only on non-flaky aggregates in the sample) | 5. | IS: 2386 Part 3 |
| 3.        | IS: 2386 Part 4*  | 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.

504.2.4. Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in Table 500-4 for the grading specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

504.2.5. Proportioning of material: The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-4. The binder content shall be within a tolerance of  $\pm 0.3$  per cent by weight of total mixture when individual specimens are taken for quality control tests in accordance with the provisions of Section 900.

### 504.3. Construction Operations

504.3.1. Weather and seasonal limitations: The provisions of As per MoRT&H clause 501.5.1 shall apply.

TABLE 500-4. COMPOSITION OF BITUMINOUS MACADAM

Mix designation	Grading 1	Grading 2
Nominal aggregate size	40mm	19mm
Layer thickness	80 - 100mm	50 - 75 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weight of total mixture <sup>1</sup>	3.1 - 3.4	3.3 - 3.5
Bitumen grade	35 to 90	35 to 90

Notes: 1. Appropriate bitumen contents for conditions in cooler areas of India may be up to 0.5% higher subject to the approval of the Engineer. \*

504.3.2. Preparation of the base: The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with As per MoRT&H clauses 501.8 and 902.3 as appropriate, and a prime coat, shall be applied in accordance with As per MoRT&H clause 502 where specified, or as directed by the Engineer.

504.3.3. Tack coat : A tack coat in accordance with As per MoRT&H clause 503 shall be applied as required by the Contract documents, or as directed by the Engineer.

504.3.4. Preparation and transportation of the mixture: The provisions of As per MoRT&H clauses 501.3 and 501.4 shall apply.

504.3.5. Spreading: The provisions of As per MoRT&H clauses 501.5.3 shall apply.

TABLE 500-5. MANUFACTURING AND ROLLING TEMPERATURES

Bitumen Penetration	Bitumen Mixing (°C)	Aggregate Mixing (°C)	Mixed Material (°C)	Rolling (°C)	Laying (°C)
---------------------	---------------------	-----------------------	---------------------	--------------	-------------

35	160 - 170	160-175	170 Maximum	100 Minimum	130 Minimum
65	150 - 165	150-170	165 Maximum	90 Minimum	125 Minimum

504.3.6. Rolling: Compaction shall be carried out in accordance with the provisions of As per MoRT&H clauses 501.6 and 501.7.

Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in As per MoRT&H clause 903.

#### 504.4. Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of As per MoRT&H clause 902. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

#### 504.5. Protection of the Layer

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of As per MoRT&H clause 513 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

#### 504.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 504.7. Measurement for Payment

Bituminous macadam shall be measured as finished work in cubic metres, or by weight in metric tonnes, where used as regulating course, or square metres at the specified thickness as indicated in the Contract or shown on the drawings, or as otherwise directed by the Engineer.

#### 504.8. Rate

The contract unit rate for bituminous macadam shall be payment in fall for carrying out the required operations as specified. The rate shall include for, all components listed in As per MoRT&H clause 501.8.8.2. (i) to (xi).

### 505. BITUMINOUS PENETRATION MACADAM

#### 505.1. Scope



The work shall consist of construction of one or more layers of compacted crushed coarse aggregates with alternate applications of bituminous binder and key aggregates in accordance with the requirements of these Specifications to be used as a base course on roads, subject to the requirements of the overall pavement design, in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Thickness of an individual course shall be 50 mm or 75 mm, or other as specified.

#### 505.2. Materials

505.2.1. Bitumen: The binder shall be paving bitumen of suitable penetration grade within the range of S-35 to S-90 or A-35 to A-90 (30/ 40 to 80/100) as per Indian Standards Specifications for "Paving Bitumen" IS: 73, or approved cutback satisfying the requirements of IS: 217 or 454. The actual grade of bitumen or cutback to be used shall be as specified or as directed by the Engineer.

505.2.2. Aggregates: The aggregates shall satisfy the physical requirements set out in As per MoRT&H clause 504.2.2. and Table 500-3. The coarse and key aggregates shall conform to the grading given in Table 500-6.

505.2.3. Quantities of materials: The quantities of materials used for this work shall be as specified in Table 500-6.

#### 505.3. Construction Operations

505.3.1. Weather and Seasonal Limitations: The provisions of As per MoRT&H clause 501.5.1. shall apply.

505.3.2. Equipment : A mechanical broom, compressor, self propelled or trailed bitumen heater/distributor, mechanical aggregate spreader and 8 to 10 tonne smooth steel wheel roller or vibrating roller are required for the preparation of Penetration Macadam.

505.3.3. Preparation of the base: The base on which the Penetration Macadam Course is to be laid shall be prepared, shaped and compacted to the specified lines, grades and sections to As per MoRT&H clauses 501 and 902 as appropriate, or as directed by the Engineer. A prime coat, where specified, shall be applied over the base in accordance with As per MoRT&H clause 502 or as directed by the Engineer. A tack coat as per As per MoRT&H clause 503 shall be applied.

505.3.4. Spreading coarse aggregates: The coarse aggregate shall be dry and clean and free from dust, and shall be spread uniformly and evenly at the rate specified in Table 500-6. It shall be spread by a self-propelled or tipper tail mounted aggregate spreader capable of spreading aggregate uniformly at the specified rates over the required widths. The surface of the layer shall be carefully checked with camber templates to ensure correct line and level and cross fall. The spreading shall be carried out such that the rolling and penetrating operations can be completed on the same day. Segregated aggregates or aggregates

contaminated with foreign material shall be removed and replaced.

TABLE 500-6. COMPOSITION OF PENETRATION MACADAM

1. IS Sieve Designation (mm)	Cumulative per cent by weight of total aggregate passing			
	For 50 mm compacted Thickness		For 75 mm compacted Thickness	
	Coarse Aggregate	Key Aggregate	2. Coarse Aggregate	Key Aggregate
63	—	—	100	—
45	100	—	58-82	—
26.5	37-72	—	—	100
22.4	—	100	5-27	50-75
13.2	2-20	50-75	—	—
11.2	—	—	—	5-25
5.6	—	5-25	—	—
2.8	0-5	0-5	0-5	0-5
Approx. Loose aggregate quantities	0.06	0.015	0.09	0.018
Binder quantity (penetration grade) <sup>(1)</sup> (kg/m <sup>2</sup> )	5		6.8	

Note:(1) If cutback bitumen is used, adjust binder quantity such that the residual bitumen is equal to the values in this table.

505.3.5. Compaction: After the spreading of coarse aggregates, dry rolling shall be carried out with an 8 - 10 tonne smooth steel wheel roller.

The requirements given in As per MoRT&H clause 501.6 and 501.7 shall apply. After initial dry rolling, the surface shall be checked with a crown template and a 3 metre straight-edge. The surface shall not vary more than 10 mm from the template or straight-edge. All surface irregularities exceeding the above limit shall be corrected by removing or adding aggregates as required.

The rolling shall continue until the compacted coarse aggregate has a firm surface true to the cross section shown on the plans and has a texture that will allow free and uniform penetration of the bituminous material.

505.3.6. Application of bituminous material: After the coarse aggregate has been rolled and checked, the bituminous binder shall be applied, at the rate given in Table 500-6, in accordance with As per MoRT&H clause 501, and at a temperature directed by the Engineer.

At the time of applying the binder, the aggregates shall be surface dry for the mil depth of the layer.

In certain circumstances, depending on the type and-size of aggregate used, the Engineer may direct the placing of a bed of clean sand or quarry fines, not exceeding 10mm in thickness, on the prepared foundation before placing the coarse aggregate. The sand or fine material shall be slightly wetted, just sufficient for it to slurry up during the compaction process. Where cut back is used, if flooding of the binder occurs it should be applied in two operations, or as directed by the Engineer.

505.3.7. Application of key aggregates: Immediately after the first application of bitumen, the key aggregates, which shall be clean, dry, and free from dust shall be spread uniformly over the surface by means of an approved mechanical spreader or by approved manual methods at the rate specified in Table 500-6.

Where directed by the Engineer, the surface shall be swept and the quantity of key aggregate adjusted to ensure uniform application, with all the surface-voids in the coarse aggregate being filled without excess. The entire surface shall then be rolled with a 8 - 10 tonnes smooth steel wheel roller (or vibrating roller operating in non-vibratory mode) in accordance with the procedure specified in As per MoRT&H clause.505.3.5.

#### 505.4. Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of As per MoRT&H clause 902. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 shall apply.

#### 505.5. Surfacing

The Penetration Macadam shall be provided with a surfacing (binder/ wearing course) within a maximum of forty-eight hours. If there is to be any delay, the penetration macadam shall be covered by a seal coat to the requirements of As per MoRT&H clause 513 before opening to traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

#### 505.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 505.7. Measurement for Payment

Penetration Macadam base course shall be measured as finished work in square metres.

## 505.8. Rate

The contract unit rate for Penetration Macadam course shall be payment in full for carrying out the required operations including, but not necessarily limited to, all components listed in As per MoRT&H clause 501.8 8.2. (i) to (xi).

## 506. BUILT-UP SPRAY GROUT

## 506.1. Scope

This work shall consist of a two-layer composite construction of compacted crushed coarse aggregates with application of bituminous binder after each layer, and with key aggregates placed on top of the second layer, in accordance with the requirements of these Specifications, to serve as a base course and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The thickness of the course shall be 75 mm.

Built-up spray grout shall be used in a single course in a pavement structure.

## 506.2. Materials

506.2.1. Bitumen: As per MoRT&H clause 504.2.1. shall apply. Where permitted by the Engineer, an appropriate grade of emulsion complying with IS 8887 may be used.

506.2.2. Aggregates: The coarse aggregate shall conform to As per MoRT&H clause 504.2.2.

The aggregate shall satisfy the physical requirements set out in Table 500-3. The coarse and key aggregates for built-up spray grout shall conform to the grading given in Table 500-7.

TABLE 500-7. GRADING REQUIREMENTS FOR COARSE AND KEY AGGREGATES FOR BUILT-UP SPRAY GROUT

IS Sieve Designation (mm)	Cumulative per cent by weight of total aggregate passing	
	Coarse aggregate	Key aggregate
53.0	100	-
26.5	40 - 75	-
22.4	-	100

13.2	0 - 20	40 - 75
5.6	-	0 - 20
2.8	0 - 5	0 - 5

### 506.3. Construction Operations

506.3.1. Weather and seasonal limitations: The provisions of As per MoRT&H clause 501.5.1 shall apply.

506.3.2. Equipment: The provisions of As per MoRT&H clause 505.3.2 shall apply.

506.3.3. Preparation of base: The base on which the built-up spray grout course is to be laid shall be prepared, shaped and compacted to the specified lines, grades and cross-sections in accordance with As per MoRT&H clauses 501 and 902 as appropriate. A prime coat shall be applied in accordance with As per MoRT&H clause 502 with approved primer as directed by the Engineer.

506.3.4. Tack coat: A tack coat shall be applied in accordance with the procedure described in As per MoRT&H clause 503, as directed by the Engineer.

506.3.5. Spreading and rolling coarse aggregates for the first layer: Immediately after the application of prime or tack coat, the clean, dry and dust free coarse aggregates shall be spread uniformly and evenly, by mechanical means, at the rate of 0.5 cu.m. per 10 sq.m. area.

Immediately after spreading of the aggregates, the entire surface shall be rolled with an 8 - 10 tonnes smooth wheel steel roller. Rolling shall commence at the edges and progress towards the centre except in super-elevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass.

The surface of the layer shall be carefully checked, after rolling, with a template and straight edge and shall be within the tolerances specified, and any deficiencies corrected by reworking and recompacting the layer.

Care shall be taken not to over-compact the layer.

506.3.6. Application of binder - first spray: The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the aggregate at the rate of 15 kg/10 sq.m. (measured in terms of residual bitumen content) at a uniform rate of spray by mechanical sprayers capable of spraying bitumen uniformly at the specified rates and temperatures. Excessive deposits of binder caused by stopping or starting of the sprayers or through leakage or for any other reason shall be removed and made good.

506.3.7. Spreading and rolling of coarse aggregate for the second layer: Immediately after the first application of the binder, the second layer of coarse aggregates shall be spread and rolled in accordance with the procedure detailed in As per MoRT&H clause 506.3.5.

506.3.8. Application of binder - second spray: The second aggregate layer shall then be sprayed with binder at the rate of 15 kg/10 sq. m. (measured in terms of residual bitumen content) in accordance with As per MoRT&H clause 506.3.6.

506.3.9. Application of key aggregate: Immediately after the second application of binder, key aggregates shall be spread uniformly and evenly, preferably by mechanical means, at the rate of 0.13 cu.m. /10 sq.m. so as to cover the surface completely. The key aggregate shall be clean, dry and free from dust and deleterious matter. If necessary, the surface shall be swept to ensure uniform application of the key aggregates. The entire surface shall then be rolled with an 8-10 tonnes smooth wheel steel roller in accordance with As per MoRT&H clause 506.3.5. While rolling is in progress, additional key aggregates, where required, shall be spread by hand. Rolling shall continue until the entire course is thoroughly compacted and the key aggregates are firmly in position.

