

Name of work :-**Repairing of some stretches on Ghaduli-Fulra-Pandhro Road km 10/00 to 20/00, Ta. Lakhapat, Dist. Kachchh**

Item No. 4:- Construction of Granular sub base of 150 mm thick in by providing GSB Gr - I coarse graded material using B.T Metal 26.5mm to 53 mm @ 35 % ,26.5mm to 4.75mm 45% & Below 2.36mm 20 % in uniform layer with motor grader on prepared surface mixing by mix in place method with vibratory roller to achieve the desired density complete as per close 401..

401 GRANULAR SUB-BASE**Scope**

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

Materials

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

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

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

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

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

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

Construction Operations

Preparation of Sub-grade

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

Spreading and Compacting

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

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

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

Surface Finish and Quality Control of Work

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

Arrangements for Traffic

During the period of construction, arrangements for the traffic shall be provided and maintained in accordance with Clause 112.

Measurements for Payment

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

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

Rate

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

- i) making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- ii) supplying all materials to be incorporated in the work including all

royalties, fees, rents where applicable with 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
- v) carrying out the required tests for quality control.

Item No. 5:- roviding, laying, spreading and compacting 150 mm thick stone aggregates of specific sizes Grade - I (45 mm to 90 mm) to water bound macadam specification including spreading in uniform thickness, hand packing , rolling with vibratory roller 80-100 kN static wt. to proper grade and camber, applying and brooming, stone screening/binding materials to fill-up the interstices of coarse aggregate, watering and compacting etc. complete as per Specification.

404 WATER BOUND MACADAM SUB-BASE/BASE

Scope

This work shall consist of clean crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary and water laid on a properly prepared 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.

Materials

404.2.1 Coarse Aggregates

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

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

S.No.	Test	Test Method	Requirements
1) ***	Los Angeles Abrasion value	IS: 2386(Part 4)	40 percent (Max)
	or Aggregate Impact value	IS: 2386 (Part-4) or IS:5640*	30 percent (Max)
2)	Combined Flakiness and Elongation Indices (Total) **	18:2386 (Part-1)	35 percent (Max)

- * Aggregates which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with 15:5640.
- ** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.
- *** In case water bound macadam is used for sub-base, the requirements in respect of Los Angeles Value and Aggregate Impact Value shall be relaxed to 50 percent and 40 percent maximum respectively.

Crushed or Broken Stone

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

Crushed Slag

Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than kN per m³ and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements:

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

Overburnt (Jhama) Brick Aggregates

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

Grading Requirement of Coarse Aggregates

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

Screenings

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

Table 400-9 : Grading Requirements of Coarse Aggregates

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

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

Screenings shall conform to the grading set forth in Table 400-10. The quantity of screenings required for various grades of stone aggregates are given in Table 400-11. The Table also

gives the quantities of materials (loose) required for 10 m² for sub-base/base compacted thickness of 75 mm.

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

Binding Material

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

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

Table 400-10: Grading For Screenings

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

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

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

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

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

Construction Operations

Preparation of Base

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

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

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

course where water bound macadam is proposed to be laid over it.

Inverted Choke/Sub-surface Drainage Layer

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

Lateral Confinement of Aggregates

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

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

Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base in the required quantities from the stockpiles to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 75 mm. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards.

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

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

to ensure a finished surface as per approved drawings.

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

Rolling

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

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

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

However, where screenings are not to be applied as in the case of aggregates like brick metal, laterite and Kankar for sub-base construction, the compaction shall be continued until the aggregates are thoroughly keyed. Rolling shall be continued and light sprinkling of water shall be done till the surface is well compacted.. Rolling shall not be done when the Sub-Bases, Bases (Non-Bituminous) and Shoulders Section 400

grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

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

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

Application of Screenings

After the coarse aggregates have been rolled to Clause 404.3.5, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be equipped with pneumatic tyres and operated so as not to disturb the coarse aggregates.

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

Sprinkling of Water and Grouting

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

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

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

Setting and Drying

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

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

Surface Finish and Quality Control of Work

404.4.1 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.

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

Reconstruction of Defective Macadam

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

Arrangements for Traffic

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

Measurements for Payment

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

Rate

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

- Item No. 6** **Providing and laying, spreading and compacting 150mm thick graded stone aggregate to Wet Mix Macadam specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed material by tipper tip site, laying in uniform layers with mechanical means in sub-base /base course on well prepared surface and compacting with vibratory roller to achieve the desired density.**

406 WET MIX MACADAM SUB-BASE/BASE

Scope

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

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

Materials

Aggregates

406.2.1.1 Physical Requirements

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

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

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

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

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

406.2.1.2 Grading Requirements

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

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

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

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

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

Construction Operations

Preparation of Base

Clause 404.3.1 shall apply.

