ISSN:2348-2079

Volume-6 Issue-2

IJIAREC

International Journal of Intellectual Advancements and Research in Engineering Computations

An experimental investigation on wet mix macadam road

Nirmal Raj V[1], Prabhu N[2], Poomughelan N[3], Ravisankar K L[4]

[1,2,3] UG Final Year, Dept. of Civil Engg., Nandha Engineering College, Erode, Tamil Nadu

[4]Assistant Professor, Dept. of Civil Engg., Nandha Engineering College, Erode, Tamil Nadu

Abstract- This Paper reveals the construction of Wet Mix Macadam Road. The study of design data based on a CBR value, Traffic data, Drainage conditions, Rainfall data, Topography of the area etc. It also includes design calculation based on Indian Road Congress (IRC) codes. Construction aspects include the use of various materials, machines and manpower. Also Quality Assurance (QA) and Quality Control (QC), aspects incorporated in the construction procedure have been studied and these are included in the project report. Testing of various materials is carried out from the laboratory. The construction of flexible pavement include site cleaning, surveying, excavation, sub-grade construction, granular sub-base, wet mix macadam, prime coat.

Key words- GSB, WMM

I. INTRODUCTION

The surface of the roadway should be stable and non-yielding, to allow the heavy wheel loads of road traffic to move with least possible rolling resistance. The road surface should also be even along the longitudinal profile to enable the fast vehicles to move safely and comfortably at the design speed. A pavement layer is considered more effective or superior, if it is able to distribute the wheel load stress through a larger area per unit depth of the layer. One of the objectives of a well designed and constructed pavement is therefore to keep this elastic deformation of the pavement within the permissible limits, so that the pavement can sustain a large number of repeated load applications during the design life and to keep the sub grade dry. Base and Sub base layer form two important layers of pavement. Base course is considered as the most important component of flexible pavement layer which sustains wheel load stresses and disperses through layer area onto the GSB layer below. A good base course enhances the load carrying capacity of the flexible pavement structure. Good quality coarse aggregates are generally used in the granular base course of flexible pavement. Sub base layer (GSB) course has to serve an effective drainage layer of pavement and also has to sustain lower magnitude of compressive stresses than the base course. Aggregates of lower strength having good permeability may be used in the GSB layer .Crushed stone aggregates are often used in the GSB layer of important highways as this material has high permeability and serves as an effective drainage layer. We can go with combining sub base and base layers suitably in the required proportions so that it provides same strength and permeability as that of a four layer pavement. By going with a composite layer of Granular sub base and wet mix macadam material it is found that by method of design, overall pavement thickness can be reduced. Hence cost of flexible pavement decreases. New technology of Cement treated granular sub base/base is used to reduce the overall pavement thickness compared to normal and composite layer pavement design , as strength of the pavement increases considerably, the permeability characteristics are also good with cement treated layers. Hence cost reduction in construction is also another advantage.

II. LITERATURE REVIEW

A. MORTH Manual by Government of India (All Clauses are as per MORTH) Specifies that

MORTH states that the work shall consist of laying and compacting well graded materials on prepared sub grade in accordance with the requirements of these specifications. The material shall be laid in one or two layers as lower sub base or upper sub base or simply sub base. Clause 401.3 Strength of sub base states, it shall be ensured to actual execution that the material to be used in sub base satisfies the requirements of CBR and other physical requirements when compacted and finished. When directed by the engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the quality of materials, as may be necessary. Clause 406 Wet mix macadam sub base/base Clause 406.1 The work shall consist of laying and compacting clean, crushed, graded aggregates and granular material, premixed with water, to a dense mass on a prepared subgrade/sub base or existing pavement as in 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 single layer of the sub base course may be increased to 200 mm upon approval of the engineer.

B. Guide lines for Wet Mix Macadam as per

IRC 109-2015

1) Grading Aggregate

Coarse aggregate shall be crushed stone, crushed gravel not less than 90 percent by weight of gravel retained on 4.75mm sieve shall have at least two fractural faces. The aggregates shall confirm to the physical requirement. Materials shall have particle size distribution and practical shape which provide high mechanical stability and should contain sufficient fines to produce a dense material when compacted. If the amount of fine aggregate produce during the crushing operation is insufficient non-plastic angular may be used to make up the deficiency in constructing a crushed stone road base, the main aim should be achieve maximum impermeability compatible with good compaction and high stability under traffic.