#### 506.4. Surface Finish and Quality Control

The surface finish of construction shall conform to the requirements of As per MoRT&H clause 902. All materials shall comply with the requirements of the relevant provisions in Section 900 of the Specifications.

#### 506.5. Final Surfacing

The built-up-spray-grout shall be provided with final surfacing within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of As per MoRT&H clause 513 before it is open to traffic. Where the seal coat is required as a result of the selected method of performing this operation, then it shall be considered incidental to the work and shall not be paid for separately.

#### 506.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be -made in accordance with the provisions of As per MoRT&H clause 112.

#### 506.7. Measurement for Payment

Built-up spray grout shall be measured as finished work in square metres.

#### 506.8. Rate

The contract unit rate for built-up spray grout shall be payment in full for carrying out the required operations as specified. The rate shall include for, but not necessarily be limited to the components listed in As per MoRT&H clause 501.8.8.2.(i) to (xi).

### 507. DENSE GRADED BITUMINOUS MACADAM

#### 507.1. Scope

This as per MoRT&H 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.

## 507.2. Materials

507.2.1. 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, or this bitumen as modified by one of the methods specified in As per MoRT&H clause 521, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

507.2.2. 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 500-8, 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.

507.2.3. 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 37).

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

TABLE 500-8. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR DENSE GRADED BITUMINOUS MACADAM

Property	Test	Specification
Cleanliness	Grain size analysis <sup>1</sup>	Max 5% passing 0.075mm sieve
Particle shape	Flakiness and Elongation Index (Combined) <sup>2</sup>	Max 30%
Strength*	Los Angeles Abrasion Value <sup>3</sup>	Max 35%
	Aggregate Impact Value <sup>4</sup>	Max 27%



Durability	Soundness: <sup>5</sup>	Max 12% Max 18%
	Sodium Sulphate	
Water Absorption	Magnesium Sulphate	Max 2%
Stripping	Water absorption <sup>6</sup>	Minimum retained
	Coating and Stripping of Bitumen	coating 95%
	Aggregate Mixtures <sup>7</sup>	Min 80%
Water	Retained Tensile Strength <sup>8</sup>	

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

2. IS: 2386 Part 1 6. IS: 2386 Part 3  
(the elongation test to be done only on non-flaky aggregates in the sample)

3. IS:2386 Part 4\* 7. IS: 6241

4. IS: 2386 Part 4\* 8. AASHTO T283\*\*

\* 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%.

507.2.4. 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 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.

507.2.5. 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 500-10, 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 500-10. COMPOSITION OF DENSE GRADED BITUMINOUS MACADAM PAVEMENT LAYERS

Grading	1	2
Nominal aggregate size	40mm	25 mm
Layer Thickness	80-100 mm	50-75 mm
IS Sieve <sup>1</sup> (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 <sup>2</sup>	Min 4 0	Min 4 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.

2. Determined by the Marshall method.

### 507.3. Mixture Design

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

TABLE 500-11. 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
Per cent voids in mineral aggregate (VMA)	See Table 500-12 below
Per cent voids filled with bitumen	65-75

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12.

TABLE 500-12. MINIMUM PER CENT VOIDS IN MINERAL AGGREGATE (VMA)

Nominal Maximum Particle Size <sup>1</sup> (mm)	Minimum VMA, Per cent Related to Design Air Voids, Per cent <sup>2</sup>		
	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.

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

507.3.2. Binder content: The binder content shall be optimised to achieve the requirements of the mixture set out in Table 500-11 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 500-11 be multiplied by 2.25, and the minimum flow shall be 3 mm.

507.3.3. 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:

- i) Source and location of all materials;
- ii) Proportions of all materials expressed as follows where each is applicable:
- iii) Binder type, and percentage by weight of total mixture;
  - a) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;
- iv) A single definite percentage passing each sieve for the mixed aggregate;
- v) The individual grading of the individual aggregate fractions, and the proportion of each in the combined grading.
- vi) The results of tests enumerated in Table 500-11 as obtained by the Contractor;
- vii) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch,
- viii) Test results of physical characteristics of aggregates to be used;
- ix) 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.

507.3.4. Plant trials - permissible variation in job mix formula: Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix

formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500- 13. These variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900.

TABLE 500-13. PERMISSIBLE VARIATIONS FROM THE JOB MIX FORMULA

Description	Permissible Variations	
	Base/binder course	Wearing course
Aggregate passing 19mm 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,	± 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.

507.3.5. 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 As per MoRT&H clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing, by the Engineer. The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of the project road, and 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.

#### 507.4. Construction Operations

507.4.1. Weather and seasonal limitations: The provisions of As per MoRT&H clause

501.5.1 shall apply.

507.4.2. Preparation of base: The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with As per MoRT&H clauses 501 and 902 as appropriate, or as directed by the Engineer. 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.

507.4.3. Geosynthetics: Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in As per MoRT&H clause 703

507.4.4. Stress absorbing layer: Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of As per MoRT&H clause 522.

507.4.5. Prime coat: Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of As per MoRT&H clause 502, or as directed by the Engineer.

507.4.6. Tack coat: Where the material on which the dense bituminous macadam is to be placed is a bitumen bound surface, a tack coat shall be applied as specified, in accordance with the provisions of As per MoRT&H clause 503, or as directed by the Engineer.

507.4.7. Mixing and transportation of the mixture: The provisions as specified in As per MoRT&H clauses 501.3 and 501.4 shall apply.

507.4.8. Spreading: The provisions of As per MoRT&H clauses 501.5.3 and 501.5.4. shall apply.

507.4.9. Rolling: The general provisions of As per MoRT&H clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

#### 507.5. 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.

#### 507.6. Surface Finish and Quality Control of Work

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

#### 507.7. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 507.8. Measurement for Payment

Dense Graded Bituminous Materials shall be measured as finished work either in cubic metres, tons or by the square metre at a specified thickness as detailed on the Contract drawings, or documents, or as directed by the Engineer.

#### 507.9. Rate

The contract unit rate for Dense Graded Bituminous Macadam shall be payment in full for carrying out the all required operations as specified, and shall include, but not necessarily limited to all components listed in As per MoRT&H clause 501.8.8.2 (i) to (xi). The rate shall include the provision of bitumen, at 4.25 per cent by weight of the total mixture.

The variance in actual percentage of bitumen used will be assessed and the payment adjusted, up or down, accordingly.

### 508. SEMI-DENSE BITUMINOUS CONCRETE

#### 508.1. Scope

This as per MoRT&H clause specifies the construction of Semi Dense Bituminous Concrete, for use in wearing/binder and profile corrective courses. This work shall consist of construction in a single or multiple layers of semi dense bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25mm to 100mm in thickness.

#### 508.2. Materials

508.2.1. Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-15, for semi dense bituminous concrete, or this bitumen as modified by one of the methods specified in As per MoRT&H clause 521, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

508.2.2. Coarse aggregates: The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-14.

508.2.3. Fine aggregates: The fine aggregates shall be all as specified in Clause 507.2.3.

508.2.4. Filler: Filler shall be generally as specified in As per MoRT&H clause 507.2.4. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-14 then 2 per cent by total weight of aggregate, of hydrated lime shall be added without

additional cost.

508.2.5. 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 shall fall within the limits shown in Table 500-15 for gradings 1 or 2 as specified in the Contract.

### 508.3. Mixture Design

508.3.1. 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 500-14. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR SEMI DENSE BITUMINOUS CONCRETE PAVEMENT LAYERS

Property	Test	Specification
Cleanliness (dust)	Grain size analysis <sup>1</sup>	Max 5% passing 0.075mm sieve
Particle shape	Flakiness and Elongation Index (Combined) <sup>2</sup>	Max 30%
Strength*	Los Angeles Abrasion Value <sup>3</sup>	Max 35%
	Aggregate Impact Value <sup>4</sup>	Max 27%
Polishing	Polished Stone Value <sup>5</sup>	Min 55
Durability	Soundness : <sup>6</sup>	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 2%
Water Absorption	Water absorption <sup>7</sup>	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures <sup>9</sup>	Minimum Retained Coating 95 %
Water Sensitivity**	Retained Tensile Strength <sup>8</sup>	Min 80 %

Notes: 1. IS: 2386 Part 1                      6. IS: 2386 Part 5

2. IS: 2386 Part 1                      7. IS: 2386 Part 3  
(the elongation test may be done only on non-flaky aggregates in the sample)

3. IS: 2386 Part 4\*                      8. AASHTOT283\*\*



4. IS: 2386 Part 4\*      9. IS: 6241

5. BS: 812 Part 114

\* 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%.

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12.

508.3.2. Binder content: The binder content shall be optimised 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.

TABLE 500-15. COMPOSITION OF SEMI DENSE BITUMINOUS CONCRETE  
PAVEMENT LAYERS

Grading	1	2
Nominal aggregate size	13 mm	10 mm
Layer Thickness	35-40 mm	25-30 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5		
19	100	
13.2	90-100	100
9.5	70-90	90-100
4.75	35-51	35-51
2.36	24-39	24-39
1.18	15-30	15-30
0.6	-	-
0.3	9-19	9-19
0.15	-	-

0.075	3-8	3-8
Bitumen content % by mass of total mix <sup>2</sup>	Min 4.5	Min 5.0
Bitumen grade (pen)	65*	65*

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

2. Determined by the Marshall method.

\* Only in exceptional circumstances, 80/100 penetration grade may be used, as approved by the Engineer.

TABLE 500-16. REQUIREMENTS FOR SEMI DENSE BITUMINOUS PAVEMENT LAYERS

Minimum stability (kN at 60 °C)	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 below
Per cent voids filled with bitumen	65-78

508.3.3. Job mix formula: The procedure for formulating the job mix formula shall be generally as specified in As per MoRT&H clause 507.3.3 and the results of tests enumerated in Table 500-16 as obtained by the Contractors.

508.3.4. Plant trials - permissible variation in job mix formula: The requirements for plant trials shall be all as specified in As per MoRT&H clause 507.3.4, and permissible limits for variation as shown in Table 500-13.

508.3.5. Laying trials: The requirements for laying trials shall be all as specified in As per MoRT&H clause 507.3.5.

#### 508.4. Construction Operations

508.4.1. Weather and seasonal limitations: The provisions of As per MoRT&H clause

501.5.1 shall apply.

508.4.2. Preparation of base: The surface on which the Semi Dense Bituminous material is to be laid shall be prepared in accordance with As per MoRT&H clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

508.4.3. Geosynthetics: Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in As per MoRT&H clause 703

508 4.4. Stress absorbing layer: Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of As per MoRT&H clause 522.

508.4.5. Tack coat: Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of As per MoRT&H clause 503.

508.4.6. Mixing and transportation of the mixture: The provisions as specified in As per MoRT&H clauses 501.3.and 501.4 shall apply.

508.4.7. Spreading: The general provisions of As per MoRT&H clauses 501.5.3 and 501.5.4 shall apply.

508.4.8. Rolling: The general provisions of As per MoRT&H clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

#### 508.5. 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.

#### 508.6. Surface Finish and Quality Control

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

#### 508.7. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

**508.8. Measurement for Payment**

The measurement shall be all as specified in As per MoRT&H clause 507.8.

**508.9. Rate**

The contract unit rate shall be all as specified in As per MoRT&H clause 507.9, except that the rate shall include the provision of bitumen at 4.75 per cent, by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

**509. BITUMINOUS CONCRETE****509.1. Scope**

This as per MoRT&H clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. Single layers shall be 25mm to 100mm in thickness.

**509.2. Materials**

509.2.1. Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-18, for bituminous concrete, or this bitumen as modified by one of the methods specified in As per MoRT&H clause 521, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

509.2.2. Coarse aggregates: The coarse aggregates shall be generally as specified in As per MoRT&H clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-17.

509.2.3. Fine aggregates: The fine aggregates shall be all as specified in As per MoRT&H clause 507.2.3.

509.2.4. Filler: Filler shall be generally as specified in As per MoRT&H clause 507.2.4. . Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-17 then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

509.2.5. Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table 500-18 for gradings 1 or 2 as specified in the Contract.

### 509.3. Mixture Design

509.3.1. 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 500-19.

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12.

509.3.2. Binder content: The binder content shall be optimised to achieve the requirements of the mixture set out in Table 500-19 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.

509.3.3. Job mix formula: The procedure for formulating the job

TABLE 500-17. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR BITUMINOUS CONCRETE PAVEMENT LAYERS

Property	Test	Specification
Cleanliness	Grain size analysis <sup>1</sup>	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (Combined) <sup>2</sup>	Max 30% (Combined) <sup>2</sup>
Strength*	Los Angeles Abrasion Value <sup>3</sup>	Max 30%
	Aggregate Impact Value <sup>4</sup>	Max 24%
Polishing	Polished Stone Value <sup>5</sup>	Min 55
Durability	Soundness: <sup>6</sup>	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption <sup>7</sup>	Max 2%

Stripping	Coating and stripping of Bitumen	Minimum retained coating
	Aggregate Mixtures <sup>9</sup>	95%

Water Sensitivity**	Retained Tensile Strength <sup>8</sup>	Min 80%
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- Notes: 1. IS: 2386 Part 1      6. IS: 2386 Part 5
2. IS: 2386 Part 1      7. IS: 2386 Part 3  
(the elongation test may be done only on non-flaky aggregates in the sample)
3. IS: 2386 Part 4\*      8. AASHTOT283\*\*
4. IS: 2386 Part 4\*      9. IS: 6241
5. BS: 812 Part 114

\* 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%.

mix formula shall be generally as specified in As per MoRT&H clause 507.3.3 and the results of tests enumerated in Table 500-19 as obtained by the Contractors.