Provision of Lateral Confinement of Aggregates

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

Preparation of Mix

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

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

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

Spreading of Mix

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

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

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

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

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

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

Compaction

After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100kN 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 with an arrangement

for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h.

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

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

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

Along forms, 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 sub-grade is soft or yielding or when it causes a wave like motion in the sub-base/base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case shall the use of unmixed material be permitted to make up the depressions.

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

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

Setting and Drying

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

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.

Surface Finish and Quality Control of Work**Surface Evenness**

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

Quality Control

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

Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, re-shaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompact 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.

Arrangement for Traffic

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

Measurements for Payment

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

Rate

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

Item No. 9 **Providing & applying evenly priming coat with bitumen Emulsion (SS-1) on prepared surface of granular base including cleaning of road surface and spraying primer at the rate of 7.50 Kg. / 10 Smt using using mechanical means.**

502 PRIME COAT OVER GRANULAR BASE

502.1 Scope

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

Materials

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

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

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

Type of Surface	Rate of Spray (kg/sq.m)
WMM/WBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9-1.2

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

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

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

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

Weather and Seasonal Limitations

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 1DOC. Cutback bitumen as primer shall not be applied to a wet surface. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water.

502.4 Construction

502.4.1 Equipment

The primer shall be applied by a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

Preparation of Road Surface

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

Application of Bituminous Primer

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

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

Curing of Primer and Opening to Traffic

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light 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.

Quality Control of Work

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

Arrangements for Traffic

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

Measurement for Payment

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

Rate

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

Item No. 10:- Providing & Laying Bituminous Grouting 37.50mm Thick Compacted with asphalt VG-30 grade at the rate of 1.99% by wt of total mixing & tack coat @ 2.5Kg/10sqmt on B.T Surface & using B.T chips of required gradation including cleaning & heating the aggregate & asphalt by continuous batching of drum mix plant and spreading the same by paver finisher and consolidation with vibrator roller and power roller including providing all materials equipment tools and plants, oil kerosine, fire wood, labor charges etc. using contractor own drum mixplant and paver finisher etc, Complete in all respects.

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: 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 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

596.3. Construction Operations

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

506.3.2. Equipment: The provisions of 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 Clauses 501 and 902 as appropriate. A prime coat shall be applied in accordance with 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 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 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 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 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 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 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 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 Clause 501.8.8.2. (i) to (xi).

Item No. 10 Providing & Laying Bituminous Grouting 37.50mm Thick Compacted with asphalt VG-30 grade at the rate of 1.99% by wt of total mixing & tack coat @ 2.5Kg/10sqmt on B.T Surface & using B.T chips of required gradation including cleaning & heating the aggregate & asphalt by continuous batching of drum mix plant and spreading the same by paver finisher and consolidation with vibrator roller and power roller including providing all materials equipment tools and plants, oil kerosine, fire wood, labor charges etc. using contractor own drum mixplant and paver finisher etc, Complete in all respects.

Item No. 11 Providing and laying 50 mm thick compacted bitumenous macadam (BM) with Emulsion tack coat @ 2.50 Kg./ 10 Sqmt using crushed stone aggregate as per MORTH gradation VG-30 grade bitumen at the rate of 3.40% by weight of total mix (i.e. 34kg/mt by wt. of total mix) for binding including heating and mixing the asphalt and aggregates by continuous Drum mix plant and transporting the mix and spreading the same by paver finisher and consolidation with vibratory road roller including using all necessary equipments, tools, plants, including cost of all materials, firewood, oil, lubricants, labour charges etc. complete.

503 TACK COAT

Scope

The work shall consist of the application of a single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or as instructed by the Engineer. The work shall be carried out on a previously prepared surface in accordance with Clause 501.8.

Materials

The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with 15:8887 or suitable low viscosity paving bitumen of VG 10 grade conforming to 15:73. The use of cutback bitumen RC:70 as per 15:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the

Engineer. The type and grade of binder for tack coat shall be as specified in the Contract or as directed by the Engineer.

Weather and Seasonal Limitations

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

Construction

Equipment

The tack coat shall be applied by a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

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 Clause 501.8. The granular or stabilized surfaces shall be primed as per Clause 502. 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.

