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To

All Chief Engineers of States/Union Territories' dealing with roads

Subject : Introduction of the technique of wet mix macadam

In our country, by and large, the principal component of the road pavement is still the water bound macadam which forms the base and/or sub-base course of the pavement structure and because of the economy achieved in construction it may continue to be so for quite some time. Therefore, any new technique which can improve the method of construction as well as performance of the water bound macadam is always welcome. Among the various improvements suggested and also practised in many countries, the wet mix macadam is a popular one.

2. Commonly known as 'wet mix macadam', this is actually a method of laying premixed water bound macadam where the graded aggregate is mixed with the help of suitable mechanical equipment with a small and controlled amount of water, usually ranging from 2% to 5% by weight and laid by automatic mechanical pavers. The control required for the amount of water to be mixed is very critical to the success of the construction so that it is just sufficient to provide a cohesive film of moisture on the particles for better bond and any excess water may lead to the weakening of the bond and subsequent failure of the macadam course.

3. Briefly, the method is expected to yield the following advantages :

(i) The mix is more homogeneous, as it is obtained under controlled condition through machines.

(ii) Laying with automatic pavers, avoiding manual work, achieves better surface profile and finish.

(iii) It is quicker in construction.

(iv) The mix can be prepared at suitable locations — where water is available in required quantity and transported to work site.

(v) Because of premixing with water, transportation over long distances does not result in significant segregation.

(vi) It is a boon to areas where water is scarce as requirement of water is considerably less in this method.

(vii) Because of the processing under controlled condition it can achieve higher unit weight and therefore greater strength.

(viii) Less effort is required in obtaining the higher unit weight, as a more uniform moisture film coating on the aggregate requires less compactive efforts to obtain higher unit weight.

4. As the work requires greater care and attention and because of the use of mechanical equipment at every stage i.e. mixing, transporting and laying; it is reasonable to expect that the cost of construction will be slightly higher than that for the conventional WBM. With use and experience, however, the cost is likely to come down. Further, because of the improved quality of mix and consequent increase of strength of the wet mix macadam, it may be possible to economise on the thickness requirement of WBM courses and/or on the requirement of bituminous surfacing over it, which would ultimately result in marginal cost difference between the wet mix macadam and the conventional WBM. This can, of course, be realised with time and practice and after obtaining improved skill and efficiency in the technique of this construction.

5. The method also has its limitations

(a) It is not advisable to lay the wet mix macadam during rains and the tempo of work suffers during rainy season. Areas with round-the-year rainfall may have to be excluded from the use of this technique.

(b) Provision of adequate drainage for the foundation area for the construction courses assumes greater importance in this method of construction. Special drainage precautions are necessary for laying wet mix macadam in trenches.

(c) After construction the top layer will need immediate sealing with a bituminous surfacing like surface dressing etc.

(d) As already stated more care and attention is required for control of moisture in the mix. OMC for the mix has to be found out and care has to be taken to either adjust moisture keeping in view the average work-time temperature and the distance for transportation involved or take steps to protect and cover the mix from moisture less during transportation on warm days.

6. Nevertheless, it has been felt that we may initiate work with this technique, in order to gain more experience regarding the actual field needs, performance and intricacies of the system so that, in the long run, we can obtain stronger and better quality macadam pavements and cut on construction time. With this in view, you are requested to select a few introductory sections in your State, if possible on NH, for construction of wet mix macadam courses and monitor and review their performances. For this purpose, tentative specifications for wet mix macadam have been framed in the Ministry and are enclosed herewith for reference and guidance.

7. It is requested that your views on the subject with special reference to its applicability on the road system in your State and your comments on the tentative specification enclosed may please be forwarded to this Ministry.

8. An early action in the matter will be very much appreciated.

TENTATIVE SPECIFICATIONS FOR WET-MIX MACADAM

1. INTRODUCTION

Wet-mix macadam is a modified version of conventional water bound macadam in which the constituent materials are premixed with just the required quantity of water in suitable mechanical equipment and laid by paver finishers. Since mechanised, the construction is quicker and there are several other advantages like better profile, smoother surface finish etc. As it is premixed with water, it can be transported over long distances without undue segregation because of cohesion between particles. It is also termed as 'premix' macadam.

2. SCOPE

2.1 It is considered to be a convenient specification for construction of roads where supply of water is not abundant and for construction on existing roads which cannot be closed to traffic for long durations.