509.3.4. Plant trials - permissible variation in job mix formula: The requirements for plant trials shall be all as specified in As per MoRT&H clause 507.3.4, and permissible limits for variation as shown in Table 500-13.

509.3.5. Laying trials: The requirements for laying trials shall be all as specified in As per MoRT&H clause 507.3.5.

#### 509.4. Construction Operations

509.4.1. Weather and seasonal limitations: The provisions of As per MoRT&H clause 501.5.1 shall apply.

TABLE 500-18. COMPOSITION OF BITUMINOUS CONCRETE PAVEMENT LAYERS

Grading	1	2
Nominal aggregate size	13 mm	10 mm
Layer Thickness	35-40 mm	25-30 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5	100	
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-37	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix <sup>2</sup>	5.0 - 6.0	5.0 - 7.0
Bitumen grade (pen)	65	65

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

2. Determined by the Marshall method.

TABLE 500-19. REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

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

(VMA)	
Per cent voids filled with bitumen (VFB)	65-75
Loss of stability on immersion in water at 60°C (ASTM D 1075)	Min. 75 per cent retained strength

509.4.2. Preparation of base: The surface on which the bituminous concrete is to be laid shall be prepared in accordance with As per MoRT&H clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

509.4.3. Geosynthetics: Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in As per MoRT&H clause 703:

509.4.4. Stress absorbing layer : Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of As per MoRT&H clause 522.

509.4.5. Tack coat: Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of As per MoRT&H clause 503.

509.4.6. Mixing and transportation of the mixture: The provisions as specified in As per MoRT&H clauses 501.3 and 501.4 shall apply.

509.4.7. Spreading: The general provisions of as per MoRT&H clauses 501.5.3 and 501.5.4 shall apply.

509.4.8. Rolling: The general provisions of as per MoRT&H clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

#### 509.5. 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.

#### 509.6. Surface Finish and Quality Control

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

#### 509.7. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112



**509.8. Measurement for Payment**

The measurement shall be all as specified in As per MoRT&H clause 507.8.

**509.9. Rate**

The contract unit rate shall be all as specified in As per MoRT&H clause 507.9, except that the rate shall include the provision of bitumen at 5.0 per cent, by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

**510. SURFACE DRESSING****510.1. Scope**

This work shall consist of the application of one coat or two coats of surface dressing, each coat consisting of a layer of bituminous binder sprayed on a previously prepared base, followed by a cover of stone chips rolled in to form a wearing course to the requirements of these Specifications. For information on the Design of Surface Dressing refer to the Manual for Construction and Supervision of Bituminous Works.

**510.2. Materials**

**510.2.1. Binder:** The binder shall have a kinematic viscosity lying in the range  $1 \times 10^4$  to  $7 \times 10^5$  centistokes at the expected range of road surface temperatures at the construction site during the period of laying. The type of binder to be used will be stated in the Contract documents and shall comply with one of the following:

Paving Bitumen      IS: 73

Bitumen Emulsion      IS: 8887

**510.2.2. Aggregates:** The chips shall conform to the requirements of As per MoRT&H clause 504.2.2, except that their water absorption shall be restricted to a maximum of 1 per cent and they shall have a Polished Stone value, as measured by the method given in BS812 (Part 114), of not less than 60. The chips shall be single sized, clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter and conforming to one of the gradings given in Table 500-21.

**510.2.3. Rates of spread of binder and chips:** For the purpose of pricing the Bill of Quantities the rates of spread given in Table 500-20 shall be priced.

Nominal Chipping Size mm	Binder (penetration grade bitumen) kg/m <sup>2</sup>	Chips Cum/m <sup>2</sup>
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19	1.2	0.015
13	1.0	0.010
10	0.9	0.008
6	0.75	0.004

Note: (1) These rates of spread are for pricing purposes - see As per MoRT&H clause 510.2.3 and As per MoRT&H clause

5108

(2) For emulsion, these rates of spread are for the residual bitumen and appropriate adjustment must be made to determine the total quantity.

(3) Refer to Manual for Construction and Supervision of Bituminous Works for the procedure of determining the rates of spread of binder and chips.

510.2.4. Anti-stripping agent: Where the proposed aggregate fails to pass the stripping test then an approved adhesion agent (Appendix 5 for details) may be added to the binder in accordance with the manufacturer's instructions. The effectiveness of the proposed anti-stripping agent must be demonstrated by the Contractor, before approval by the Engineer.

510.2.5. Pre-coated chips: As an alternative to the use of an adhesion agent the chips may be pre-coated before they are spread except when the sprayed binder film is a bitumen emulsion. Pre-coating the chips may be carried out in any one of the two methods:

- a) Mixing them with 0.75 to 1.0 per cent of paving bitumen by weight of chips in a suitable mixer, the chips being heated to 160°C and the bitumen to its application temperature. The pre-coated chips shall be allowed to cure for at least one week or until they become non sticky and can be spread easily.
- b) Spraying the chips with a light application of creosote, diesel oil or kerosene at ambient temperature. This spraying can be done in a concrete mixer or on a belt conveying the chips from stockpile to gritting lorries.

### 510.3. Construction operations

510.3.1. Weather and seasonal limitations : As per MoRT&H clause 501.5.1 shall apply.

TABLE 500-21. GRADING REQUIREMENTS FOR CHIPS FOR SURFACE DRESSING

IS Sieve Designation mm	Cumulative per cent by weight of total aggregate passing for the following nominal sizes (mm)			
	19	13	10	6
26.5	100	-	-	-
19.0	85-100	100	-	-
13.2	0-40	85-100	100	-
9.5	0-7	0-40	85-100	100
6.3	-	0-7	0-35	85-100
4.75	-	-	0-10	-
3.35	-	-	-	0-35
2.36	0-2	0-2	0-2	0.10
0.60	-	-	-	0-2
0.075	0-1.5	0-1.5	0-1.5	0-1.5
Minimum 65% by weight of aggregate	Passing 19 mm, retained 13.2 mm	Passing 13.2 mm, retained 9.5 mm	Passing 9.5 mm, retained 6.3 mm	Passing 6.3 mm, retained 3.35mm

510.3.2. Preparation of base: The base on which the surface dressing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with As per MoRT&H clause 501 or as directed by the Engineer. Prime coat, where needed, shall be provided as per As per MoRT&H clause 502 or as directed by the Engineer. Where the existing surface shows signs of fatting up, the excess bitumen shall be removed by burning off, or manually, as specified in the Contract or directed by the Engineer. The bituminous surface to be dressed shall be thoroughly cleaned either by using a mechanical broom and / or compressed air, or any other approved equipment / method as specified in the Contract or by the Engineer. The prepared surface shall be dust free, clean and dry, (except in the case of cationic emulsion where the surface shall be damp).

510.3.3. Application of binder : The equipment and general procedures shall all be in accordance with the Manual for Construction and Supervision of Bituminous Works. The application temperature for the grade of binder used shall be as given in Table 500-22 and the rate of spray as given in 510.2.3.

510.3.4. Application of stone chips : The equipment and general procedure shall all be in accordance with the Manual for Construction and Supervision of Bituminous Works. For relatively small areas of surface dressing, careful application of chips by hand may be acceptable if approved by the Engineer. The rate of application of chips shall be as determined by the procedure given in the Manual for Construction and Supervision of

Bituminous Works. Immediately after application of the binder, clean, dry chips (in the case of emulsion binder the chippings may be damp) shall be spread uniformly on the surface so as to cover the surface completely with a single layer of chips.

TABLE 500-22. SPRAYING TEMPERATURES FOR BINDERS

Binder grades	Whirling spray jets		Slot jets	
	Min <sup>o</sup> C	Max <sup>o</sup> C	Min <sup>o</sup> C	Max <sup>o</sup> C
Penetration Grades				
400/500	160	170	140	150
280/320	165	175	150	160
180/200	170	190	155	165
80/100	180	200	165	175

510.3.5. Rolling : Rolling of the chips should preferably be carried out by a pneumatic tyred roller in accordance with As per MoRT&H clause 501.6 and As per MoRT&H clause 501.7. Traditional steel wheeled rollers tend to crush the aggregates and if their use cannot be avoided their weight should be limited to 8 tonnes. Rolling shall commence at the edges and progress towards the centre except in superelevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. While rolling is in progress additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

510.3.6. Application of second coat of surface dressing : Where surface dressing in two coats is specified, the second coat should not be applied until the first coat has been open to traffic for 2 or 3 weeks. The surface on which the second coat is laid must be clean and free of dust. The construction operations for the second coat shall be the same as described in As per MoRT&H clauses 510.3.3 to 510.3.5.

#### 510.4. Opening to Traffic

Traffic shall not be permitted to run on any newly surface dressed area until the following day. In special circumstances, however, the Engineer may allow the road to be opened to traffic immediately after rolling, but in such cases traffic speed shall be limited to 20 km per hour until the following day.

#### 510.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of As per MoRT&H clause 902.

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

#### 510.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 510.7. Measurement for Payment

Each coat of surface dressing shall be measured as finished work, for the area instructed to be covered, in square metres.

#### 510.8. Rate

The Contract unit rate for surface dressing, based on the notional rates of spread for binder and each size of chippings given in As per MoRT&H clause 510.2.3, which shall be adjusted, plus or minus, for the difference between the notional rates of spread and the rates of spread determined as described in the Manual for Construction and Supervision of Bituminous Works, and approved by the Engineer, multiplied by the rates entered in the Bill of Quantities for binder and each size of Chipping. The adjusted rate shall be payment in full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 501.8.8.2. (i) to (xi).

### 511. OPEN-GRADED PREMIX SURFACING

#### 511.1. Open-graded Premix Surfacing using Penetration Bitumen or Cutback.

511.1.1. Scope : This work shall consist of the preparation, laying and compaction of an open-graded premix surfacing material of 20 mm thickness composed of small-sized aggregate premixed with a bituminous binder on a previously prepared base, in accordance with the requirements of these Specifications, to serve as a wearing course.

#### 511.1.2. Materials

511.1.2.1. Binder : The binder shall be a penetration bitumen of a suitable grade as specified in the Contract, or as directed by the Engineer, and satisfying the requirements of IS: 73.

511.1.2.2. Aggregate: The aggregate shall conform to As per MoRT&H clause 504.2.2 except that the water absorption shall be limited to a maximum of 1 per cent. The Polished Stone Value, as measured by the test in BS 812- (Part 114), shall not be less than 55.

511.1.2.3. Proportioning of materials: The materials shall be proportioned in accordance with Table 500-23.

#### 511.1.3. Construction operations

511.1.3.1. Weather and seasonal limitations : As per MoRT&H clause 501.5.1 shall apply.

511.1.3.2. Preparation of surface : The underlying surface on which the bituminous surfacing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross-section in accordance with As per MoRT&H clause 501. A prime coat where needed shall be applied in accordance with As per MoRT&H clause 502 as directed by the Engineer.

TABLE 500-23. QUANTITIES OF MATERIALS REQUIRED FOR 10 m<sup>2</sup> OF ROAD SURFACE FOR 20mm THICK OPEN-GRADED PREMIX SURFACING USING PENETRATION BITUMEN OR CUTBACK

Aggregates	
(a) Nominal Stone size 13.2mm (passing 22.4 mm sieve and retained on 11.2 mm sieve)	0.18m <sup>3</sup>
(b) Nominal Stone size 11.2 mm (passing 13.2 mm sieve and retained on 5.6 mm sieve)	0.09m <sup>3</sup>
Total	0.27m <sup>3</sup>
Binder (quantities in terms of straight run bitumen)	
(a) For 0.18 m <sup>3</sup> of 13.2 mm nominal size stone at 52 kg bitumen per m <sup>3</sup>	9.5 kg
(b) For 0.09 m <sup>3</sup> of 11.2 mm nominal size stone at 56 kg bitumen per m <sup>3</sup>	5.1 kg
Total	14.6 kg

511.1.3.3. Tack coat: A tack coat complying with As per MoRT&H clause 503, shall be applied over the base preparatory to laying of the surfacing.

511.1.3.4. Preparation of premix : Hot mix plant of appropriate capacity and type shall be used for the preparation of the mix material. The hot mix plant shall have separate dryer arrangement for heating aggregate.

The temperature of the binder at the time of mixing shall be in the range of 150°C to 163° C and that of the aggregate in the range of 155°C to 163°C provided that the difference in temperature between the binder and aggregate at no time exceeds 14°C. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly and the discharge temperature of mix shall be between 130°C and 160°C.

The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or hand barrows. The vehicles employed for transport shall be clean and the mix being transported covered in transit if so directed by the Engineer.