Application of Tack Coat

The application of tack coat shall be at the rate specified in Table 500-5, and it shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract, then it shall be the rate specified in Table 500-5. No dilution or heating at site of RS1 bitumen emulsion shall be permitted. Paving bitumen if used for tack coat shall be heated to appropriate temperature in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for cutback, 50°C to 80°C. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed or 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 500-5 : Rate of Application of Tack Coat

Type of Surface	Rate of Spray of Binder in Kg per sq. m
Bituminous surfaces	0.20-0.30
Granular surfaces treated with primer	0.25-0.30
Cement concrete pavement	0.30-0.35

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.

Quality Control of Work

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

Arrangements for Traffic

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

Measurement for Payment

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

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 or at the rate specified in the Contract, with the provision that the variation between this quantity and actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

- Item No. 11** **Providing and laying 50 mm thick compacted bituminous macadam (BM) with Emulsion tack coat @ 2.50 Kg./ 10 Sqmt using crushed stone aggregate as per MORTH gradation VG-30 grade bitumen at the rate of 3.40% by weight of total mix (i.e. 34kg/mt by wt. of total mix) for binding including heating and mixing the asphalt and aggregates by continuous Drum mix plant and transporting the mix and spreading the same by paver finisher and consolidation with vibratory road roller including using all necessary equipments, tools, plants, including cost of all materials, firewood, oil, lubricants, labour charges etc. complete.**

504 BITUMINOUS MACADAM

Scope

This work shall consist of construction in a single course having 50 mm to 100 mm 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. Since the bituminous macadam is an open-graded mix, there is a potential that it may trap water or moisture vapour within the pavement system. Therefore, adjacent layer (shoulders) should have proper drainage quality to prevent moisture-induced damage to the BM.

Materials

504.2.1 Bitumen

The bitumen shall be viscosity graded paving bitumen complying with Indian Standard Specification for paving bitumen, IS:73 or as specified in the Contract. The type and grade of bitumen to be used would depend upon the climatic conditions and the traffic. Guidelines for selection of bitumen are given in Table 500-1.

504.2.2 Coarse Aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. It shall be clean, hard, durable and cubical shape, free from dust and soft organic and other deleterious substances. The aggregate shall satisfy the physical requirements specified in Table 500-6. Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces resulting from crushing operation. Before approval of the source, the aggregates shall be tested for stripping. Where the Contractor's selected source of aggregates have poor affinity for bitumen, as a condition for the approval

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of that source, the bitumen shall be treated with approved anti-stripping agents, as per the
manufacturer's recommendations, without additional payment.

504.2.3 Fine Aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a

combination of two, passing 2.36 mm sieve and retained on 75 micron sieve. It shall be clean,
hard, durable, free from dust and soft organic and other deleterious substances. Natural sand
shall not be used in the binder course.

Table 500-6 : Physical Properties of Coarse Aggregate

Property	Test	Requirement	Test method
Cleanliness	Grain size analysis	Max. 5% passing 0.075 micron	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices	Max. 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or	Max. 40%	IS:2386 Part IV
	Aggregate Impact Value	Max. 30%	IS:2386 Part IV
Durability	Soundness (Sodium or Magnesium)	5 cycles	IS:2386 Part V IS:2386 Part IV
	Sodium Sulphate	Max. 12%	
	Magnesium Sulphate	Max.	
Water absorption	Water absorption	Max. 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate	Min. Retained Coating 95%	IS:6241
Water sensitivity	Retained Tensile strength*	Min. 80%	AASHT0283

⋮

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

Aggregate Grading and Binder Content

The combined grading of the coarse aggregates and fine aggregates, when tested in
accordance with IS:2386 Part 1, wet sieving method, shall conform to limits given in
Table 500-8. The type and quantity of bitumen and appropriate thickness is also given in
Table 500-7.

Proportioning of Material

The combined aggregate grading shall not vary from the lower limit on one sieve to the higher limit on the adjacent sieve to avoid gap grading. The aggregate may be proportioned and blended to produce a uniform mix complying with the requirements in Table 500-7. The binder content shall be within a tolerance of ± 0.3 percent by weight of total mix when individual specimens are taken for quality control tests in accordance with the provisions of Section 900.

504.3 Construction Operation

504.3.1 Weather and Seasonal Limitations

The provisions of Clause 501.5.1 shall apply.

Table 500-7 :Aggregate Grading and Bitumen Content

Grading	1	2
Nominal maximum aggregate size*	40mm	19mm
Layer thickness	80-100 mm	50-75 mm
IS Sieve size (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** percent by mass of total mix	3.3**	3.4**

Nominal maximum aggregate size is the largest specified sieve size upon which any of the aggregate material is retained.

