A STUDY ON THE MARSHALL PROPERTIES OF DBM MIX PREPARED USING VG-30 AND CRMB-55 AS BINDER MATERIALS

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Abstract

A good bituminous mix design is anticipated to produce a mix which is supposed to be sufficiently sturdy, long-lasting, resistive.DBM is used as a binder course in the highway pavement. Binder is a prime material in the bituminous mix. Marshall properties of bituminous mix varies from binder to binder. In this work an effort has been ended to evaluate the Marshall properties of dense bituminous macadam prepared using VG-30 and CRMB-55 as binder materials. DBM mix is prepared using 2% lime as filler material and VG-30, CRMB-55 as binder material. Marshall method of bituminous mix design is adopted to decide the optimum bitumen content (OBC)and Marshall properties were determined at optimum bitumen content. On the basis of limited laboratory studies carried out, it is conclude that CRMB-55 is superior binder material in terms of Marshall properties.

Key Words: *VG-30, CRMB-55, Lime, and DBM.*

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1. INTRODUCTION

Greater part of the roads in India is black topped. Earlier due to scarcity of cement, it was a trend and convention to adopt the bituminous road as flexible pavement. Therefore, bituminous pavement are adopted over cement concrete roads, since it has a immense pro that these pavement can be enhanced and strengthened as the traffic increases in the different phase.. Dense bituminous macadam is a binder course used for road construction with more number of heavy commercial vehicles. The permanence and remote future acceptable performance of pavements are invariably shaped and altered to a large scale by the occupied pavement integral materials and their natural properties. In DBM, constituents of mix such as coarse aggregate, fine aggregates, filler material and bitumen or modified bitumen as binder material are the chief ingredients and therefore mandatorily have to posses superior quality without any compromise. Hence the choice of pavement material is an essential assignment. The pertinence and glutinous properties of binder material, moreover with the appropriate proportioning of coarse aggregates and fine aggregate is the fundamental necessity to result in effective and applicable bituminous mixes. In a DBM mix, there is a wide scope for using different types of binder to obtain a good mix without affecting the durability of pavement.

2. OBJECTIVES OF PRESENT STUDIES

The main objectives of the analysis are-

- Ensure the properties of aggregates by conducting the test in the laboratory as per MoRT&H (IV Revision) specification.
- To conduct tests on bitumen binder.
- To determine the optimum bitumen content for bituminous concrete mix (Grade-2) prepared using VG-30 and CRMB-55 as binder materials by adopting Marshall method of bituminous mix design.
- To determine the Marshall properties of bituminous concrete mix (Grade-2) prepared using VG-30 at OBC.
- To determine the Marshall properties of bituminous concrete mix (Grade-2) prepared using CRMB-55 at OBC.
- To compare the Marshall properties of bituminous concrete mix (Grade 2) prepared using VG-30 and CRMB-55.

3. EXPERIMENTAL INVESTIGATION

DBM mix is prepared using viscosity grade (VG-30) and CRMB-55 as binder material . Aggregate material was tested in the laboratory to ensure its selection as pavement material for the construction of road. Marshall method of bituminous mix design is used for preparing bituminous mix design.

3.1 Aggregates

Aggregates posses good shear and compressive strength, therefore results in better interlocking properties. To assess the properties of aggregates i.e. sufficient strength, hardness, toughness, specific gravity and shape, tests were conducted on aggregates in the laboratory and the test results are presented in table-1.

Table-1: Aggregates Test Results

Test Particulars	Test Results	Requirements as per MORT&H
Aggregate impact value (%)	20.46%	Max 27%
Los Angeles abrasion value (%)	25.68%	Max 35%
Combined Flakiness and Elongation Index, (%)	22.41%	Max 35%
Water absorption (%)	0.36%	Max 2%
Aggregate specific Gravity		
• Coarse aggregate	2.67	Min 2.5
• Fine aggregate	2.655	

3.2 Mineral Filler:

Mineral filler fills the voids, stiffens the binder and offers permeability. In the present study, lime is used as mineral filler. The specific gravity of lime is found as 2.34 and gradation details are presented in the table 2.