511.1.3.5. Spreading and rolling : The pre mixed material shall be spread by suitable means to the desired thickness, grades and cross-fall (camber) making due allowance for any extra quantity required to fill up depressions, if any. The cross-fall should be checked by means of camber boards and irregularities levelled out. Excessive use of blades or rakes should be avoided. 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 centre longitudinally, except that on superelevated and uni-directional cambered portions, it shall progress from the lower to upper edge parallel to the centre 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 preceding 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 100° C. 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.

511.1.3.6. Seal coat : A seal coat conforming to As per MoRT&H clause 513 of the type specified in the Contract shall be applied to the surface immediately after laying the surfacing.

511.1.4. Opening to traffic : No traffic shall be allowed on the road until the seal coat has been laid. After the seal coat is laid, the road may be opened to traffic according to As per MoRT&H clause 513.4.

511.1.5. Surface finish and quality control of work : The surface finish of construction shall conform to the requirements of As per MoRT&H clause 902. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

511.1.6. Arrangements for traffic : During the period of construction, arrangement of traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

511.1.7. Measurement for payment: Open graded premix surfacing shall be measured as finished work, for the area instructed to be covered, in square metres. The area will be the net area covered, and all allowance for wastage and cutting of joints shall -be deemed to be included in the rate.

511.1.8. Rate : The contract unit rate for open-graded premix surfacing shall be payment in

full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 501.8.8.2. (i) to (xi).

#### 511.2. Open graded premix surfacing using cationic bitumen emulsion

511.2.1. Scope : This work shall consist of the preparation, laying and compaction of an open graded premix surfacing of 20 mm thickness composed of small-sized aggregate premixed with a cationic bitumen emulsion on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course.

#### 511.2.2. Materials

511.2.2.1. Binder : The binder for Premix wearing course shall be cationic bitumen emulsion of Medium Setting (MS) grade complying with I.S.8887 and having a bitumen content 65 per cent minimum by weight. For liquid seal coat RS grade of Cationic bitumen emulsion shall be used. Where expressly specified in the Contract MS grade emulsion shall be used or otherwise directed by the Engineer. Slow Setting (SS) grade Cationic bitumen Emulsion shall be used for premix seal coat.

511.2.2.2. Aggregate : The requirements of As per MoRT&H clause 511.1.2.2. shall apply.

511.2.3. Proportioning of materials: The materials shall be proportioned as quantities given in Tables 500-24 and 500-25.

TABLE 500-24. QUANTITIES OF AGGREGATE FOR 10 M<sup>2</sup> AREA

(A) Premix Carpet	
(a) Coarse aggregate nominal 13.2 mm size; passing IS 22.4 mm sieve and retained on IS 11.2 mm sieve	0.18 m <sup>3</sup>
(b) Coarse aggregate nominal 11.2 mm size; passing IS 132 mm sieve and retained on IS 5.6 mm sieve	0.09 m <sup>3</sup>
(B) For Seal Coat :	9.5 kg

Refer to As per MoRT&H clause 513

TABLE 500-25. QUANTITIES OF EMULSION BINDER

	For 10m <sup>3</sup> area
(A) For Premix Carpet :	20 to 23 kg



## (B) For Seal Coat:

(a) for liquid seal coat	12 to 14 kg
(b) for premix seal coat	10 to 12 kg

## 511.2.4. Construction operations

511.2.4.1. Weather and seasonal limitations : As per MoRT&H clause 501.5.1 shall apply except that the minimum air temperature for laying shall be 10°C. Cationic bitumen emulsions shall not normally be stored below 0°C.

511.2.4.2. Preparation of surface: The underlying surface on which the premix surfacing is to be laid shall be prepared, in accordance with the requirements of As per MoRT&H clause 504.3.2 for a newly primed surface, and in accordance with As per MoRT&H clause 507.4.2 where an existing bituminous surface is to be overlaid.

511.2.4.3. Preparation of binder : Before opening, the cationic bitumen emulsion drums shall be rolled at slow speed, to and fro, at least 5 times, for a distance of about 10 metres, to distribute any storage sedimentation.

511.2.4.4. Tack coat: A tack coat complying with As per MoRT&H clause 503, shall be applied over the surface preparatory to laying of the surfacing where specified in the Contract, or directed by the Engineer.

511.2.4.5. Preparation of premix : Premixing of cationic bitumen emulsion and aggregates can be carried out in a suitable mixer such as cold mixing plant as per IS: 5435 (Revised) or concrete mixer or by pay loaders in exceptional cases where approved by the Engineer. Where specified in the Contract continuous mixing operation shall be done either in batch or continuous hot mix plant suitable for emulsion mixes.

When using concrete mixer for preparing the premix, 0.135 cu.m. (0.09 cu.m. of 13.2 mm size and 0.045 cu.m. of 11.2 mm size) of aggregates per batch shall be used which quantity will cover 5 sq.m. of road surface with 20 mm average thickness.

The aggregates required for one batch shall be prepared adjacent to the mixer.

First the coarse aggregate of 13.2 mm size shall be placed into the mixer followed by 5 to 6.5 kg of Cationic bitumen emulsion and then the 11.2 mm size aggregate shall be added, followed by 5 to 6.5 kg of Cationic bitumen emulsion. After the materials have been mixed thoroughly, the mix shall be immediately transported to the laying site in suitable vehicles. Too much mixing shall be avoided.

When mixed manually by shovels, with the approval of the Engineer, 0.06 cu.m. of aggregates can be conveniently mixed in one heap, with appropriate quantity of emulsion. It is preferable to make the aggregates damp before mixing as it reduces the effort required for

mixing and also helps to get better coating of aggregates. The 13.2 mm size aggregates and emulsion are mixed first and then the 11.2 mm size aggregates and remaining quantity of emulsion are added and mixed. Too much mixing shall be avoided.

511.2.4.6. Spreading and rolling: The premixed cationic bitumen emulsion and aggregates shall be spread within 10 minutes of applying the tack coat. All levelling, raking, etc. should be completed within 20 minutes of the time of mixing.

The mix should be spread uniformly to the desired thickness, grades and crossfall (camber) making due allowance for any extra quantity required to fill up depressions, if any. The crossfall should be checked by ' means of camber boards and irregularities leveled out. Too much raking is to be avoided.

The rolling shall start immediately after laying the premix. A smooth ' wheeled tandem roller of 8-10 tonnes shall be used, unless other compaction methods are approved by the Engineer, based on the results of laying trials, if necessary. While rolling, wheels of roller should be clean and kept moist to prevent the premix from adhering to the wheels. In no case shall fuel / lubricating oil be used for this purpose. Use of water for this purpose shall be strictly limited to an absolute minimum.

Rolling shall commence at the edges and progress towards the centre longitudinally except in the case of superelevated and uni-directional cambered sections where rolling shall be carried out from the lower edge towards the higher edge parallel to the centre line of the road.

After one pass of roller over the whole area, depressions or uncovered spots should be corrected by adding premix material. Rolling shall be continued until the entire surface has been rolled to maximum compaction and all the roller marks eliminated. In each pass of the roller the preceding track shall be overlapped uniformly by at least 1/3 width. Roller(s) shall not stand on newly laid material. Joints both longitudinal and transverse to the road sections 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 surface coat of binder before the new mix is placed against it.

511.2.4.7. Seal coat: A seal coat, conforming to As per MoRT&H clause 510 or As per MoRT&H clause 513, as specified in the Contract, shall be applied 4 to 6 hours after laying the premix carpet.

511.2.5. Opening to traffic : Traffic should not be allowed over the premix surface with or without seal coat, for 6 to 8 hours after rolling. In case of single lane roads, traffic shall be allowed onto the surface once it has reached ambient temperature, but speed must be rigorously restricted to not more than 16 km per hour. If any premix material is picked up by vehicle tyres, the spot shall be filled up by new mix. If traffic conditions permit, the road shall not be opened until a full 24 hours after laying.

511.2.6. Surface Finish and quality control: The surface finish of construction shall conform

to the requirements of As per MoRT&H clause 902.

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

511.2.7. Arrangements for traffic : During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

511.2.8. Measurement for payment : Open graded premix carpet shall be measured as finished work, for the area specified to be covered, in square metres at the specified thickness, in cubic metres, or in tonnes weight as specified in the Contract. The area will be the net area covered, and all allowances for wastage and cutting of joints shall be deemed to be included in the rate.

511.2.9. Rate : The contract unit rate for premix carpet and seal coat shall be payment in full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 501.8.8.2. (i) to (xi).

Bitumen quantities are to be as stated in Table 500-23 for premix, 3.0 Kg per 10 sq.m. for tack coat, 13Kg per 10 sq.m. for liquid seal coat and 11 Kg per 10 sq.m. for premix seal coat. The rate will be adjusted according to actual material used.

## 512. CLOSE-GRADED PREMIX SURFACING/ MIXED SEAL SURFACING

### 512.1. Scope

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

512.1.2. Close graded premix surfacing shall be of Type A or Type B as specified in the Contract documents.

### 512.2. Materials

512.2.1. Binder : The provisions of As per MoRT&H clause 511.1.2.1 shall apply.

512.2.2. Coarse aggregates : The provisions of As per MoRT&H clause 511.1.2.2 shall apply.

512.2.3. Fine aggregates : The fine aggregates shall consist of crushed rock quarry sands, natural gravel / sand or a mixture of both. These shall be clean, hard, durable, un-coated,

mineral particles, dry and free from injurious, soft or flaky particles and organic or deleterious substances.

512.2.4. Aggregate gradation: The coarse and fine aggregates shall be so graded or combined as to conform to one or the other gradings shown in Table 500-26, as specified in the contract.

TABLE 500-26. AGGREGATE GRADATION

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

512.2.5. Proportioning of materials: The total quantity of aggregates used for Type A or B close-graded premix surfacing shall be 0.27 cubic metre per 10 square metre area. The quantity of binder used for premixing in terms of straight-run bitumen shall be 22.0 kg and 19.0 kg per 10 square metre area for Type A and Type B surfacing respectively.

#### 512.3. Construction Operations

The provisions of As per MoRT&H clause 511.1.3.1 through 511.1.3.5 shall apply.

#### 512.4. Opening to Traffic

Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. Excessive traffic speeds should not be permitted.

#### 512.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of As per MoRT&H clause 902. For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply,

#### 512.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be in accordance with the provisions of As per MoRT&H clause 112.

#### 512.7. Measurements for Payment

Close-graded premix surfacing. Type A or B shall be measured as finished work, for the area specified to be covered, in square metres at a specified thickness. The area will be the net area covered, and all allowances for wastage and cutting of joints shall be deemed to be included in the rate.

#### 512.8. Rate

The contract unit rate for close-graded premix surfacing. Type A or B shall be payment in full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 501.8.8.2. (i) to (xi).

### 513. SEAL COAT

#### 513.1. Scope

513.1.1. This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and cross fall (camber).

513.1.2. Seal coat shall be of either of the two types specified below:

A) Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chips.

B) Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

#### 513.2. Materials

513.2.1. Binder: The requirements of As per MoRT&H clauses 511.1.2. and 511.2.2.1 shall apply.

The quantity of bitumen per 10 square metres, shall be 9.8 kg for Type A, and 6.8 kg for Type B seal coat. Where bituminous emulsion is used as a binder the quantities for Type A and Type B seal coats shall be 15 Kg and 10.5 Kg respectively.

513.2.2. Stone chips for Type A seal coat : The stone chips shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They should be free of soft or disintegrated stone, organic or other deleterious matter. Stone chips shall be of 6.7mm size defined as 100 per cent passing through 11.2 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 10 square metre area. The chips shall satisfy the quality requirements in Table 500-3 except that the upper limit for water absorption value shall be 1 per cent.

513.2.3. Aggregate for Type B seal coat : The aggregate shall be sand or grit and shall

consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky / elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36mm sieve and be retained on 180-micron sieve. The quantity used for premixing shall be 0.06 cubic metres per 10 square metres area.

### 513.3. Construction Operations

513.3.1. Weather and seasonal limitations: The requirements of As per MoRT&H clause 501.5.1 shall apply.

513.3.2. Preparation of surface : The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other extraneous matter.

513.3.3. Construction of Type A seal coat: Bitumen shall be heated to 150°C-163°C and sprayed at the rate specified on the dry surface in a uniform manner with a self-propelled mechanical sprayer as described in the Manual for Construction and Supervision of Bituminous Works.

Immediately after the application of binder, stone chips, which shall be clean and dry, shall be spread uniformly at the rate specified on the surface preferably by means of a self-propelled or towed mechanical grit spreader so as to cover the surface completely. If necessary, the surface shall be brushed to ensure uniform spread of chips.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled steel roller, 8 - 10 tonne static weight vibratory roller, or other equipment approved by the Engineer after laying trials if required. Rolling shall commence at the edges and progress towards the centre except in superelevated and unidirectional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

513.3.4. Construction of Type B seal coat: A mixer of appropriate capacity and type approved by the Engineer shall be used for preparation of the mixed material. The plant shall have separate dryer arrangements for heating aggregate.