** Corresponds to specific gravity of the Aggregate being 2.7. In case aggregates have specific gravity more than 2.7, bitumen content can be reduced proportionately. Further, for regions where highest daily mean air temperature is 30°C or lower and lowest daily mean air temperature is -10°C or lower, the

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bitumen content may be increased by
0.5 percent.

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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 Clauses 501.8 and 902.3 as appropriate, and a prime coat, shall be applied in accordance with Clause 502 where specified, 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 get access, other approved methods shall be used as directed by the Engineer.

Tack Coat

A tack coat in accordance with Clause 503 shall be applied as required under the Contract or as directed by the Engineer.

Preparation and Transportation of the Mix

The provisions of Clauses 501.3 and 501.4 shall apply.

Spreading

The provisions of Clause 501.5.3 shall apply.

Rolling

Compaction shall be carried out in accordance with the provisions of 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 Clause 903.

504.4 Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of Clause 902. For control of the quality of materials and the works carried out, the relevant provisions of Section 900 shall apply.

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, by the Contractor the course shall be covered by a seal coat to the requirement of Clause 512 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.

.Arrangements for Traffic

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

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.

Rate

The contract unit rate for bituminous macadam shall be payment in full for carrying out the required operations as specified. The rate shall include cost for all components listed in Clause 501.8.8.2.

Item No. 12:- Providing and laying 25 mm thick compacted S.D.B.C with B.T. stone chips as per MORTH gradation and asphalt VG - 30 for mixing at the rate of 5.00 % by weight of total mix i.e (50.00 kg/MT by weight of total mix) including heating the asphalt and aggregates by continuous Drum mix plant & spreading the same by paver finisher including rolling & consolidation with 10-12 tones vibratory and power roller & providing all materials, equipments, tools & plants, fire wood, oil, kerosene, labour charges etc. and using contractor's own machineries Batch mix plant and paver finisher etc. complete.

508. SEMI-DENSE BITUMINOUS CONCRETE

508.1. Scope

This 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 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 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 ¹	Max 5% passing 0.075mm sieve
Panicle shape	Flakiness and Elongation Index (Combined) ²	Max 30%
Strength*	Los Angeles Abrasion Value ³	Max 35%
	Aggregate Impact Value ⁴	Max 27%
Polishing	Polished Stone Value ⁵	Min 55
Durability	Soundness: ⁶	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption ⁷	Max 2%
Stripping	Coating and Stripping of Bitumen	Minimum Retained
	Aggregate Mixtures ⁹	Coating 95%
Water Sensitivity**	Retained Tensile Strength ⁸	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 500-45. COMPOSITION OF SEMI DENSE BITUMINOUS CONCRETE
PAVEMENT LAYERS**

Grading	1	2
Nominal aggregate size	13mm	10mm
Layer Thickness	35-40 mm	25-30 mm
IS Sieve ¹ (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 ³	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
Per cent voids filled with bitumen (VFB)	65-78

508.3.3. 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 500-16 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 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 Clause 507.3.5.

508.4. Construction Operations

508.4.1. Weather and seasonal limitations: The provisions of 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 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 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 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 Clause 503.

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

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

508.4.8. 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.

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 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 Clause 112.

508.8. Measurement for Payment

The measurement shall be all as specified in Clause 507.8.

508.9. 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 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.

- Item No. 16:-** Chevron sign :-Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 60x50 cm as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.3 mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 50 x 50 x 5mm; painted with best quality epoxy coatings in black and white bends. the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg, including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting

801 TRAFFIC SIGNS

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.

Materials

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

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.

Reinforcing Steel

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

Bolts, Nuts, Washers

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

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.

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
A	Mechanical Properties of ACM		
1)	Peel off strength with retro reflective sheeting (Drum Peel Test)	ASTM 0903	Min. 4 N/mm
2)	Tensile strength	ASTM E8	Min. 40 N/mm ²
3)	0.2% Proof Stress	ASTM E8	Min. 34 N/mm ²
4)	Elongation	ASTM E8	Min. 6%
5)	Flexural strength	ASTM 393	Min. 130 N/mm ²
6)	Flexural modulus	ASTM 393	Min. 44.00 N/mm ²
7)	Shear strength with Punch shear test	ASTM 732	Min. 30 N/mm ²
8	Properties of Aluminium Skin		
1)	Tensile strength (Rm)	ASTM E8	Min. 65 N/mm ²
2)	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm ²
3)	Elongation	ASTM E8	A50 Min. 2%

4)	0.2% Proof Stress	ASTM E8	Min. 10 N/mm ²
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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. 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.

Traffic Signs having Retro-Reflective Sheeting

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 Clauses 801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC:67.