Table-2: Gradation Details of Lime as Filler Material

IS Sieve size (mm)	Cumulative %passing by weight of total aggregates	
	Obtained	Requirement as per MORTH IV Revision
0.6	100	100
0.3	100	95-100
0.075	97	85-100

3.3 Bitumen

In the present study viscosity grade (VG-30) bitumen and CRMB-55 is used as binder materials and tested for the conventional tests like Penetration, Softening point, Ductility, Flash point, Specific gravity and Viscosity. Specific gravity of binder VG-30 and CRMB-55 are 1.011 and 1.02 respectively. Table-3 and Table-4 present the outcomes of experiments.

Table-3: Bitumen (VG-30) Test Results

Test Particulars	Test outcome	Specifications as per IS73:2006
Penetration at 25°C, 100gm, 5 Seconds, 0.1mm	60	50-70
Softening point (Ring & Ball), °C	51.4	Min 47
Flash point, °C	263	Min 220
Fire point, °C	278	Min 220
Ductility @27 °C, cm	92	Min 75

Table-4: CRMB-55 Test Results

Test Particulars	Test outcome	Specifications as per IRC SP-53:2010
Penetration at 25°C, 100gm, 5 Seconds, 0.1mm	58	50-80
Softening point (Ring & Ball), °C	59	Min 55
Flash point, °C	269	Min 220
Elastic Recovery	84	Min 60
Separation	2	Max 3
Ductility @27 °C, cm	98	Min 60

Table-5 : Thin film oven test result of CRMB-55

Test Particulars	Test outcome	Specifications as per IRC SP-53:2010
Loss in mass, %	0.51	Max 1
Increase in softening point	3	Max 6
Reduction in penetration of residue	31	Max 35
Elastic recovery of half thread	65	Min 50

3.4 Aggregate Gradation:

Bituminous concrete mix (Grading-2) is adopted for the present study as MoRT&H (IV revision) and presented in table 6.

Table-6: Aggregate Gradation for Bituminous Concrete Mix (Grading-2)

Sieve Size in mm	% Passing (Specified)	% Passing (Mid Limit)
45	100	100
37.5	95-100	89.5
26.5	63-93	79
13.2	55-75	62
4.75	38-54	50
2.36	28-42	41
0.3	7-21	32
0.075	2-28	23

3.5 Marshall Method of Mix Design

The stability of a bituminous mix can be explained as load carried by Marshall specimen at the 60 degree Celsius. Flow is measured as deformation of Marshall specimen in the units of 0.25mm. The two main aspects of Marshall method of bituminous mix design are Stability flow test and density void analysis.

4. ANALYSIS OF DATA

Marshall Properties of DBM (Grade-1) prepared using VG-30 and CRMB-55 as binder material are determined. The results obtained for Marshall properties of bituminous concrete mix at 4.5%, 5%, 5.5% and 6% bitumen content are presented in table-7 to table-10.

Table-7: Marshall properties of bituminous concrete mix prepared using VG-30 as binder material

Bitumen content %	Marshall stability, kg	Flow mm	Bulk density gm/cc	Total air voids, %	Voids Filled with bitumen %	Voids in Mineral Aggregates, %
3.5	2234.7	2.5	2.37	5.71	58.31	13.69
4	2629.8	3.3	2.38	4.56	66.67	13.7
4.5	2937.6	3.6	2.39	3.71	73.48	14.01
5	2650.8	4.1	2.37	3.7	75.58	15.18
5.5	2353.05	4.5	2.36	3.5	78,42	16.22

Table-8: Marshall properties of bituminous concrete mix prepared using VG-30 as binder material at optimum bitumen content

SN	Marshall properties	Test results obtained	Requirements as per MORT&H (IV revision) Specifications
1	Optimum Bitumen Content (%)	4.076	Min 5
2	Marshall Stability, kg	2960.31	900
3	Flow, mm	3.6	2.0 - 4.0
4	Air voids,(Vv) %	3.5	3.0 - 6.0
5	VMA, %	13.89	Min 14
6	VFB, %	74.7	65-75