2.2 Wet mix macadam can be adopted for construction of both sub-bases and base-courses. In general, it is recommended for all situations where water bound macadam is used excepting for very heavily trafficked existing roads, where top courses are to be provided in the nature of bituminous surfacing only.

2.3 Laying of wet mix macadam during rains shall be avoided.

3. DESCRIPTION

The work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade, subbase, 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-in-charge.

4. MATERIALS

4.1 Aggregate — General Requirements

4.1.1 The aggregate shall consist of either crushed ot broken stone, crushed slag, overburnt bricks or one of the naturally occurring aggregates such as kankar or laterite of suitable quality as stated hereafter and approved by the Engineer-in-charge. The aggregate shall conform to the physical requirements set forth in the Table-1 below.

Table-1 Physical requirements of Aggregates for Wet-mix macadam

Sl. No.	Type of construction	Test	Test Method	Requirement
1.	Sub-base	Los Angeles Abrasion Value* or	IS : 2386 (Part IV)	max. 60%
		Aggregate Impact Value*	—do—	max. 50%
2.	Base	(a) Los-Angeles Abrasion Value* or	—do—	max. 50%
		Aggregate Impact Value*	—do—	max. 40%
		(b) Flakiness Index	IS : 2386 (Part I)	max. 30%

Note : 1. *Aggregates may pass the requirements of either the Los-Angeles Test or Aggregate Impact Value Test.

2. Fraction of the aggregates passing 425 micron sieve when tested in accordance with IS : 2720 (Part V) should not have a PI value of more than 6.

4.1.2 Crushed stone

Crushed stone shall be free of flat, elongated, soft and disintegrated particles. They should also not contain an excess of dirt or other objectionable matter.

4.1.3 Crushed slag

Crushed slag should be manufacturerd out of air cooled blast furnace slag. It should be of angular shape, reasonably uniform in quality and density and generally free of any thin, elongated and soft pieces, as well as dirt or other objectionable matter. Crushed slag should not weight less than 1120 kg per m^3 or absorb water by more than 10 per cent of its weight when tested in accordance with IS : 2386 (Part-III).

4.1.4 Overburnt brick aggregates

Brick aggregate shall be made of overburnt bricks or brickbats and be free from dust and other foreign matter.

4.1.5 Laterite

Laterite shall be hard, compact, heavy and of dark colour. The light coloured sandy laterite as well as those containing much ochrous clay shall be rejected.

4.1.6 **Kankar**

Kankar shall be tough, having a blue almost opalescent fracture. It shall not contain any clay in the cavities between nodules.

4.2 **Aggregates — Grading Requirements**

4.2.1 The aggregates shall conform to one of the gradings given in Table-2.

Table 2-Grading Requirements of Aggregates for Wet-Mix-Macadam

Sieve Designation (IS : 460)	Per cent by weight passing the sieve	
	Grading 1 Max. nominal size 40 mm	Grading 2 Max. nominal size 20 mm
50mm	100	
40 mm	95-100	
25 mm	—	100
20 mm	60-80	90-100
10 mm	40-60	—
4.75 mm	25-40	35-55
2.36 micron	15-30	—
600 micron	8-22	10.30
75 micron	0-8	2-9

4.2.2 The nominal size of aggregate to be used in a given case would depend on availability. While both the gradings can be used for base/sub-base courses construction, preferably layers of grading No. 1 should not be used above layers of grading No. 2

4.2.3 Generally it should be possible to obtain aggregates conforming to the above gradings directly from the crusher. However, where this is not so for any reason, necessary quantities of missing fractions could be blended as to bring the grading of the mixed material upto the specified limits.

4.3 **Quantity of Aggregates**

Approximate quantity of aggregates required for 75 mm and 100 mm compacted thickness of wet-mix macadam will range from 1.1 to 1.2m^3 and 1.45 to 1.6m^3 respectively per 10m^2 area.

5. CONSTRUCTION OPERATION

5.1 **Preparation of Base for Receiving the Wet-mix Macadam Course**

5.1.1 The sub-grade, sub-base or base to receive the wet mix macadam course should be prepared to the required grade and camber and cleaned of all dust, direct and other extraneous matter. Any ruts or soft yielding places that have appeared due to improper drainage, service under traffic, or other reasons, should be corrected and rolled until firm. If necessary, the existing surface may be scarified and reshaped to achieve this objective.

5.1.2 Where the existing road surface is black-topped, 50mm × 50 mm furrows should be cut in the existing surface at 45° to centre-line of the carriageway, spaced every one metre, before proceeding with the laying of the wet-mix macadam.