The binder shall be heated in boilers of suitable design, approved by the Engineer to the temperature appropriate to the grade of bitumen or as directed by the Engineer. The aggregates shall be dry and suitably heated to a temperature between 150°C and 165°C or as directed by the Engineer before these components are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued until the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as a sufficient length has been covered with the premixed material, the surface shall be rolled with an 8-10 tonne smooth-wheeled roller. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

#### 513.4. Opening to Traffic

In the case of Type B seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. In the case of Type A seal coat, traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases traffic speed shall be rigorously limited to 16 km per hour until the following day.

#### 513.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of As per MoRT&H clause 902.

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

#### 513.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 513.7. Measurement for Payment

Seal coat, Type A or B shall be measured as finished work, over the area specified to be covered, in square metres at the thickness specified in the Contract.

#### 513.8. Rate

The contract unit rate for seal coat Type A or B shall be payment in full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 501.8.8.2. (i) to (xi).

### 514. SUPPLY OF STONE AGGREGATES FOR PAVEMENT COURSES

#### 514.1. Scope

This Specification As per MoRT&H clause shall apply to the supply of stone aggregates only. The work shall consist only of collection, transportation and stacking the stone aggregates

and stone filler for subsequent use in pavement courses. The actual work of laying the pavement courses shall, however, be governed by the individual Specification As per MoRT&H clause for the actual work, given elsewhere in this Specification. The size and quantities of the aggregates to be supplied shall be so selected by the Engineer that the grading requirements set forth in the individual Specification As per MoRT&H clauses for the pavement courses, for which the supply is intended, are satisfied.

All the materials shall be procured from approved sources and shall conform to the physical requirements, specified in the respective Specification As per MoRT&H clauses for the individual items given elsewhere in this Specification.

#### 514.2. Sizes of Stone Aggregates

The stone aggregates shall be designated by their standard sizes in the Contract and shall conform to the requirements shown in Table 500-27.

TABLE 500-27. SIZE REQUIREMENTS FOR COARSE STONE AGGREGATES

S. No.	Nominal size of aggregate	Designation of sieve through which aggregate's shall pass	Designation of sieve on which the aggregates shall be wholly retained
(i)	75 mm	106 mm	63 mm
(ii)	63 mm	90 mm	53 mm
(iii)	45 mm	53 mm	26.5 mm
(iv)	26.5 mm	45 mm	22.4 mm
(v)	22.4 mm	26.5 mm	13.2 mm
(vi)	13.2 mm	22.4 mm	11.2 mm
(vii)	11.2 mm	13.2 mm	6.7 mm
(viii)	6.7 mm	11.2 mm	2.8 mm

#### 514.3. Stacking

##### 1. Coarse Aggregates:

Only the aggregates satisfying the Specification requirements shall be conveyed to the roadside and stacked. Each size of aggregate shall be stacked separately. Likewise, materials obtained from different quarry sources shall be stacked separately and in such a manner that there is no contamination of one source with another.

##### 2. Fine Aggregate: As stated in the individual relevant Specification As per MoRT&H clauses.

The aggregates shall be stacked entirely clear of the roadway on even clear hard ground, or



on a platform prepared in advance for the purpose by the Contractor at his own cost and in a manner that allows correct and ready measurement. If the stockpile is placed on ground where the scraping action of the loader can contaminate the material with underlying soil, then the stockpile shall be rejected by the Engineer. Materials shall not be stacked in locations liable to inundation or flooding.

The dimensions of the stockpiles and their location shall be approved by the Engineer. Where the material is improperly stacked, the Engineer shall direct complete re-stacking of the materials in an approved manner at the Contractor's cost.

Stone filler shall be supplied in a dry state in bags or other suitable containers approved by the Engineer and shall be protected from the environment, so as to prevent deterioration in quality.

#### 514.4. Quality Control of Materials

The Engineer shall exercise control over the quality of the materials so as to ascertain their conformity with the Specification requirements, by carrying out tests for the specified properties.

Testing shall be to the following frequencies and the Engineer may, at his discretion, direct these to be modified according to requirements:

Coarse and fine: One test for each specified property per 50 m<sup>3</sup> of stone aggregates.

Stone filler: One test for each specified property for every five tonnes, subject to a minimum of one test for each consignment.

Materials shall only be brought to site from a previously tested and approved source, and any materials not conforming to the requirements of the Specification shall be rejected by the Engineer and removed from the work site.

#### 514.5. Measurement for Payment

Coarse and fine aggregates supplied to the site shall be paid for in cubic metres. The actual volume of the aggregates to be paid for shall be computed after deducting the specified percentages in Table 500-28, from the volume computed by stack measurements, to allow for bulking.

Unless otherwise directed by the Engineer, measurements shall not be taken until sufficient materials for use on the road have been collected and stacked. Immediately after measurement, the stacks shall be marked by white wash or other means as directed by the Engineer.

Stone filler as delivered to the site shall be measured in tonnes.

TABLE 500-28. PER CENT REDUCTION IN VOLUME OF AGGREGATES

S. No.	Standard size of aggregates	Percentage reduction in volume computed by stack measurements to arrive at the volume to be paid for
1.	75 mm and 63 mm	12.5
2.	45 mm and 26.5 mm	10.0
3.	22.4 mm, 13.2 mm, 11.2 mm and 6.7 mm	5.0
4.	Fine aggregate	5.0

## 514.6. Rates

The contract unit rates for different sizes of coarse aggregate, fine aggregate and stone filler shall be payment in full for collecting, conveying and stacking or storing at the site including full compensation for :

- i) all royalties, fees, rents where necessary;
- ii) all leads and lifts; and
- iii) all labour, tools, equipment and incidentals to complete the work to the Specifications.
- iv) all necessary testing of material, both initial, to approve the source, and regular control testing thereafter.

521. MODIFIED BINDER<sup>1</sup>

## 521.1. Scope

Modified binders comprise a base binder, to which is added either natural rubber, crumb rubber or a polymer such as Styrene-Butadiene- Styrene (SBS), Ethylene-Vinyl-Acetate (EVA) or Low Density Polyethylene (LDPE). The purpose is to achieve a high performance binder with improved properties, particularly at extremes of temperature.

<sup>1</sup>~~This Specification As per MoRT&H clause has been introduced for the first time.~~ Difficulties in using this As per MoRT&H clause and suggestions for improvement may be forwarded to DG (RD), Ministry of Road Transport & Highways, Transport Bhavan, Parliament Street, New Delhi - 110 001. Fax No. # 3710236.

## 521.2. Materials

521.2.1. Base Binder : The base binder into which the modifier is incorporated shall conform to IS:73. The choice of grade shall be such that it is compatible with the modifier and, when

mixed shall have the properties described in As per MoRT&H clause 521.3.

521.2.2. Modifier : The modifier shall be a natural rubber, crumb rubber or any other polymer which is compatible with the base binder and which allows the properties given in As per MoRT&H clause 521.3 to be achieved. For further details, IRC: SP: 53-1999 may be referred to. The modifier, in the required quantity shall be blended at the refinery or at the site plant capable of producing modified binder.

#### 521.3. Modifier Proportions

The quantity of modifier to be added shall be determined by tests on the base binder and the modified binder and the properties desired. A reference may be made to the Manual for Construction and Supervision of Bituminous Works for indicative dosage of different types of modifiers. The properties of the modified binder shall be as given in Table 500-44, 500-45 or 500-46 according to the requirements of the Contract.

#### 521.4. Mixing

The modifier shall be blended with the base binder so that it disperses thoroughly prior to use. The type of mixing equipment used shall be suited to the modifier type. Further guidance is given in the Manual for Construction and Supervision of Bituminous Works.

#### 521.5. Quality Control of Materials

521.5.1. Binder Properties : For control of the quality of the base binder, the relevant provisions of Section 900 shall apply. Additionally, the modified binder shall be tested for all the properties listed in Table 500-44, 500-45 or 500-46 as appropriate and certificates produced prior to use.

During use, the requirements for softening point, penetration and elastic recovery shall be tested regularly. If the modified binder is produced on site then tests shall be carried out daily. If pre-blended modified binder is used tests shall be carried out weekly.

Designation	Grade and Requirements			Methods of Test
	PMB 120	PMB 70	PMB 40	
Penetration at 25°C, 0.1 mm, 100g, 5sec.	90 to 150	50 to 89	30 to 49	IS: 1203-1978
Penetration at 4°C, 0.1 mm, 200g, 60 sec., Minimum*	35	22	18	IS: 1205-1978
Softening Point, (R & B), °C, Minimum	38	48	59	IS: 1205-1978
Fraass Breaking Point, °C, Maximum	-24	-16	-12	IS: 9381-1978
Ductility at 27°C, cm, Minimum	75	50	50	IS: 1208-1978
Flash Point, COC, °C, Minimum	220	220	220	IS: 1209-1978

Elastic Recovery of Half Thread in	70 (50)**	60 (40)**	50 (30)**	ASTM D5976 – 1996
Ductilometer at 15°C, %, Minimum				
Separation, Difference in softening Point, R&B, °C, Maximum	4	4	4	ASTM D5976 – 1996
Viscosity at 150°C, Poise	1-3	2-6	4-8	IS: 1206-1978
<i>Test on Thin Film Oven Test Residue, TFOT (IS: 9382-1979)</i>				
Designation	Grade and Requirements			Method of Test
	PMB 120	PMB 70	PMB 40	
Penetration at 4°C, 0.1 mm, 200g, 60 sec., Minimum*	18	15	15	IS: 1203-1978
Loss in Weight, %, Maximum	1.0	1.0	1.0	IS: 9382-1979
Increase in Softening Point, °C, %, Maximum	7	6	5	IS: 1205-1978
Reduction in Penetration at 25°C, %, Maximum	35	35	35	IS: 1203-1978
Elastic Recovery of Half Thread in	60 (35)**	40 (30)**	35 (25)**	ASTM D5976-1996
Ductilometer at 15°C, %, Maximum				

\* Relevant to snow bound cold climate areas

\*\* Natural Rubber Modified Bitumen

521.5.2. Storage Stability : Pre-blended modified binders which are to be stored without circulation or agitation facility shall be tested for storage stability prior to use, in accordance with Appendix 1 of IRC:SP:53-1999. The mean of the differences in softening point, top to bottom, of not less than three pairs of samples shall not exceed 5°C.

Designation	Grade and Requirements			Methods of Test
	PMB 120	PMB 70	PMB 40	
Penetration at 25°C, 0.1 mm, 100g, 5sec.	90 to 150	50 to 89	30 to 49	IS: 1203-1978
Penetration at 4°C, 0.1 mm, 200g, 60 sec., Minimum*	35	22	18	IS: 1205-1978
Softening Point, (R & B), °C, Minimum	38	48	59	IS: 1205-1978
Fraass Breaking Point, °C,	-20	-15	-10	IS: 9381-1978

## Maximum

Ductility at 27°C, cm, Minimum	50	40	30	IS: 1208-1978
Flash Point, COC, °C, Minimum	220	220	220	IS: 1209-1978
Elastic Recovery of Half Thread in	60	50	40	ASTM D5976 - 1996
Ductilometer at 15°C, %, Minimum				
Separation, Difference in	3	3	3	ASTM D5976 - 1996
Point, R&B, °C, Maximum				
Viscosity at 150°C, Poise	1-2	2-4	4-8	IS: 1206-1978

*Test on Thin Film Oven Test Residue, TFOT (IS: 9382-1979)*

Designation	Grade and Requirements			Method of Test
	PMB 120	PMB 70	PMB 40	
Penetration at 4°C, 0.1 mm, 200g, 60 sec., Minimum*	18	15	12	IS: 1203-1978
Loss in Weight, %, Maximum	1.0	1.0	1.0	IS: 9382-1979
Increase in Softening Point, °C, %, Maximum	7	6	5	IS: 1205-1978
Reduction in Penetration at 25°C, %, Maximum	35	35	35	IS: 1203-1978
Elastic Recovery of Half Thread in	45	35	30	ASTM D5976-1996
Ductilometer at 15°C, %, Maximum				

\* Relevant to snow bound cold climate areas

Other pre-blended modified binders shall be stored with appropriate circulation or agitation facility, according to the manufacturer's instructions.

## 521.6. Measurement for Payment

Modified binder supplied for the Contract shall be paid for in Tonnes.

TABLE 500-46. REQUIREMENTS OF POLYMER MODIFIED BINDERS (TREATED WITH MODIFIED CRUMB RUBBER)

Designation	Grade and Requirements	Methods of Test
-------------	------------------------	-----------------

	CRMB 60	CRMB 55	CRMB 50	
Penetration at 25°C, 0.1 mm, 100g, 5sec.	50 - 70	50 - 60	40 - 60	IS: 1203-1978
Softening Point, (R & B), °C, Minimum	50	55	60	IS: 1205-1978
Elastic Recovery of Half Thread in	40	35	30	ASTM D5976 – 1996
Ductilometer at 15°C, %, Minimum				
<i>Test on Thin Film Oven Test Residue, TFOT (IS: 9382-1979)</i>				
Reduction in Penetration at 25°C, %, Maximum	60	60	60	IS: 1203-1978
Increase in Softening Point, °C, %, Maximum	5	5	5	IS: 1205-1978
Elastic Recovery of Half Thread in Ductilometer at 15°C, %, Minimum	25	20	15	ASTM D5976-1996

CRMB - Crumb Rubber Modified Bitumen

#### 521.7 Rate

The contract rate for modified binder shall be as per contract agreement.