Table-9: Marshall properties of bituminous concrete mix prepared using CRMB-55 as binder material

Bitumen content %	Marshall stability, kg	Flow mm	Bulk density gm/cc	Total air voids, %	Voids Filled with bitumen %	Voids in Mineral Aggregates, %
3.5	2280	2.6	2.38	5.54	59.02	13.53
4	2796.51	3.5	2.383	4.74	65.82	13.88
4.5	3190.14	3.7	2.394	3.62	73.98	13.92
5	3061.8	4.3	2.38	3.52	75.3	15.24
5.5	2787.84	4.4	2.368	3.34	79.25	16.1

Table-10: Marshall properties of bituminous concrete mix prepared using CRMB-55 as binder material at optimum bitumen content

SN	Marshall properties	Test results obtained	Requirements as per MORT&H (IV revision) Specifications
1	Optimum Bitumen Content (%)	4.383	Min 5
2	Marshall Stability, kg	3168	900
3	Flow, mm	3.7	2.0 - 4.0
4	Air voids,(Vv) %	3.54	3.0 - 6.0
5	VMA, %	13.85	Min 14
6	VFB, %	74.44	65-75

Result obtained for Marshall properties of bituminous concrete mix prepared using VG-30 and CRMB-55 as filler materials are presented in fig1- fig5.