5.1.3 In all cases, the foundation should be kept well drained throughout the construction operations.

5.2 **Provision of Lateral Confinement of Aggregates**

5.2.1 Before starting with wet-mix macadam construction, necessary arrangements should be made for the lateral confinement of aggregates. This could be done by constructing side shoulders in advance to a thickness corresponding to the compacted layer of the wet-mix macadam course. After the shoulders are ready, their inside edges should be trimmed vertical and the included area cleaned of all spilled material, thereby setting the stage for spread of aggregates. The practice of constructing the macadam in a trench excavated after finishing formation must be completely avoided.

5.3 **Mixing of Aggregates with Water**

Aggregates for wet-mix macadam should be mixed with the requisite quantity of water in a power mixer of suitable capacity and optimum moisture for mixing should be determined in accordance with IS : 2720 (Part-VII) after replacing the aggregate fraction, retained on 20 mm sieve with material of 4.75 mm to 20 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 ±0.5 per cent. The mixed material should be uniformly wet and no segregation should be permitted.

5.4 **Spreading of Aggregates**

5.4.1 Immediately after mixing, the aggregates should be spread uniformly and evenly upon the prepared base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. The aggregates should be spread to proper profile by using templates placed across the road about 6 metre apart. Where possible approved mechanical devices may be used for this purpose so as to minimise the need for their manupulation by hand.

5.4.2 The wet-mix macadam course should normally be constructed in layers each not exceeding 75mm in compacted thickness or more if otherwise specified. In no case however, shall the thickness of the compacted layer exceed 100 mm.

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 be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

5.5 Rolling

5.5.1 After aggregates have been laid to the required thickness, grade and camber, these should be compacted to the full width by rolling with either three-wheeled power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller of approved type.

5.5.2 Except in superelevated portions, the rolling should begin at edges with the roller running forward and backward until the edges have been firmly compacted. The roller should then progress gradually towards the centre parallel to the centre-line of the road, uniformly lapping each proceeding rear wheel track by one half width.

On superelevated portions of the road, rolling should commence from the lower edge and progress gradually towards the upper edge of the pavement.

5.5.3 Rolling should not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross-section, the surface should also be checked transversely by template for camber, and any irregularities corrected in the manner described above. In no case should the use of unmixed material permitted to make up the depressions.

5.5.4 Rolling should be continued till the density achieved is at least 100 per cent of the maximum dry density for the material as determined by the method outlined in IS : 2720-Part VII. After completion the surface of any finished layer should be well-closed, free from movement under compaction plant or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas should be made good to the full thickness of the layer and recompacted.

5.6 Opening to Traffic

5.6.1 Preferably no vehicular traffic of any kind should be allowed on the finished wet-mix macadam surface till it has dried and the wearing surface laid. In exceptional cases, construction traffic may be allowed with approval of Engineer-in-charge for short durations once the course is completely dry provided vehicles move over the full width avoiding any rutting or uneven compaction.

6. SURFACE EVENNESS OF WET-MIX MACADAM COURSE

6.1 The surface evenness of the completed wet-mix macadam course in the longitudinal and transverse directions shall be within the following tolerances :

(a)	Longitudinal profile when tested with a 3 metre straight edge	Max. permissible variation : 12 mm
(b)	Cross profile when checked with a camber template	Max. permissible variation : 8 mm

The longitudinal profile shall be checked with a 3 metre long straight edge at the middle of each traffic lane along a line parallel to the centre-line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 metre. In general the surface finish of construction shall conform to the requirements of clause 901 of Specification for Road and Bridge works of MOT(RW) when not otherwise specified.

7. RECTIFICATION OF SURFACE IRREGULARITY

7.1 Where the surface irregularity of the wet-mix macadam course exceeds the tolerances specified in para 6, or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompacted in accordance with para 5. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

7.2 In general, control on the quality of materials and works shall be exercised by the Engineer-in-charge in accordance with Clause 902 of the Specifications for Road and Bridge works of the MOT(RW) where otherwise not specified.

8. ARRANGEMENT FOR TRAFFIC

During the period of construction the flow of traffic shall be maintained as indicated in Clause 105 of the Specification for Road & Bridge works (MOT) wherever applicable.

9. MEASUREMENT FOR PAYMENT

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

10. RATES

Clause 401.7 of the Specification for Road and Bridge works (MOT) shall apply.