High Intensity Grade Sheeting

801.3.2.1 High Intensity Grade (Type III)

This high intensity retro reflective sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof plastic having a smooth surface or as an unmetallised micro prismatic reflective material element. 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 0:4956-09) as indicated in **Table 800-2**.

**Table 800-2 : Acceptable Minimum Co-efficient of Retro-Reflection for High Intensity Grade Sheeting (Type III) (Encapsulated Lens Type)
(Candelas Per Lux Per Square Metre)**

Observation Angle in Degrees	Entrance Angle in Degrees	White	Yellow	Orange	Green	Red	Blue	Brown
0.108	-40	300	200	120	54	54	24	14
0.108	+30°	180	120	72	32	32	14	10
0.2°	-40	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-40	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

- A minimum of Coefficient of Retro-reflection (RA) $\text{cd}/\text{fc}/\text{ft}^2$ ($\text{cd}/\text{lx} \cdot 1\text{m}^2$).
- B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the Contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

High Intensity Micro-Prismatic Grade Sheeting (HIP) (Type IV)

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

**Table 800-3 :Acceptable Minimum Co-efficient of Retro-Reflection for High Intensity Micro-Prismatic Grade Sheeting (Type IV)
(Candelas Per Lux Per Square Metre)**

Observation	Entrance	White	Yellow	Orange	Green	Red	Blue	Brown
0.106	-40	500	380	200	70	90	42	25
0.106	+30°	240	175	94	32	42	20	12
0.2°	-40	360	270	145	50	65	30	18
0.2°	+30°	170	135	68	25	30	14	8.5
0.5°	-40	150	110	60	21	27	13	7.5
0.5°	+30°	72	54	28	10	13	6	3.5

- A Minimum Coefficient of Retro reflection (RA) $\text{cd}/\text{fc}/\text{ft}^2$ ($\text{cd}/\text{lx} \cdot 1\text{m}^2$).
- B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table . At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

Prismatic Grade Sheeting

Prismatic Grade Sheeting (Type VIII)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. The retro reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro reflection (determined in accordance with ASTM E 810) as indicated in Table 800-4.

Prismatic Grade Sheeting (Type IX)

The reflective sheeting shall be retro-reflective sheeting made of micro prismatic retro-reflective material. The retro-reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM E 810) as indicated in Table 800-5.

Table 800-4: Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting (Type VIII) (Candelas Per Lux per Square Metre)

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

- A Minimum Coefficient of Retro reflection (RA) cd/fc/FF (cd-lx-1m²).
- 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.

Table 800-5 : Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting (Type IX) (Candelas Per Lux per Square Metre)

Observation	Entrance	White	Yellow	Orange	Green	Red	Blue	Fluorescent Yellow/Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^a	-4'	600	500	250	66	130	130	530	400	200
0.1° ^a	+30°	370	280	140	37	74	17	300	220	110
0.2°	-4'	380	285	145	38	76	17	300	230	115
0.2°	+30°	215	162	82	22	43	10	170	130	65
0.5°	-4'	240	180	90	24	48	11	190	145	72
0.5°	+30°	135	100	50	14	27	6.0	110	81	41
1.0°	-4'	80	60	30	8.0	16	3.6	64	48	24
1.0°	+30°	45	34	17	4.5	9.0	2.0	36	27	14

A Minimum Coefficient of Retro reflection (RA) cd/fc/ft² (cd-lx-1m²).

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.

801.3.4.3 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° _B	-4'	830	620	290	83	125	37	25	660	500	250
0.1° _B	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4'	580	435	200	58	87	26	17	460	350	175
0.2°	+30°	220	165	77	22	33	10	7.0	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) $\text{cd}/\text{fc}/\text{ft}^2$ ($\text{cd}/\text{lx}/\text{m}^2$).
- B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro 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 Adhesives

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 suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. The sheeting shall be applied in accordance with the manufacturer's specifications.

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.

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 informative 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.

Colour for Signs

Signs shall be provided with retro-reflective sheeting and/or overlay film/ screening ink. The reverse side of all signs shall be painted grey.

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.

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.

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.

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 aluminium backing or materials as per 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.

Sizes of Letters

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.

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.

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.

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 retro-reflective sheeting has been tested for various parameters such as co-efficient of retro-reflection, 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.

Installation

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.

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/ fibre glass/ powder coated paint. Any part of support post below ground shall be painted with protective paint.

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.

Measurement for Payment

The measurement of standard cautionary, mandatory and information signs shall be in numbers of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square metres.