### 522. CRACK PREVENTION COURSES<sup>1</sup>

#### 522.1. Scope

This as per MoRT&H clause covers the provision of Stress Absorbing Membrane (SAM) and Stress Absorbing Membrane Interlayer (SAMI) as measures to inhibit the propagation of cracks. A SAM is an elastomeric bitumen rubber membrane, which is laid over a cracked road surface, together with a covering of aggregate chips, in order to extend the life of the pavement before major treatment is carried out. SAM can be laid as a single coat or a double coat. A SAMI is a layer which is applied to a cracked pavement surface but which is followed (within 12 months) by the application of an overlay course. A SAMI may be a material similar to that used for a SAM. It may alternatively consist of a bitumen-impregnated geotextile.

<sup>1</sup>This Specification As per MoRT&H clause has been introduced for the first time. Difficulties in using this As per MoRT&H clause and suggestions for improvement may be forwarded to DG (RD), Ministry of Road Transport & Highways, Transport Bhavan, Parliament Street, New Delhi - 110 001. Fax No. # 3710236.

#### 522.2. Materials

522.2.1. Binder : Binder shall be a modified binder complying with the requirements of As per MoRT&H clause 523, according to the requirements of the Contract, except that paving

grade bitumen of 80-100 penetration complying with the requirements of IS:73 shall be used in the case of a bitumen impregnated geotextile.

522.2.2. Aggregate : The requirements of As per MoRT&H clause 510.2.2 apply except that the Polished Stone Value requirement does not apply in the case of a SAMI. Where required by the contract, aggregate shall be pre-coated using either of the techniques permitted by As per MoRT&H clause 510.2.5.

522.2.3. Rates of spread of binder and aggregate : The rates of spread of binder and aggregate shall be according to one of the size alternatives in Table 500-47, as required by the Contract.

522.2.4. Geotextile: The use of geotextile as prescribed for Sl. No. 7 in Table 500-47 shall conform to the requirements of As per MoRT&H clause 703.3.

### 522.3. Construction Operations

522.3.1. Weather and seasonal limitations: As per MoRT&H clause 501.5.1 shall apply.

522.3.2. Preparation of base: The base on which the SAM, SAMI or bitumen impregnated geotextile is to be laid shall be prepared, in accordance with As per MoRT&H clause 501 and as directed by the Engineer. The surface shall be thoroughly cleaned either by using a mechanical brush or any other equipment / method approved by the Engineer. Dust removed in the process shall be blown off with compressed air.

522.3.3. Application of binder: The equipment and general procedures shall all be in accordance with the Manual for Construction and Supervision of Bituminous Works. The application temperature for modified binder shall be 160-170°C. Binder for bitumen impregnated geotextile shall be applied according to As per MoRT&H clause 502.4. The surface on which the binder is to be applied shall be dry.

TABLE 500-47. QUANTITY OF MATERIALS REQUIRED FOR 10 SQ.M. OF ROAD SURFACE FOR STRESS ABSORBING MEMBRANE

Sl. No.	Type and Width of Crack	Specification of SAM to be applied	Quantity of binder Kg/10m <sup>2</sup>	Quantity of chipping
1.	Hair cracks and map cracks upto 3mm width	Single coat SAM or 2 <sup>nd</sup> coat of two coat SAM	8 - 10	0.10 m <sup>3</sup> of 5.6 mm chips
2.	Map cracks or alligator cracks 3mm to 6mm width	Single coat SAM	10 - 12	0.11 m <sup>3</sup> of 5.6 mm chips

3.	Map cracks or alligator cracks 6mm to 9mm width	Two coat SAM	12 - 14	0.12m <sup>3</sup> of 5.6mm and 11.2mm chips in 1:1 ratio
		1 <sup>st</sup> coat		
4.	Cracks above 9mm width and cracked area above 50%	2 <sup>nd</sup> coat	8 - 10	0.10 <sup>3</sup> of 5.6mm chips
		Two coat SAM		
5.	All types of cracks with crack width above 6mm	1 <sup>st</sup> coat	14 - 16	0.12m <sup>3</sup> of 11.2mm chips
		2 <sup>nd</sup> coat	8 - 10	0.10m <sup>3</sup> of 5.6mm chips
6.	All types of cracks with crack width above 6mm	Single SAM interlayer	coat as 8 - 10	0.10m <sup>3</sup> of 5.6mm chips
7.	All types of cracks with crack width above 6mm	Single SAM interlayer	coat as 10 - 12	0.10m <sup>3</sup> of 11.2mm chips
8.	Bitumen Impregnated Geotextile			

522.3.4. Application of aggregates : The equipment and general procedures shall all be in accordance with the Manual for Construction and Supervision of Bituminous Works. Immediately after application of the modified binder, clean, dry aggregate shall be spread uniformly on the surface.

522.3.5. Sweeping : The surface of SAMs and SAMIs shall be swept to ensure uniform spread of aggregate and that there are no loose chips on the surface.

522.3.6. Two coat SAM or SAMI: Where a two coat SAM or SAMI is required by the Contract, the second coat shall be applied within 90 days of the first.

522.3.7. Geotextile placement: For bitumen impregnated geotextile, the requirements of As per MoRT&H clause 703.4.5.

#### 522.4. Opening to Traffic

Traffic may be permitted over a SAM or SAMI 2 hours after rolling, but the speed shall be limited to 21) km/h, until the following day. Speed control measures are to be approved by the Engineer, prior to laying

#### 522.5. Surface Finish and Quality Control of Work

The surface finish shall conform to the requirements of As per MoRT&H clause 902.

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



#### 522.6. Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of As per MoRT&H clause 112.

#### 522.7. Measurement for Payment

Each application of SAM, SAMI or bitumen-impregnated geotextile shall be measured as finished work, for the area specified, in square metres.

#### 522.8. Rate

The contract unit rate for SAM, SAMI or bitumen impregnated geotextile shall be payment in full for carrying out the required operations including full compensation for all components listed in As per MoRT&H clause 501.8.8.2, (i) to (xi).

### **800 TRAFFIC SIGNS, MARKINGS AND OTHER ROAD APPURTENANCES**

#### **801 TRAFFIC SIGNS**

##### **801.1 Scope**

The work shall consist of the fabrication, supply and installation of ground mounted traffic signs on roads. The details of the signs shall be as shown in the drawings and in conformity with the Code of Practice for Road Signs, IRC:67-2010.

##### **801.2 Materials**

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

##### **801.2.1 Concrete**

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

##### **801.2.2 Reinforcing Steel**

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

##### **801.2.3 Bolts, Nuts, Washers**

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

##### **801.2.4 Plates and Supports**

Plates and support sections for the sign posts shall conform to IS:226 and IS:2062 or any other relevant IS Specifications.

##### **801.2.5 Substrate**

Sign panels shall be fabricated on aluminium sheet, aluminium composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium alloy conforming to IS:736-Material Designation 24345 or 1900. Aluminium Composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LOPE) between two thick skins/sheets of aluminium with overall thickness and 3 mm or 4 mm (as

specified in the Contract), and aluminium skin of thickness 0.5 mm and 0.3 mm respectively on both sides.

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

**Table 800-1 : Specifications for Aluminium Composite Material (ACM)**

S. No.	Description	Specification	
		Standard Test	Acceptable Value
<b>A</b>	<b>Mechanical Properties of ACM</b>		
1)	Peel off strength with retro reflective sheeting (Drum Peel Test)	ASTM D903	Min. 4 N/mm
2)	Tensile strength	ASTM E8	Min. 40 N/mm <sup>2</sup>
3)	0.2% Proof Stress	ASTM E8	Min. 34 N/mm <sup>2</sup>
4)	Elongation	ASTM E8	Min. 6%
5)	Flexural strength	ASTM 393	Min. 130 N/mm <sup>2</sup>
6)	Flexural modulus	ASTM 393	Min. 44.00 N/mm <sup>2</sup>
7)	Shear strength with Punch shear test	ASTM 732	Min. 30 N/mm <sup>2</sup>
<b>B</b>	<b>Properties of Aluminium Skin</b>		
1)	Tensile strength (Rm)	ASTM E8	Min. 65 N/mm <sup>2</sup>
2)	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm <sup>2</sup>
3)	Elongation	ASTM E8	A50 Min. 2%
4)	0.2% Proof Stress	ASTM E8	Min. 10 N/mm <sup>2</sup>

### 801.2.6 Plate Thickness

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

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

### 801.3 Traffic Signs having Retro-Reflective Sheeting

#### 801.3.1 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 show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for co-efficient of retro-reflection, day/night time colour luminous, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance and its having passed these tests shall be obtained from a Government Laboratory / institute, by the manufacturer of the sheeting. The retro-reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-prismatic Grade retro-reflective element material as given in As per MoRT&H clauses

801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC:67.

### 801.3.2 High Intensity Grade Sheeting

#### 801.3.4.3 Prismatic Grade Sheeting (Type XI)

A Retro-reflective sheeting typically manufactured as a cube corner. The reflective sheeting shall be retro-reflective sheeting made of micro prismatic retro-reflective material. The retro-reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM E 810) as indicated in Table 800-6.

**Table 800-6 : Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting Type A (Type XI) (Candelas Per Lux per Square Metre)**

Observation	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow/Green	Fluorescent Yellow	Fluorescent Orange
0.1° <sup>a</sup>	-4°	830	620	290	83	125	37	25	660	500	250
0.1° <sup>a</sup>	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4°	580	435	200	58	87	26	17	460	350	175
0.2°	+30°	220	165	77	22	33	10	7.0	180	130	66
0.5°	-4°	420	315	150	42	63	19	13	340	250	125
0.5°	+30°	150	110	53	15	23	7.0	5.0	120	90	45
1.0°	-4°	120	90	42	12	18	5.0	4.0	96	72	36
1.0°	+30°	45	34	16	5.0	7.0	2.0	1.0	36	27	14

- A. Minimum Coefficient of Retro reflection (RA)  $cd/fcft > (cd-lx-1 m^2)$
- B. Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original Retro-reflectance.

### 801.3.5 Adhesive

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

### 801.3.6 Fabrication

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

There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joint shall be used.- The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

### **801.3.7 Messages/Borders**

The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary/mandatory sign boards. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informatory and other sign boards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut-outs shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 percent of the values of corresponding colour in Tables 800-2 to 800-8 as applicable. Cut-out messages and borders, wherever used, shall be either made out of retro-reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

### **801.3.8 Colour for Signs**

801.3.8.1 Signs shall be provided with retro-reflective sheeting and/or overlay film screening ink. The reverse side of all signs shall be painted grey.

801.3.8.2 Except in the case of railway level crossing signs the sign posts shall be painted in 250 mm side bands, alternately black and white. The lowest band next to the ground shall be in black.

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

Table 800-7 : Colour Specified Limits (Daytime)

Colour	1		2		3		4		Daytime Luminance Factor (Y%)	
	x	y	x	y	x	y	x	y	Min.	Max.
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329	15	--
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472	24	45
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771	2.5	11
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346	2.5	11
Blue	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216	1	10
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404	12	30
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390	1	6
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	--
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	--
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	--

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

801.3.8.4 The Regulatory/Prohibitory and warning signs shall be provided with white background and red border. The legend/ symbol for these signs shall be in black colour. The Mandatory sign shall be provided with Blue background and white Symbol/letter.

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

### 801.3.9 Refurbishment

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminum backing or materials as per As per MoRT&H clause 801.2.5, 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.

### 801.3.10 Sizes of Letters

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

Table 800-8 : Acceptable Limits for Sizes of Letters

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

The thickness of the letters and their relation to the x-height, the width, the heights are indicated in Table IV (a) of the Annexure-4 of IRC:67 to facilitate the design of the informatory signs and definition plates.

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

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

#### 801.3.11 Warranty and Durability

The Contractor shall obtain from the manufacturer a ten year warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of micro-prismatic sheeting and a seven-year warranty for high intensity grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters/legends and their bonding to the retro-reflective sheeting. The Contractor/supplier shall also furnish the LOT numbers and certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty and that the contractor/supplier is the authorized converter of the particular sheeting.

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

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

## 801.4 Installation

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

**801.4.2** All components of signs (including its back side) and supports, other than the reflective portion and G.I. posts shall be thoroughly de-scaled, cleaned, primed and painted with two coats of epoxy/ fiber glass/ powder coated paint. Any part of support post below ground shall be painted with protective paint.

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

### 801.1 Hot Applied Thermoplastic Road Marking

#### 801.1.1 Thermoplastic Material

##### 801.2.1.1 General

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

#### 801.2.1.2 Requirements:

- i. 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 800-9.

Table 800-9 : Proportions of Constituents of Marking Material (Percentage by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-30	30-30
Titanium Dioxide	10.0 min.	- -
Calcium Carbonate and Inert Fillers	42.0 max.	See Note below
Yellow Pigments	- -	See Note below

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

- ii. Properties: The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262-(Part I), shall be as below:

## a) luminance:

White: Daylight luminance at 45°-65 percent min. as per AASHTO M249

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M 249

## b) Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

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

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

e) Softening point:  $102.5^{\circ}\text{C} \pm 9.5^{\circ}\text{C}$  as per ASTM D 36.