Table 1 Aggregate Grating

IS sieve	53 mm	45 mm	22.40 mm	11.20 mm	4.75 mm	2.36 mm	600 mic	75 mic
% by weight passing sieve	100	95-100	60-80	40-60	25-40	15-30	6-18	4-8

The grading of the wet mix macadam shall be within and approximately parallel to the grading envelope. The grading with in the limit set forth in the table 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 the vice versa. The grading can be produced by crushing rock and may be an all-in product, usually termed a "crusher-run", if it is unable to achieve the required grading directly and continuously from crushing, screen the material into at least four fraction and reconstitute the material to conform to the specification by mixing together in a pug mill.

C.AASTHO guide for design of pavement structure, (American Association state Highway and transport official Washington DC 1993.) Specifies that

1) Particle Size

The utilization of angular, nearly equi-dimensional aggregate with unpleasant surface texture is preferred over rounded, smooth aggregate particles; thin or flat and elongated particles have reduced strength when load is applied to the flat side of the aggregate or across its shortest dimension are also prone to segregation and break down during compaction, making extra fines.

2) Base Stability

Granular base should have high stability, especially in a flexible asphalt pavement structure. Large angular aggregate, dense graded and consisting of hard durable particles, is preferred for stability. For maximum base stability, the granular base should have sufficient fineness to just fill the voids and the entire gradation should be close to its maximum density. However, while base density is, maximized at fines content between 6 to 20%, load carrying capacity decreases when fines content exceeds about 9%.Stability also increases with percentage of crushed particles and increases coarse aggregate size.

3. Permeability

Porousness Since the granular sub base gives seepage to the asphalt structure ,its reviewing and pressure driven conductivity are imperative ,the fines content is generally restricted to 10 percent for typical asphalt development and 6 percent where free depleting sub base is required.

D. Indian department of transportation manual Aggregates specification and requirements

Determinations are for the most part clear, concise, quantitative depictions of the critical attributes of a development material. The determinations required by INDOT are archived in the most recent version of the Standard Specifications and the current Supplemental Specifications. . The particulars are to be taken after while assessing totals. There are two general kinds of prerequisites for total: quality and degree.

III. MIX PROPOSION

A. Proportioning of materials by Rutchforth method for GSB and WMM

Four groups of Aggregates of nominal size 40 mm, 20 mm, 10 mm and dust are proportioned using Rutchforth method.

B. Preparation of specimens for CBR tests

1) Preparation of specimen for CBR test for GSB, WMM and proportions of GSB and WMM

Using the volume of CBR mould and knowing the density of coarse aggregates obtain the required mass of coarse aggregate required to be filled in the mould. The materials taken for conducting CBR tests are GSB II, WMM, 25%GSB II-75%WMM, 50%GSB II-50%WMM, 75% GSB II-75%WMM.The CBR tests are conducted separately each time for every material. Take the aggregates in a tray and add known quantity of water (Optimum moisture quantity determined for aggregates) and mix thoroughly and separate this mass into five parts. Fill the first layer of the aggregates in mould and compact them by giving 56 blows using 4.5 kg rammer. Now fill the second layer and give 56 blows to the aggregates by 4.5 kg rammer and repeat the procedure for another three layers, then conduct the CBR test.

IV.RESULT AND DISCUSSION

A. Results of Materials Tests

1) Mix Design for Granular Sub Base (GSB)

The sieve analysis on Granular sub base(GSB) aggregates have been carried out and the percentage passing of 40 mm, 20 mm, 10mm aggregates and dust are tabulated.

Table 2 Sieve Analysis Test

Size mm	Percentage finer for the given material			
	60mm metal	40mm metal	20mm metal	Gravel
75.0	100	100	100	100
26.5	1	11	98	100
4.75	0	0	0	83
0.075	0	0	0	35

The results of sieve analysis performed on the 60mm, 40mm, 20mm metal ,and gravel(as designated by the client) and the recommendations for the GSB (Grading I) conforming to specifications are given below

Table 3 Recommended Specification

Size, mm	75	26.5	4.75	0.075
Percentage finer for the recommended mix	100	55	18.3	7.7
Grading requirements for GSB (Grading I)	100	55-75	10-30	<10

