

## 401. GRANULAR SUB-BASE

### 401. 1. Scope

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

### 401.2. Materials

**401.2.1.** The material to be used for the work shall be natural sand, moorum, gravel, crushedstone, or combination thereof depending upon the grading required.. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 400-1.

While the gradings in Table 400-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 400-2. The grading to be adopted for a project shall be as specified in the Contract.

**401.2.2. Physical requirements:** The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS :812 (Part III) . The water absorption value of the coarse aggregate shall be determined as per IS : 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS : 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which be taken as being the density relating to a uniform air voids content of 5 percent.

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

IS Sieve	Per cent by weight passing the IS sieve		
	Grading I	Grading II	Grading III
Designation			
75.0 Mm	100	-	-
53.0 Mm	80-100	100	-
26.5 Mm	55-90	70-100	100
9.50 Mm	35-65	50-80	65-95
4.75 Mm	25-55	40-65	50-80
2.36 Mm	20-40	30-50	40-65
0.425 mm	10-25	15-25	20-35
0.075 mm	3-10	3-10	3-10
CBR Value (Minimum)	30	25	20

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

IS Sieve	Per cent by weight passing the IS Sieve		
	Grading I	Grading II	Grading III
Designation			
75.0 Mm	100	-	-
53.0 Mm		100	
26.5 Mm	55-75	50-80	100
9.50 Mm			

4.75 Mm	10-30	15-35	25-45
2.36 Mm			
0.425 mm			
0.075 mm	<10	<10	<10
CBR Value (Minimum)	30	25	20

**Note :** The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

#### 401.3. Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the “quality” of materials, as may be necessary.

#### 401.4. Construction Operations

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

**401.4.2. Spreading and compacting:** The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

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

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

Moisture content of the loose material shall be checked in accordance with IS : 2720 (Part 2) and suitably 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 like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot-drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MN/m<sup>2</sup> or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super elevation and shall commence at the edges and progress towards the centre for portions having crossfall on both sides.

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

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS : 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks

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

**401.5. Surface Finish and Quality Control of Work**

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

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

**401.6. Arrangements for Traffic**

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

**401.7. Measurements for**

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

**401.8 . Rate**

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

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

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

**406.1. Scope**

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

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

**406.2. Materials**

**406.2.1. Aggregates**

**406.2.1.1. Physical requirements:** Coarse aggregates shall be crushed stone. The aggregates shall conform to the physical requirements set forth in Table 400-10 below. Sevaliya special aggregate is only acceptable.

**TABLE 400-10. PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB-BASE/BASE COURSES**

Test	Test Method	Requirements
1. * Los Angeles abrasion value Or	IS : 2386 (Part-4)	40 per cent (Max.)

* Aggregate Impact value	IS : 2386 (Part-4) or IS : 5640	30 per cent (Max.)
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 adsorption 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 400-11.

**TABLE 400-11. GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM**

IS Sieve Designation	Per cent by weight passing the IS sieve
53.00 Mm	100
45.00 Mm	95-100
26.50 Mm	-
22.40 Mm	60-80
11.20 Mm	40-60
4.75 Mm	25-40
2.36 Mm	15-30
600.00 Micron	8-22
75.00 Micron	0-8

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6

The final gradation approved within these limits shall and shall not vary from the low limit on one sieve to or vice versa.

be well graded from coarse to fine the high limit on the adjacent sieve

### 406.3. Construction Operations

**406.3.1. Preparation of base:** Clause 404.3.1. shall apply.

**406.3.2. Provision of lateral confinement of aggregates:** While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 407.4.1.

**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. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS : 2720 (Part-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. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

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

(i) Loading hoppers and suitable distribution mechanism

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

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

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

**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/superelevation, 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 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. 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**

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

#### **406.5. Surface Finish and Quality Control of Work**

**406.5.1. Surface evenness:** The surface finish of construction shall conform to the requirements of Clause 902.

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

#### **406.6. Rectification of Surface Irregularity**

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

#### **406.7. Arrangement for Traffic**

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

#### **406.8. Measurements for Payment**

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

#### **406.9. Rates**

The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8.

### **408. CEMENT CONCRETE KERB AND KERB WITH CHANNEL**

#### **408.1. Scope**

This work shall consist of constructing cement concrete kerbs and kerbs with channel in the central median and/or along the footpaths or separators in conformity with the lines, levels and dimensions as specified in the drawings.

#### **408.2. Materials**

Kerbs and kerb with channel shall be provided in cement concrete of Grade M20 in accordance with Section 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, precast 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 producing a well-compacted mass of concrete free of voids and honeycombs, shall be used.

#### **408.5. Construction Operations**

**408.5.1.** Kerb shall be laid on firm foundation of minimum 150 mm thickness of cement concrete of M10 grade cast-in-situ or on extended width of pavement. The foundation shall have a projection 50 mm 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 carriage is towards median (as in case of superelevated 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 5 m intervals or as specified by the Engineer.

**408.5.4.** Kerbs on the drainage ends such as along the footpath or the median in superelevated 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 tolerances with respect to true line and level shall be  $\pm 6$  mm.

#### **408.6. Measurements for Payment**

Cement concrete kerb/kerb with channel shall be measured in linear metre for the complete item of work.

Foundation of kerb, where separately provided shall be measured in linear metre for complete item of work.

#### **408.7. Rates**

The Contract unit rates for cement concrete kerb/kerb with channel and foundation for kerb shall be payment in full compensation for furnishing all materials, labour, tools, equipment for construction and other incidental cost necessary to complete the work.