## f) Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M 249

iii. Storage life : The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.

iv. Reflectorisation: Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in As per MoRT&H clause 803.4.2.

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

1) The name, trade mark or other means of identification of manufacturer

2) Batch number

3) Date of manufacture

4) Colour (white or yellow)

5) Maximum application temperature and maximum safe heating temperature.

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 Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

### 801.1.2 Reflectorizing Glass Beads

#### 801.2.2.1 General

This Specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800-9 and Type 2 beads are those which are to be sprayed on the surface vide As per MoRT&H clause 803.6.4.



801.2.2.2 The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions. These shall conform to the requirements spelt out in As per MoRT&H clause 803.4.2.3.

801.2.2.3 Specific Requirements

- a. Gradation: The glass beads shall meet the gradation requirements for the two types as given in Table 800-10.

Table 800-10: Gradation Requirements for Glass Beads

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

- b. Roundness: The glass beads shall have a minimum of 70 percent true spheres.
- c. Refractive index: The glass beads shall have a minimum refractive index of 1.50.
- d. Free flowing properties: The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

801.2.2.4 Test Methods

The specific requirements shall be tested with the following methods:

- i. Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter dessicator which is filled within 25 mm of the top of a dessicator plate with sulphuric acid water solution (specific gravity 1.10). Cover the dessicator and let it stand for 4 hours at 20°C to 29°C. Remove sample from dessicator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be 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 I).
- iii. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of these Specifications. However, if so required, these tests may be carried out as directed by the Engineer.

### 801.1.3 Application Properties of Thermoplastic Material

801.2.3.1 The thermoplastic material shall readily get screeded /extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

801.2.3.2 The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

### 801.1.4 Preparation

- i. The material shall be melted in accordance with the manufacturer's instructions in a heater with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- ii. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

### 801.2 Reflectorised Paint

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorising glass beads for reflectorising paints where used shall conform to the requirements of Morth As per MoRT&H clause 803.4.2.

### 801.3 Application

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

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

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

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

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

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

801.3.5 The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices Band C of BS: 3262 (Part 3).

801.3.6 The markings shall be done to accuracy within the tolerances given below:

- i. Width of lines and other markings shall not deviate from the specified width by more than 5 percent.
- ii. The position of lines, letters, figures, arrows and other markings shall not deviate from the position specified by more than 20 mm
- iii. The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10 mm in 15 m.
- iv. The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

In broken lines, the length of segment and the gap between segments shall be as indicated on the drawings; if these lengths are altered by the Engineer, the ratio of the lengths of the painted sections shall remain the same.

801.3.7 Properties of Finished Road Markings

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.

- a) The stripe shall not be slippery when wet.
- b) The marking shall not lift from the pavement in freezing weather.
- c) After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures upto 60°C.
- d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil dripping from traffic.
- e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS:164

### **803 REFLECTIVE PAVEMENT MARKERS (ROAD STUDS)**

## 803.1 Scope

The work shall cover the providing and fixing of reflective pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the Contract.

## 803.2 Material

803.2.1 Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS (Hi-impact Polystyrene) or Acrylonitrile Butadiene Styrene (ABS) or any other suitable material approved by the Engineer. The markers shall support a load of 13,635 kg tested in accordance with ASTM 04280.

803.2.2 Reflective panels shall consist of 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 moulded of methyl methacrylate conforming to ASTM 0 788 or equivalent.

## 803.3 Design

The slope or retro-reflecting surface shall preferably be  $35 \pm 5^\circ$  to base and the area of each retro-reflecting surface shall not be less than 13.0 sq.cm.

## 803.4 Optical Performance

## 803.4.1 Unidirectional and Bi-directional Studs

Each reflector or combination of reflectors on each face of the stud shall have a Coefficient of Luminous Intensity (C.I.L.) not less than that given in Tables 800-13 or 800-14 as appropriate.

## 803.4.2 Omni-directional Studs

Each Omni-directional stud shall have a C.I.L. of not less than 2 mcd/l

**Table 800-13 : Minimum C.I.L. Values for Category 'A' Studs**

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L & R	0.3°	220	110	44
0° U 10° L & R	0.5°	120	60	24

**Table 800-14 : Minimum C.I.L. Values for Category 'B' Studs**

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		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:*

1. 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.

2. The stud incorporating one or more corner cube reflectors shall be included in Category 'A'. The stud incorporating one or more bi-convex reflectors shall be included in Category 'B'.

### 803.5 Tests

803.5.1 Co-efficient of luminance intensity can be measured by procedure described in ASTM E 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS:873-Part 4: 1973.

803.5.2 Under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L. at anyone position of measurement is less than the values specified in Tables 800-13 or 800-14 provided that

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

### 803.6 Fixing of Reflective Markers

#### 803.6.1 Requirements

The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic. The reflecting portions of the studs shall be free from crevices or ledges where dirt might accumulate. Marker height shall not be less than 10 mm and shall not exceed 20 mm. and its width shall not exceed 130 mm. 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. All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacturer.

#### 803.6.2 Placement

The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails shall be used to affix the marker so that they do not pose safety hazard on the roads. 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 until the surfacing has been opened to traffic for a period of not less than 14 hours. 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.

The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the of 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. 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.

#### 803.6.3 Warranty and Durability

The contractor shall submit a two year warranty for satisfactory field performance including stipulated retro-reflectance of the reflecting panel, 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 carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, 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.

### **900 QUALITY CONTROL TESTS DURING CONSTRUCTION**

Please refer to As per MoRT&H clause 900, Quality Control for Road works in “Specifications for road and bridge works”, (Fifth Revision) Ministry of Road Transport and Highways, Published by Indian Road Congress, New Delhi 2013.

#### **504.1 General**

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the As per MoRT&H clauses for the relevant items of work.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in Tables 900-3 and 900-4 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer.

Table 900-3 : Control Tests and their Minimum Frequency for Sub-Bases and Bases

S. No.	Type of Construction	Test	Frequency (min.)
1)	Granular	i) Gradation ii) Atterberg limits iii) Moisture content prior to compaction iv) Density of compacted layer v) Deleterious constituents vi) CBR	One test per 400 cu.m One test per 400 cu.m One test per 400 cu.m One test per 1000 sq.m As required As required
2)	Lime/Cement Stabilised Soil Sub-base	i) Quality of lime/ cement ii) Lime/Cement content iii) Degree of pulverization iv) CBR or Unconfined Compressive Strength test on a set of 3 specimens v) Moisture content prior to compaction vi) Density of compacted layer vii) Deleterious constituents	One test for each consignment subject to a minimum of one test per 5 tonnes Regularly, through procedural checks Periodically as considered necessary As required One set of two tests per 500 sq.m One set of two tests per 500 sq.m As required
3)	Water Bound Macadam	i) Aggregate Impact Value ii) Grading of aggregate iii) Combined Flakiness and Elongation Indices iv) Atterberg limits of binding material v) Atterberg limits of screenings	One test per 1000 cu.m of aggregate One test per 250 cu.m One test per 500 cu.m of aggregate One test per 50 cu.m of binding material One test per 100 cu.m of aggregate
4)	Wet Mix Macadam	i) Aggregate Impact Value ii) Grading of aggregate iii) Combined Flakiness and Elongation Indices iv) Atterberg limits of portion of aggregate passing 425 micron sieve v) Density of compacted layer	One test per 1000 cu.m of aggregate One test per 200 cu.m of aggregate One test per 500 cu.m of aggregate One test per 200 cu.m of aggregate One set of three tests per 1000 sq.m

Table 900-4: Control Tests for Bituminous Works and their Minimum Frequency

5)	Dense Bituminous Macadam/Bituminous Concrete	i)	Quality of binder	Number of samples per lot and tests as per IS:73 or IRC:SP:53, IS:15462
		ii)	Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iii)	Flakiness and Elongation Indices	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iv)	Soundness test (Sodium or Magnesium Sulphate test)	One test for each source and whenever there is change in the quality of aggregate
		v)	Water absorption of aggregates	One test for each source and whenever there is change in the quality of aggregate

		vi)	Sand equivalent test	One test for each source and whenever there is change in the quality of aggregate
		vii)	Plasticity Index	One test for each source and whenever there is change in the quality of aggregate
		viii)	Polished stone value	One test for each source and whenever there is change in the quality of aggregate
		ix)	Percentage of fractured face	One test per 350 cu.m of aggregate when crushed gravel is used
		x)	Mix grading	One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xi)	Stability and voids analysis of mix including theoretical maximum specific of loose mix	Three tests for stability, flow value, density and void contents for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xii)	Moisture Susceptibility of mix (AASHTO T283)	One test for each mix type whenever there is change in the quality or source of coarse or fine aggregate
		xiii)	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
		xiv)	Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xv)	Rate of spread of mix material	After every 5 <sup>th</sup> truck load
		xvi)	Density of Compacted layer	One test per 700 sq.m area



**2601. DESCRIPTION**

This work shall consist of fabrication and placing of expansion joints as indicated on the drawing and conforming to these specifications, or as directed by the Engineer.

**2602. GENERAL**

- a) The expansion joints shall be designed and duly got approved by the Engineer. It shall cater for expected movement and rotation of the structure at the joints and provide smooth riding surface. It shall also be easy for inspection, maintenance and replacement.
- b) Expansion joints shall be robust, durable, watertight and replaceable. Site fabricated expansion joints shall be prohibited. Expansion joints shall be obtained by the Engineer either directly or through the Contractor from approved manufacturers and be of proven type.
- c) For bridges with prestressed concrete superstructure with individual span length more than 20 m or built with innovative design/construction elastomeric expansion joints of slab seal or strip seal type shall be provided.
- d) For slab type of bridges of spans less than 10 metres continuous surfacing may be provided across the expansion gaps, supported on a 20 mm thick plate placed and fixed at the level of the deck slab.
- e) For bridges other than those mentioned in (c) above with spans above 10 metres, an alternative specification of sliding steel plate joint or filled joints with copper plates may also be adopted if approved by the Engineer, apart from elastomeric expansion joint of slab seal or strip seal type.
- f) Vehicular traffic shall not be allowed over expansion joints after its construction for such period as may be determined by the Engineer.
- g) Proprietary type deck joints offered by the Contractor in lieu of the type specified shall comply in all respects with the manufacturer's specifications and meet the required range of movements and rotations and be fit for the purpose of ensuring satisfactory long term performance in the bridge.

Where alternative type proprietary deck joints are proposed by the Contractor, the following information shall be provided.

- i) Name and location of the proposed manufacturer.
- ii) Dimensions and general details of the joint including material specifications, holding down bolt or anchorage details and installation procedures.
- iii) Evidence of satisfactory performance under similar environmental conditions of similar joints being produced by the manufacturer.

Any acceptance of alternative types will be at the sole discretion of the Engineer.

Such deck joints shall be installed in accordance with the manufacturer's recommendations and to the general requirements of this Specification.

No expansion joint shall be provided only for the width of the carriageway. It shall follow the profile including the kerb and the footway and fascia, if provided. The type of expansion joint for the latter may be made different from that used for the carriageway expansion joint.

### **2603. REQUIREMENTS**

2603.1. The requirement criterion will be separately applicable for the expansion joint proper and the transition zone of attachment to the deck.

2603.2. There are two types of performance requirements for the expansion joint proper viz. from the necessity of the bridge and from the road users e.g. man, animal and vehicle.

#### **2603.3. Performance Requirement with Respect to Bridges**

The expansion joint shall :

- a) Withstand the imposed load including the impact load from live load and other sources.
- b) Allow expansion and contraction movement due to temperature, creep, shrinkage, prestressing and structural deformations.
- c) Permit relative rotation in elevation and plan due to the causes as noted above,
- d) Be waterproof. Bridge deck expansion joint seals play a critical role in preventing the degradation of the structural components of the bridge system. Without effective joint seals, water passes through the bridge deck and works harmfully to corrode steel components and cause deterioration of the concrete. Rainwater gathers various corroding additives from the atmosphere and also from the carriageway.
- e) Ensure sealing. In case bridge deck joints are not sealed, apart from loss of waterproofing, grit and other forms of road debris may enter the joint. Debris, when impacted with the joint can seriously restrict the movement instead of facilitating the same. In the case of proprietary joints being accepted for adoption, the sealing shall be as specified by them,
- f) Ensure long life by being resistant to corrosion,
- g) Be easy to install,
- h) Be easy to maintain. Replace ability of expansion joint shall be one of the basic criteria for selection of type of expansion joint,
- i) Be resistant to the materials likely to collect/spill over the deck in its normal service.

#### **26.03.4. Performance Requirement with Respect to User**

The expansion joint shall

- a) Provide smooth continuity at the top of the deck for riding comfort~
- b) Be of skid resistant surface,
- c) Re- non-damaging to the rubber tyre,
- d) Make minimum noise during vehicular crossing,

- e) Ensure that animal paws and hooves should not get entangled where bridges are used by animal drawn traffic,
- f) Permit passing of bullock cart steel tyre for bridges where bullock carts ply,
- g) Look good aesthetically.