Rate

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

- Item No. 15 Road Marking with Hot Applied Thermoplastic paint with Reflectorising Glass Bends on Bituminous surface Providing and laying of hot applied thermoplastic compound 2.5 mm. thick including reflectorising glass beads @ 250 gms per sqm. area, Thickness of 2.5 mm is excluding of surface applied glass beads as per IRC:35-2015. The Finished surface to be level, Uniform and free from streaks and holes. zebra patta patta / bump patta lane /center line / edge line / cut patta. the white color marking should provide luminance coefficient on cement road shall be min. 130 mcd/m²/lux and asphalt road shall be min. 100 mcd/m²/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015. Warranty for the Retro reflectivity should be two years.**

803 ROAD MARKINGS

Scope

The work shall consist of providing road markings of specified width, layout and design using paint of the required specifications as given in the Contract and as per guidelines contained in from IRC:35-1997.

Materials

Road markings shall be of ordinary road marking paint hot applied thermoplastic compound, reflectorised paint or cold applied reflective paint as specified in the item and the material shall meet the requirements as specified in these Specifications.

803.3 Ordinary Road Marking Paint

803.3.1 Ordinary paint used for road marking shall conform to Grade I as per IS:164.

803.3.2 The road marking shall preferably be laid with appropriate road marking machinery.

803.4 Hot Applied Thermoplastic Road Marking

803.4.1 Thermoplastic Material

803.4.1.1 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.

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 1), shall be as below:
- a) **Luminance :**
- White: Daylight luminance at 45°-65 percent min. as per AASHTO M 249
- Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M249
- 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°C ± 9.5°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 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.

Reflectorizing Glass Beads

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 Clause 803.6.4.

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 Clause 803.4.2.3.

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	Type2
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.

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 1).
- 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.

803.4.3 Application Properties of Thermoplastic Material

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.

The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

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.

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 Clause 803.4.2.

Application

803.6.1 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.

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.

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.

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.

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

803.6.6 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.

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

Measurements for Payment

The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any).

In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers.

803.6.9 Rate

The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications.

803.7 Cold Applied Reflective Paint

803.7.1 General

The work shall consist of marking traffic stripes using a solvent based cold applied paint, which shall be applied on the asphalt/cement concrete road surface by brush or by Road Marker (Spray equipment capable of spraying the paint on the road). Glass beads shall be

subsequently spread pneumatically on to the paint when it is still wet so that the beads will be firmly held by the paint after drying. Colour of the paint shall be white or yellow (IS Colour No. 356) as specified in the drawings or as directed by the engineer.

Material

The cold applied paint material shall be homogeneously composed of binder, pigment, extenders and other additives as required for the formulation.

Composition

The pigments and extenders shall be uniformly dispersed in the binder medium dissolved in organic solvents. The material shall be free from skin, dirt and foreign objects and shall comply with requirements indicated in Table 800-11.

Table 800-11 : Proportions of Constituents or Paints (Percentage by Weight)

Component	White	Yellow
Binder	25.0 min.	18.0 min.
Titanium Dioxide	20.0 min.	--
Calcium Carbonate and Inert Fillers	16.0 min.	29.0 min.
Yellow Pigments	--	14.0 min.

Properties

Non-Volatile Matter content by weight shall be a minimum of 65 percent as determined in accordance with test method ASTM D1644. The liquid paint shall have a density of 1.3 g/cc minimum as determined in accordance with test method ASTM D1475.

Appearance

Drying Time of the paint as determined by the test method ASTM D711 shall be a maximum of 20 minutes at a wet film thickness of 350 micron. The paint shall set to bear traffic after 40 minutes when the ambient temperature is higher than 24°C. The paint shall not be applied when the surface temperature of the road is higher than 40°C.

Properties of the Dried Paint Film

When tested using a sand abrasion tester as described in ASTM D968, the quantity of sand required for removal of a 75 micron thick unbeaded dry film shall be greater than 65 litres.

Elongation

The unbeaded dry film shall pass the test in accordance with ASTM D 1737 and ASTM D2205.

Water Resistance

The unbeaded dry film shall pass the test in accordance with ASTM 01647 and ASTM 02205.

Skid Resistance

Skid resistance for the beaded dry film shall be not less than 45 as per BS 6044.

Storage Life

The material shall meet the specifications for a period of one year. During this period, the paint material when stored in an airtight container shall not form skin. The material shall also not form a cake at the bottom of the container.

Minimum Thickness of the Unbeaded Cold Applied Paint Coat

The minimum thickness of the wet unbeaded coat of paint shall not be less than 400 micron, and the minimum thickness of the dry unbeaded coat of paint shall not be less than 200 microns.