### **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 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 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 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 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 2.36 mm 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<sup>0</sup>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<sup>0</sup>C or when the wind speed at any temperature exceeds 40 km/h at 2 m 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 highpressure 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, leveled 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 leveled 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 300 mm 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<sup>0</sup>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 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 materials 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 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 center longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the center 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 300 mm.

In portions with super elevated and unidirectional 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 Primer 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 Clause 404: Water Bound Macadam or 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 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 Clause 502.

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 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 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 Clauses 501.8.3.1 and 501.8.3.2, the profile corrective course shall be laid using material as described in 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 Clause 501.8.3.3, and after applying a tack coat conforming to 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

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

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

**501.8.5. Environmental protection:** The provisions of Clause 111 and the provision of *Annexure A to Clause 501* shall apply.

#### **501.8.6. 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 3 mm 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 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 Clause 516.9.

The contract unit rate for crack sealing 3 mm to 6 mm 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 6 mm to 15 mm 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 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 utilize 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 Specifications.

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 this 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.

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**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) Surface of medium porosity; such as cement stabilized soil base,
- (iii) Surface 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 <sup>0</sup> C (Centistokes)	Quantity of Liquid Bituminous Material per 10 sq.m. (kg)
Low porosity	30 - 60	6 to 9
Medium porosity	70 - 140	9 to 12
High porosity	250 - 500	12 to 15

**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<sup>0</sup>C. Surfaces which are 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 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 Clauses 703.3.2 and 703.4 shall apply. The bituminous primer shall be sprayed uniformly in accordance with Clause 501. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified. **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.

**502.4.4. Tack coat:** Over the primed surface, a tack coat should be applied in accordance with Clause 503.

### **502.5. Quality Control of Work**

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

### **502.6. Arrangements for Traffic**

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

### **502.7. Measurement for Payment**

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

### **502.8. Rate**

The contract unit rate for prime coat with adjustments as described in Clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in 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 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 a 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<sup>0</sup>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 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 requirements of 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 rates 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 temperature for a bituminous emulsion shall be 20<sup>0</sup>C to 70<sup>0</sup>C and for a cutback, 50<sup>0</sup>C to 80<sup>0</sup>C if RC-70/MC-70 is used. Where a geosynthetic is proposed for use, the provisions of 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.

**TABLE 500-2. RATE OF APPLICATION OF TACK COAT**

Type 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	
a) Granular base (not primed)	0.35 to 0.40
b) Cement concrete pavement	0.30 to 0.35

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 provision of Clause 112.

**503.7. Measurement for Payment**

Tack coat shall be measured in terms of surface area of 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 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.

**507. DENSE GRADED BITUMINOUS MACADAM**

**507.1.. Scope**

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

**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 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 consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 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.

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

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

**TABLE 500-8. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE**

**FOR DENSE GRADED BITUMINOUS MACADAM**

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

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 T 283\*\*

\* 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 rockdust, 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 coat.

**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 quality 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	40 mm	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 <sup>0</sup> 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 (VFB)	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		
	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 therequirements 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 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 shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

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

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

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

**507.4. Construction Operations**

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

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

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

507.4.5. **Stress absorbing layer:** Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 522.

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

507.4.7. **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 Clause 503, or as directed by the Engineer.

507.4.8. **Mixing and transportation of the mixture:** The provisions as specified in Clauses 501.3 and 501.4 shall apply.

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

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

#### **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 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 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 Clause 501.8.8.2 (i) to (xi). The rate shall include the provision of bitumen, 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.

### **BITUMINOUS CONCRETE**

## 509.1. Scope

This 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. A single layer shall be 25mm to 100 mm 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 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 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 Clause 507.2.3.

**509.2.4. Filler:** Filler shall be generally as specified in 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 sieving 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 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 22.4 mm sieve, where approved by the Engineer.

**509.3.3. Job mix formula:** The procedure for formulating the job mix formula shall be generally as specified in Clause 507.3.3 and the results of tests enumerated in Table 500-19 as obtained by the Contractors.

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

Property	Test	Specification
Cleanliness (dust)	Grain size analysis <sup>1</sup>	Max 5 % passing 0.075 mm sieve
Particle shape	Flakiness and Elongation	Max 30 %
	Index	(Combined) <sup>2</sup>
Strength *	Loss 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 Aggregate Mixtures <sup>9</sup>	Minimum retained coating 95 %
Water Sensitivity**	Retained Tensile Strength <sup>8</sup>	Min 80 %





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 <sup>0</sup> 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
Per cent voids filled with bitumen (VFB)	65 – 75
Loss of stability on immersion in water at 60 <sup>0</sup> C (ASTM D 1075)	Min. 75 per cent retained strength

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

**509.4.3. Stress absorbing layer:** Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 522.

**509.4.4. Tack coat:** Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the provisions of Clause 503.

**509.4.5. Mixing and transportation of the mixture:** The provisions as specified in Clauses 501.3 and 501.4 shall apply.

**509.4.6. Spreading:** The general provisions of Clauses 501.5.3 and 501.5.4 shall

apply.

**509.4.7. Rolling:** The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trails.

**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 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 Clause 112.

**509.8. Measurement for Payment**

The measurement shall be all as specified in Clause 507.8.

**509.9. Rate**

The contract unit rate shall be all as specified in Clause 507.9, except that the rate shall include the provision of bitumen at 5.0 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.