Recommended Design Mix (By weight)

25% of 60mm metal,
22% of 40mm metal,
31% of 20mm metal and

Table 4 Liquid limit and plastic limit test on GSB

Tests	Test Result	Specifications
Liquid limit	23%	Not more than 25%
Plastic limit	17%	-
Plasticity index	6%	Not more than 6%

22% of Gravel

Modified proctor compaction test

Optimum moisture content, OMC : 4.0%
Maximum dry density : 2.367 g/cc

Soaked CBR test (Compacted at OMC)

CBR corresponding to 2.5mm penetration : 54%
CBR corresponding to 5.0mm penetration : 70%
Design CBR : 70%

2) Mix Design for WMM

The results of sieve analysis performed on the metal 20mm metal , 12mm metal, 6mm metal and Quarry Dust and the recommendations for the WMM(Grading II) conforming to specification are given below

Table 5 Sieve Analysis Test

Size mm	Percentage finer for the given material				
	40mm metal	20mm metal	120mm metal	6mm metal	Quarry dust
26.5	11	100	100	100	100
22.4	2	83	100	100	100
4.75	0	0	2	7	100
0.6	0	0	0	0	63
0.075	0	0	0	0	9.6

Recommended Design Mix (By weight):

22% of 20mm metal,
22% of 12mm metal,
22% of 6mm metal and

Table 6 Recommended Specification

Size, mm	26.5	22.4	4.75	0.6	0.075
Percentage finer for the recommended mix	100	55	18.3		7.7
Grading requirements for GSB (Grading I)	100	55-75	10-30		<10

34% of Quarry Dust

Table 7 Liquid limit and plastic limit test on WMM

Size, mm	26.5	22.4	4.75	0.6	0.075
Percentage finer for the recommended mix	100	96.3	36.0	21.4	3.3
Grading requirements for GSB (Grading I)	100	50-100	35-55	10-30	2-9

Modified proctor compaction test

Optimum moisture content, OMC : 5.0%
Maximum dry density : 2.345 g/cc

Soaked CBR test (Compacted at OMC)

CBR corresponding to 2.5mm penetration : 97.8%
CBR corresponding to 5.0mm penetration : 130.4%
Design CBR : 130.4%

CONCLUSION

- Flexible Pavement consisting of Composite layer of GSB and WMM gives satisfactory permeability and strength.
- It is found that pavement consisting of composite layer of GSB and WMM with 25% and 75 % respectively has reduced thickness (25 mm thickness reduction) as per experimental work.
- With the use of Cement treated sub base (1.5% cement by weight of aggregates) pavement thickness is reduced by 90 mm.

- Adopting Composite layer pavement (25%GSB-75%WMM) and Cement treated sub base pavement would give sufficient strength, permeability with overall reduction in pavement thickness and would result in less investment or cost saving for the same strength character as compared to Normal Conventional Flexible pavement and it may be higher fatigue life.
- The WMM roads gets dry sooner and can be opened for traffic within less time as compare to the WBM roads which take about one month for getting dry.

REFERENCE

[1] Global security org military publications "Sub base and Base materials", June 2000.
[2] Indian department of transportation manual "Aggregate Specification and requirement" 1999.
[3] IRC 37-2001 "Guidelines for design of flexible pavement" (second revision) July -2001, New Delhi.
[4] IS 383-1970 "Indian standard specifications for Coarse and fine aggregates from natural source of concrete" (second revision) 1993.
[5] *Kincaid, Peter (1986). The Rule of the Road: An International Guide to History and Practice.*
[6] Lay, Maxwell G (1992), Ways of the World: A History of the World's Roads and of the Vehicles That Used Them, New Brunswick, N.J.: Rutgers University Press, p. 73, ISBN 0-8135-1758-3, retrieved 18 June 2010.
[7] *Lucas, Brian (2005).* "Which side of the road do they drive on?". Retrieved 2006-08-03.
[8] McAdam, John Loudon (1824), Remarks on the Present System of Road Making; With Observations, Deduced from Practice and Experience (8th ed.), London: Longman, Hurst, Rees, Orme, and Brown, Paternobter Row, retrieved 26 September 2011.
[9] Ministry of Road transport and Highways, "Specification of road and bridge works" (fourth revision) Indian Roads Congress, New Delhi, India 2001