Retro-reflective Properties

The co-efficient of retro-reflection as per British Standards BS EN 1436:1998 shall be as under:

For white paint (Beaded)	-300 mcd/m ² /lux on application
	-100 mcd/m ² /lux after defect liability period of one year
For yellow paint (Beaded)	-200 mcd/m ² /lux on application
	-100 mcd/m ² /lux after defect liability period of one year

The luminous Co-efficient as per British Standards BS EN 1436:1998 shall be as under:

For white paint (Un-beaded)	100 mcd/m ² /lux on application
For yellow paint (Un-beaded)	80 mcd/m ² /lux on application

Marking

Each container of the cold-paint shall be clearly and indelibly marked with the following information:

- i) The name, trade/patent mark

- ii) Batch No.
- iii) Month of Manufacture
- iv) Colour (White or Yellow)

Sampling and Testing

The cold applied reflective road marking paint shall be sampled and tested in accordance with appropriate ASTM/BS test methods.

The contractor shall furnish to the Engineer a copy of certified test methods from the manufacturer of cold applied reflective road marking paint showing the results of:

- a) No pick up time as per ASTM D 711.
- b) Resistance to wear as per ASTM D 4060 or as per ASTM D 968 from approved laboratories.
- c) material safety data sheet shall be obtained from the manufacturer and kept with the paint materials.

Reflectorising Glass Beads

General

Reflection shall be achieved by pneumatically spreading glass beads on to the paint when it is still wet. The beads shall be firmly held by the paint after drying.

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 Clause 803.6.7.3.

Specific Requirements

- i) **Gradation:** The glass beads shall meet the gradation requirements as per No.4 of BS:6088 as given in Table 800-12.

Table 800-12 : Gradation Requirements for Glass Beads

Sieve Size	Percentage Retained
250 micron	0-10
150 micron	80-100
Below 150 micron	0-20

- ii) **Roundness:** The glass beads shall have a minimum of 70 percent true Spheres.

- iii) **Refractive Index:** The glass beads shall have a minimum refractive Index of 1.50.
- iv) **Free Flowing Properties:** The glass beads shall be free of hard lumps, clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test as given in Clause 803.6.5.4.

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-1)
- 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.

Preparation

The cold applied reflective road marking paint shall be stirred well to form homogeneously with the thinner recommended/supplied by the manufacturer and put into the machine with the consistency level recommended by the machine manufacturer by using proper viscometers. The thinner shall not be added more than that recommended by the manufacturer to avoid bleeding.

Application

803.7.5.6.1 Marking shall be done by machine. For locations where painting can not 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.

The cold applied paint shall be applied on the asphalt/cement concrete road surface by brush or by Road Marker/Spray equipment capable of spraying the paint on the road surface. Glass beads @ 300 gms per sq.m shall be subsequently spread pneumatically on to the paint when it is still wet so that the beads will be firmly held by the paint after drying.

The pavement temperature shall not be more than 40°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease oils and all other foreign matter before application of paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of a 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.

Cold applied paint shall be applied in intermittent or continues lines of uniform thickness of at least 200 micron of unbeaded dry film thickness unless specified otherwise. When arrows or letters are to be provided, cold applied paint may be applied manually. In addition to the beads recommended for, a further quantity of 300 gms of glass beads per sqm. conforming to the specification shall be sprayed uniformly in to a mono-layer on to the cold paint line in quick succession of the cold paint spraying operation.

The minimum. thickness specified above in Clause 803.7.5.5.5 is exclusive of surface applied glass beads.

The finished line shall be free from ruggedness on sides and ends and be parallel to general alignment of the carriage way.

The upper surface of the lines shall be of uniform level and free from streaks.

803.7.5.7 Properties of Finished Road Marking

As per Clause 803.6.7.

Measurement for Payments

As per Clause 803.5.2.1.

Rate

As per Clause 803.5.3.

Audible and Vibratory Pavement Markings

Description

The work shall involve application of audible and vibratory pavement markings in accordance with the drawings or the direction of the Engineer.

Materials

Thermoplastic: thermoplastic material shall meet the requirements of Clause 803.4.1 of these Specifications.

Glass Spheres: Use glass spheres meeting the requirements of Clause 803.4.2. The Engineer will take random samples of glass spheres in accordance with ASTM D 1214 and the Department's Sampling, Testing and Reporting Guide schedule.