#### 2603.5. Performance Requirement for Transition Zone

It is the zone of connection of joint assembly and the adjoining deck.  
The expansion joint shall :

- a) Permit transfer of generated forces without distress, i.e., without getting uprooted. The purpose will not be served if the bonding is with the wearing coat only. Anchorage must be provided with the deck structural element,
- b) Ensure that surface in the transition zone stays undisturbed during long term service.

### **2608. TESTS AND STANDARDS OF ACCEPTANCE**

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

### **2609. MEASUREMENTS FOR PAYMENT**

The expansion joint shall be measured in running metres. For filled joints, the rate per running metre shall include the cost of sealant for the depth provided in this drawing.

### **2610. RATE**

The contract unit rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as per these specifications in the case of Bridge Contractor supplying the expansion joint. If the manufacturer supplies the expansion joint directly to the Engineer, the cost of installation, handling and fixing shall be borne by the Bridge Contractor.

### **Wearing Coat**

#### **2701. DESCRIPTION**

This work shall include wearing coat and bridge appurtenances such as railing, approach slab, drainage spouts, weep holes in conformity with details shown on the drawing and these specifications or as approved by the Engineer.

#### **2702. WEARING COAT**

##### **2702.1. Bituminous Wearing Coat**

Specifications for bituminous concrete/bitumen mastic in wearing coat shall conform to Section 500 except for the special requirements as stated hereinafter.

**2702.1.1. Principles of bituminous wearing coat shall comprise the following :**

- i) A Layer of mastic asphalt, 6 mm thick after applying a prime coat over the top of the deck before the wearing coat is laid. The prime coat and the Layer of mastic asphalt shall be laid as per As per MoRT&H clauses 503 and 515 respectively.
- ii) 50 mm thick asphaltic concrete wearing coat in two layers of 25 mm each as per As per MoRT&H clause 512.

In case of high rainfall intensity areas, the, thickness of mastic asphalt layer may be increased to 12 mm.

2702.1.2. For high traffic density, an alternative specification for wearing course comprising 40 mm bituminous concrete overlaid with 25 mm thick bitumen mastic layer can be adopted. The work shall be done in conformity with Section 500.

**2702.2. Cement, Concrete Wearing Coat**

Cement concrete wearing coat may be provided in case of isolated bridge construction or bridges located in remote areas. It shall not be laid monolithic with the deck.

The thickness of wearing coat shall be 75 mm. The minimum grade of concrete shall be M 30 with water cement ratio as 0.4.

Curing of wearing coat earlier than what is generally required may be resorted to, so as to avoid formation of shrinkage cracks in hot weather.

All carriageway and footpath surfaces shall have non-skid characteristics.

The cross slope in the deck shall be kept as 2.5 per cent for decks, level in longitudinal profile.

2702.3. For providing cross camber no variation in thickness of wearing coat shall be permitted.

**2707. TESTS AND STANDARDS OF ACCEPTANCE**

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

### **2708. MEASUREMENTS FOR Payment**

The measurement for payment for wearing coat, railings and approach slab shall be made as given below :

- i) Cement concrete wearing coat shall be measured in cubic metres. Asphaltic concrete wearing coat shall be measured in square metres.
- ii) Railings shall be measured in running metres.
- iii) Approach slab and its base shall be measured separately in cubic metres.
- iv) Drainage spouts shall be measured in numbers.
- v) Weep holes in concrete brick masonry structure shall be measured in numbers. For structures in stone masonry, weep holes shall be deemed to be included in the item of stone masonry work and shall not be measured separately.

### **2709. RATE**

The contract unit rate for wearing coat shall include the cost of all labour, material, tools and plant and other cost necessary for completion of the work as per these Specifications.

The contract unit rate of railings shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications.

The contract unit rate for approach slab shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications. The rate for base shall include cost of all labour, material, tools and plant required, including preparation of surface and consolidation complete in all respects.

The contract unit rate for each drainage spout shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications. It shall also include the cost of providing flow drainpipes with all fixtures upto the point of ground drains wherever shown on the drawings.

The contract unit rate for weep hole shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications.

### **Pipe Culverts**

#### **2901. SCOPE**

This work shall consist of furnishing and installing reinforced cement concrete pipes, of the type, diameter and length required at the locations shown on the drawings or as ordered by the Engineer and in accordance with the requirements of these Specifications.

**2902. MATERIALS.**

All materials used in the construction of pipe culverts shall conform to the requirements of Section 1000.

Each consignment of cement concrete pipes shall be inspected, tested, if necessary, and approved by the Engineer either at the place of manufacture or at the site before their incorporation in the works.

**2903. EXCAVATION FOR PIPE**

The foundation bed for pipe culverts shall be excavated true to the lines and grades shown on the drawings or as directed by the Engineer. The pipes shall be placed in shallow excavation of the natural ground or in open trenches cut in existing embankments, taken down to levels as shown on the drawings. In case of high embankments where the height of fill is more than three times the external diameter of the pipe, the embankment shall first be built to an elevation above the top of the pipe equal to the external diameter of the pipe, and to width on each side of the pipe of not less than five times the diameter of pipe, after which a trench shall be excavated and the pipe shall be laid.

Where trenching is involved, its width on either side of the pipe shall be a minimum of 150 mm or one fourth of the diameter of the pipe whichever is more and shall not be more than one third the diameter of the pipe. The sides of the trench shall be as nearly vertical as possible.

The pipe shall be placed where the ground for the foundation is reasonably firm. Installation of pipes under existing bridges or culverts shall be avoided as far as possible. When during excavation the material encountered is soft, spongy or other unstable soil, and unless other special construction methods are called for on the drawings or in special provisions, such unsuitable material shall be removed to such depth, width and length as directed by the Engineer. The excavation shall then be backfilled with approved granular material, which shall be properly shaped, and thoroughly compacted upto the specified level.

Where bed rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in this area be removed and the space filled with approved earth, free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Trenches shall be kept free from water until the pipes are installed and the joints have hardened.

**2904. BEDDING FOR PIPE**

The bedding surface shall provide a firm foundation of uniform density throughout the length of the culvert, shall conform to the specified levels and grade, and shall be of one of the following two types as specified on the drawings:

- i) First Class bedding: Under first class bedding, the pipe shall be evenly bedded on a continuous layer of well compacted approved granular material, shaped concentrically to fit the lower part of the pipe exterior for at least ten per cent of its overall height or as otherwise shown on the drawings. The bedding material shall be well-graded sand or another granular material passing 5.6 mm sieve suitably compacted/rammed. Me compacted thickness

of the bedding layer shall be as shown on the drawings and in no case shall it be less than 75 mm.

- ii) Concrete cradle bedding: When indicated on the drawings or directed by the Engineer, the pipe shall be bedded in a cradle constructed of concrete having a mix not leaner than M 15 conforming to Section 1700. The shape and dimensions of the cradle shall be as indicated on the drawings. The pipes shall be laid on the concrete bedding before the concrete has set.

### **2905. LAYING OF PIPE**

No pipe shall be laid in position until the foundation has been approved by the Engineer. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

The arrangement for lifting, loading and unloading concrete pipes from factory/yard and at site shall be such that the pipes do not suffer any undue structural strain, any damage due to fall or impact. The arrangement may be got approved by the Engineer.

Similarly, the arrangement for lowering the pipe in the bed shall be got approved by the Engineer. It may be with tripod pulley arrangement or simply by manual labour in a manner that the pipe is placed in the proper position without damage.

The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. In case of use of pipes with bell mouth, the belled end shall face upstream. The pipes shall be fitted and matched so that when laid inwork, they form a culvert with a smooth uniform invert.

Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

### **2906. JOINTING**

The pipes shall be jointed either by collar joint or by flush joint. In the former case, the collars shall be of RCC 150 to 200 mm wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm according to the diameter of the pipe. Caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking, the collar shall be so placed that its centre coincides with the joint and an even annular space is left between the collar and the pipe.

Flush joint may be internal flush joint or external flush joint. In either case, the ends of the pipes shall be specially shaped to form a self-centering joint with jointing space 13 mm wide. The jointing space shall be filled with cement mortar; 1 cement to 2 sand, mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed.

For jointing pipe lines under light hydraulic pressure, the recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.

### **2907. BACKFILLING**

Trenches shall be backfilled immediately after the pipes have been laid and the jointing material has hardened. The backfill soil shall be clean, free from boulders, large roots, excessive amounts of sods or other vegetable matter, and lumps and shall be approved by the Engineer. Backfilling upto 300 mm above the top of the pipe shall be carefully done and the soil thoroughly rammed, tamped or vibrated in layers not exceeding 150 mm, particular care being taken to thoroughly consolidate the materials under the haunches of the pipe. Approved pneumatic or light mechanical tamping equipment can be used.

The Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of high embankment, after filling the trench upto the top of the pipe in the above said manner, a loose fill of a depth equal to external diameter of the pipe shall be placed over the pipe before further layers are added and compacted.

### **2908. HEADWALLS AND OTHER ANCILLARY WORKS**

Headwalls, wing walls, aprons and other ancillary works shall be constructed in accordance with the details shown on the drawings or as directed by the Engineer. Masonry for the walls shall conform, to Section 1300, 1400 or 1700 as applicable. Aprons shall conform to Section 2500.

### **2909. OPENING TO TRAFFIC**

No traffic shall be permitted to cross the pipe line unless height of filling above the top of the pipe line is atleast 600 mm.

### **2910. MEASUREMENTS FOR PAYMENT**

R.C.C. pipe culverts shall be measured along their centre between the inlet and outlet ends in linear metres.

Selected granular material and cement concrete for pipe bedding shall be measured as laid in cubic metres. Ancillary works like headwalls, etc., shall be measured as provided for under the respective Sections.

### **2911. RATE**

The Contract unit rate for the pipes shall include the cost of pipes including loading, unloading, hauling, handling, storing, laying in position and jointing complete and all incidental costs to complete the work as per these Specifications.

Ancillary works such as excavation including backfilling, concrete and masonry shall be paid for separately, as provided under the respective As per MoRT&H clauses.



## CONTROL AND ROAD SAFETY

The Contractor shall comply strictly with the specifications given in the code of practice for traffic control at work zone which sets out the requirements, standards and procedures and provides guidance to implement traffic control plan necessary for carrying out work activities on the road so as to protect the public, equipment and workmen.

The Contractor shall submit detailed construction sequence and detailed traffic diversion schemes including scaled cross-sectional drawings and layout plans to the Employer for Tender evaluation. All construction sequences proposed by the Contractor shall have primary considerations for the safety of road users. Protective measures shall be presented to the Employer for evaluation and approval before award of Tender.

The Contractor shall note the traffic conditions at the Site and his proposed traffic diversion schemes shall be based on his investigation and appreciation of the Site for the completion of the whole of the Works.

The Contractor shall note that the construction methods and schedule of his Works proposed shall not cause any disruption to traffic flow.

All accesses to premises affected shall be maintained at all times. Unless authorised in writing by the Engineer, the Contractor shall not be allowed to close off any traffic lane along any existing roads.

He shall not be allowed to place, or cause obstruction near or on the carriageway in a manner which would cause a reduction in the traffic capacity of the road.

Closure of any traffic lane or any carriageway required shall be implemented in accordance with the approved traffic diversion scheme for all affected traffic movements.

All temporary traffic diversion schemes proposed for the Works shall be provided with a one-to-one replacement of all affected traffic lanes, footpath, pedestrian crossing, bus-stop and other road related facilities. Alternative pedestrian crossing facilities shall be provided prior to the dismantling of existing facilities.

The Contractor shall adhere to the minimum provisions of work zone safety as per IRC SP55. The Contractor's qualified engineer shall submit all detailed temporary traffic diversion schemes for the Works to the Engineer and relevant authorities including the Traffic Police, and etc. for approval.

These proposed traffic diversion schemes shall be submitted in properly scaled engineering drawings and shall be supported with traffic analysis report. Such drawings shall include traffic layout plans showing all traffic signs, lane-markings, advance warning and directional signs etc., longitudinal section drawings and all other drawings necessary for the implementation of the schemes.

The Contractor shall comply with the requirements of all relevant authorities in his implementation of the temporary traffic diversion scheme.

The temporary diversion road pavement shall be Asphalted or equivalent. The Contractor shall also liaise, co-ordinate with and assist the Employer in scheming and designing the provision of adequate street lighting along the diversion route.

Foundations for lamp-posts and all ancillary works shall be provided by the Contractor.

For traffic diversion schemes which are to be implemented for a period of more than 3 months, all lane-markings shall be done in thermoplastic material. Lane-markings for each stage of the traffic diversion shall be maintained and, if necessary, replaced and repainted in good condition at all times to the satisfaction of the Engineer.

All existing lane markings affected by the temporary diversion of traffic are to be properly grinded off. Diverted lane/arrow markings must be properly painted and must not be confused with the existing markings.

The Contractor shall note that all vehicular impact guardrails or kerbs removed during the construction stage shall be replaced with water filled safety barriers complete with safety reflective discs.