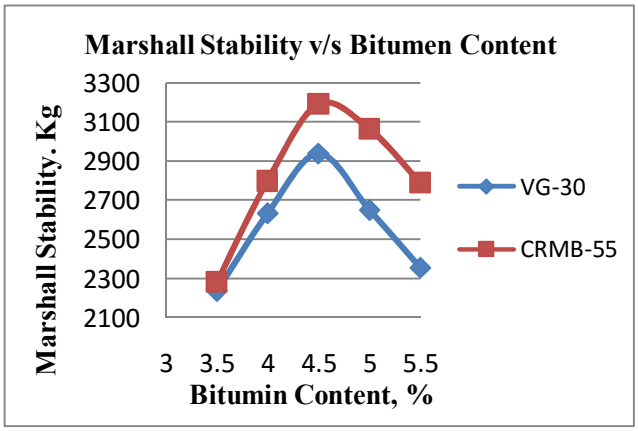

Fig-1: Marshall Stability V/S Bitumen Content

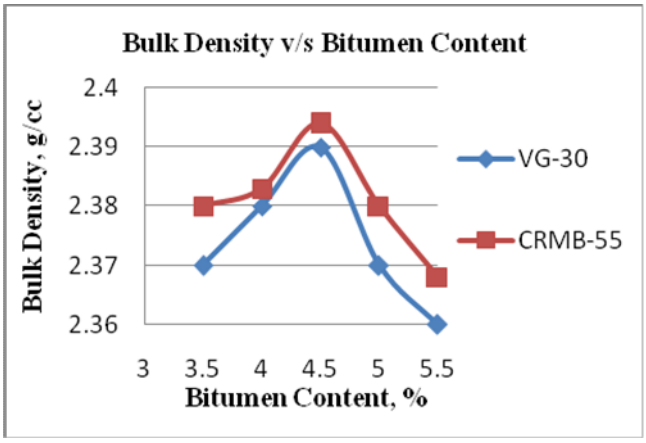

Fig-2: Bulk Density V/S Bitumen Content

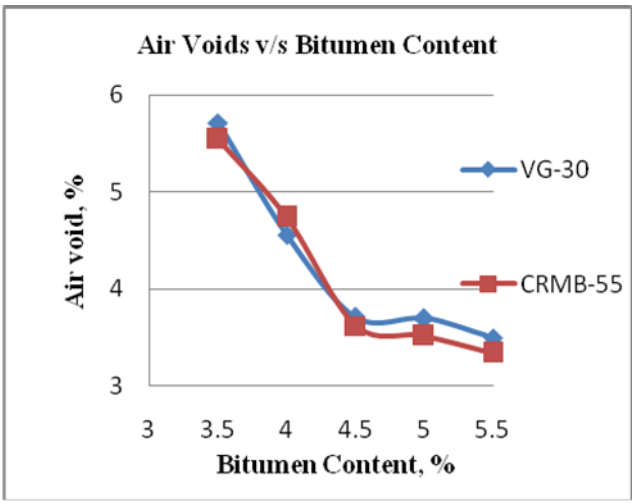

Fig-3: Air Voids V/S Bitumen Content

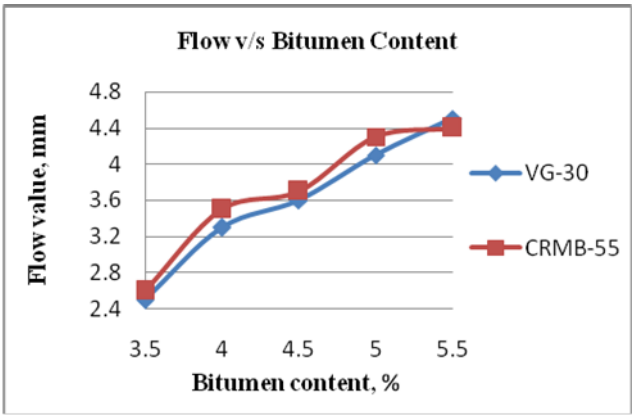

Fig-4: Flow V/S Bitumen Content

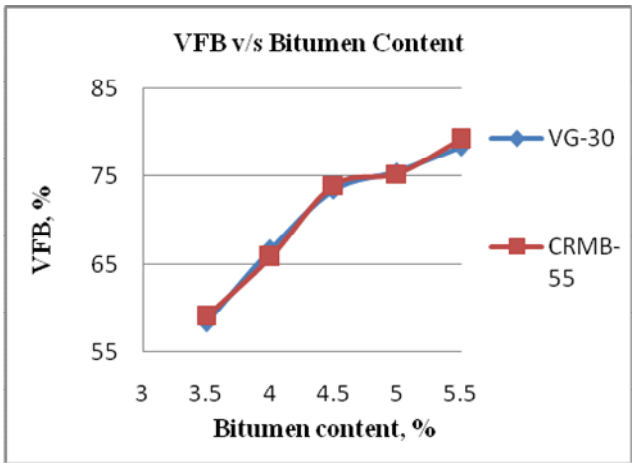

Fig-5: VFB V/S Bitumen Content

5. DISCUSSION

The results obtained for the Marshall properties of bituminous concrete mix specimen prepared using VG-30 and CRMB-55 as binder materials are discussed in the following points-

- There is marginal reduction in optimum bitumen content of about 0.78% in the specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.
- There is substantial increase in Marshall stability value of about 15.10% in the specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.
- There is no variation in bulk density value of specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.
- There is marginal increase in percentage air voids value of about 1.10% in the specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.
- There is marginal increase in flow value of about 2.70% in the specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.
- There is marginal reduction in VMA value of about 0.29% in the specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.
- There is marginal reduction in VFB value of about 0.35% in the specimens prepared using CRMB-55 as binder material when compared to specimens prepared using VG-30 as binder material.

6. CONCLUSIONS

As per the investigation made in this current study, the following conclusion are drawn.

1. Aggregates are satisfying the requirements as per MORT&H (IVth Revision) specifications.
2. The test results of binder are satisfying the requirements as per IS73:2006 and IRC:SP-53:2010.
3. There is a marginal increase in the stability value for the specimen prepared using VG-30 as binder material.
4. There is no variation in bulk density value of specimens prepared using VG-30 as binder material.
5. There is marginal increase in percentage air voids value for the specimens prepared using VG-30 as binder material.
6. There is marginal increase in flow value for the specimens prepared using VG-30 as binder material.
7. There is marginal reduction in VMA value for the specimens prepared using CRMB-55 as binder material.
8. There is marginal reduction in VFB value for the specimens prepared using CRMB-55 as binder material.
9. On the basis of limited laboratory studies carried out, it can be conclude that CRMB-55 is superior binder material in terms of Marshall properties.

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BIOGRAPHIES

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