Equipment

The equipment capable of providing continuous, uniform heating of the striping material to temperatures exceeding 200°C, mixing and agitating the material in the reservoir shall be used to provide a homogenous mixture without segregation. Equipment will maintain the striping material in a plastic state, in all mixing and conveying parts, including the line dispensing device until applied. Equipment shall be capable of producing a consistent pattern of transverse bars positioned at regular and predetermined intervals. It shall meet the following requirements:

- a) capable of travelling at a uniform rate of speed, both uphill and downhill, to produce a uniform application of striping material and capable of following straight lines and making normal curves in a true arc.
- b) capable of applying glass spheres to the surface of the completed stripe by automatic sphere dispensers attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. The glass sphere dispensers should be equipped with an automatic cut-off control that is synchronized with the cut-off of the thermoplastic material and applies the glass spheres uniformly on the entire traffic stripe surface with 50 percent to 60 percent embedment equipped with a special kettle for uniformly heating and melting the striping material.
- c) equipped with special kettle for uniformly heating and melting the striping material. The kettle must be equipped with an automatic temperature control device and material thermometer for positive temperature control and to prevent overheating or scorching of the thermoplastic material.
- d) meets the requirements of the fire safety standards.

803.8.4 Application

803.8.4.1 General

Before applying traffic stripes and markings, any material that would adversely affect the bond of the traffic stripes shall be removed by a method approved by the Engineer.

Before applying traffic stripes to any portland cement surface, a primer, sealer or surface preparation adhesive of the type recommended by the manufacturer shall be applied. Longitudinal lines should be offset by at least 50 mm from construction joints of Portland cement concrete pavement.

Traffic stripes or markings shall be applied only to dry surface, and when the ambient air and surface temperature is at least 10°C and rising for asphalt surfaces and 16°C and rising for concrete surface.

Striping shall be applied to the same tolerances in dimensions and in alignment. When applying traffic stripes and marking over existing markings, ensure that not more than 50 mm on either end and not more than 25 mm on either side of the existing line is visible.

803.8.4.2 Thickness

Base lines shall be applied having a thickness of 2 mm to 2.2 mm exclusive of the transverse audible bars, when measured above the pavement surface at the edge of the base line.

As an alternative to the flat base line, a profiled baseline meeting the following dimensions may be applied. The profiled baseline shall have a minimum height of 4 mm, when measured above the pavement surface at the edge of the inverted rib profile. The thickness in the bottom of the profile marking shall be 0.9 mm to 1.3 mm. The individual profiles shall be located transversely across the full width of the traffic stripe at approximately 25 mm. On center, with a bottom width between 2.5 mm and 8 mm.

Dimensions of Transverse Audible Bars

The raised transverse bars shall be applied with a profile such that the leading and trailing edges are sloped at a sufficient angle to create an audible and vibratory warning,

Transverse bars on shoulder and centerline markings shall have a height of 11 mm to 14 mm, including the base line. The height shall be measured above the pavement surface at the edge of the marking, after application of drop-on glass spheres. The bars shall have an approximate length of 65 mm. The bars may have a drainage channel on each bar, the width of each drainage channel will not exceed 6.5 mm at the bottom of the channel. The longitudinal distance between bars shall be 750 mm.

Retro-reflectivity

White and yellow audible and vibratory markings shall attain an initial retro reflectance of not less than 300 mcd/1xm² and not less than 250 mcd/1x m² , respectively.

Glass Spheres

Glass spheres shall be applied to all markings. The manufacturer shall determine if a single or double application of glass spheres is used and the recommended drop rates for each application shall be adopted.

Contractor's Responsibility

The Engineer shall be notified by the contractor, prior to the placement of audible and vibratory markings. The contractor shall furnish the Engineer with the manufacturer's name and LOT numbers of the thermoplastic materials and glass spheres to be used. He will ensure that the LOT numbers appear on the thermoplastic materials and glass spheres packages. The contractor shall furnish a copy of certified test reports to the Engineer, showing results of tests specified in these Specifications or as per appropriate ASTM/BS method. The Engineer would have the right to test the markings within 3 days of receipt of the Contractor's certification. If the retro reflectivity values measure less than the values shown above, it shall be removed and the stripping reapplied.

Protection of Newly Applied Audible and Vibratory Markings

Traffic shall not be allowed onto or vehicles permitted to cross newly applied pavement markings until they are sufficiently dry. Any portion of the pavement markings damaged by passing traffic or from any other cause shall be removed and replaced.

Observation Period

Pavement markings shall be subject to a 180 day observation period under normal traffic. The observation period will begin with the satisfactory completion and acceptance of the pavement marking work. The pavement markings shall show no signs of failure during the observation period. Any pavement markings that do not perform satisfactorily under traffic during the 180 day observation period, shall be replaced by the contractor at his own cost.

Measurement for Payment

Audible and vibratory pavement markings shall be measured in linear metre. Payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work.
Specifications.