"COMPARATIVE STUDY ON THE MECHANICAL PROPERTIES OF NEAT AND MODIFIED BINDER MIX "

Mr. Abhishek P J[1]PG Student, Mr.Suhas R[2]Assistant professor,Dr.S.P.Mahendra[3] Professor

1,2- Department of Highway Technology,
Dayananda Sagar College of Engineering,
Bengaluru, India
3- Department of Civil Engineering,
P.E.S. College of Engineering
Mandya, India

Abstract-

With the growing population, industrialization, urbanization and globalization, there is a demand for clean water, air, waste disposal, safe and rapid transportation system with continuous. With the continuous increase in number of vehicles, require the need of sustainable infrastructure of road. It is necessary to improve the quality and performance pavements. Fly ash can be economically used in a number of ways, such as mineral mixtures in Portland cement, mineral filling and hot asphalt coating.

The basic properties of aggregates and bitumen is found by conduction laboratory experiments. In these dissertation work of comparative study PMB-40 is used as modified bitumen and VG-30 is used as conventional bitumen. Initially the properties of both bitumen is studied individually and its behavior in the Dense Bituminous Macadam (DBM) mix is observed by conducting Marshall Stability test. Later for the DBM mix with VG-30 grade bitumen fly ash is added and change in the mechanical properties of the mix is observed. This is achieved by adding fly ash at the rate of 2%, 4%, 6%, 8%, 10% and 12% by weight of fine aggregates in the DBM mix. The Marshall properties such as stability, flow value, bulk density VFB and VMA is analyzed for VG-30, PMB-40, VG-30 paving mixes with fly as additive. For the mix with maximum strength and minimum strength is analyzed for its performance evaluations using Immersion Wheel tracking equipment.

From this dissertation work it is observed that, maximum stability obtained by adding fly ash as additive in VG-30 paving mix is at 8%. In performance evaluation PMB-40 paving mix has more rutting resistance and which is followed by VG-30 paving mix with fly ash as additive and conventional paving mix. Cost analysis for these three paving mixes having the cost required for construction is very high in PMB-40 bitumen, for DBM construction PMB-40 bitumen mix nearly doubles the cost of VG-30 paving mix. In paving mix with fly ash as additive having the cost of construction which is slightly higher than the VG-30 paving mix but by using fly as additive it is possible to reduce the thickness by 10mm in DBM so this can reduce the cost of construction.

***Key words*—Dense Bituminous Mix,MoRTH, Marshall Stability, Immersion Wheel Tracking, Cost analysis.**

I. INTRODUCTION

Flexible pavements that have a bituminous coating are generally placed in many parts of the world. Heavy traffic caused by the commercial vehicle and the seasonal pavement temperature are responsible for the early development of symptoms such as cracks, ripples, boiling and skinning of the bituminous surface due to climatic changes in different periods of time. Under these conditions, flexible sidewalks will be fragile in winter and mild in summer.Several studies have shown that by adding additives, the properties

of bitumen and the properties of bituminous mixtures can be greatly improved to meet the requirements of the sidewalk so that early development of the disaster can be avoided and the sidewalks deteriorated. Stability, durability, adhesion, slip resistance and workability are desirable properties of good bituminous mixtures. If the above properties are poor in the bitumen mixture, this will lead to a road failure. A good combination is one that has all the desirable properties.

II. SCOPE AND OBJECTIVE OF THE STUDY

To conduct Comparative Study on the Mechanical Properties of Neat and Modified Binder Mix

a) To assess the properties of aggregates and bitumen by conducting the tests in the laboratory.
b) To study the effect of fly ash as modifier in various proportions in Viscous Grade (VG30) paving mixes using Marshall Stability test.
c) To evaluate the mechanical properties of PMB40 paving mix using Marshall Stability test.
d) To recommend the best paving mix for dense bitumen macadam.
e) To determine asphalt deformation using immersion wheel tracking.
f) To evaluate the economic analysis.

III. MATERIALS USED IN THE STUDY

I. AGGREGATES:The aggregates selected for the Dense Bituminous Macadam are subjected to various aggregate tests as specified by IRC: SP: 79: 2008 and MoRTH section 500, confirming to the table 500-8. Good durable quality crushed aggregates of different sizes are obtained from quarry Q-con near Mandya.

Table 1: Properties of Coarse Aggregates

SI NO	Aggregate tests	Standard results as per MORTH-500
1	Aggregate Impact Test	Max 27%
2	Specific Gravity	2.5-2.7
3	Flakiness index Elongation index Combined index	Max 30%
4	Abrasion test	Max 35%
5	Water Absorption	Max 2%
6	Crushing strength	Max 30%

II. BINDER:.Bitumen (VG-30) and PMB40 was used as the binder in the mixture design of Dense Bituminous Macadam Mix throughout the dissertation work.

Table 2: Properties of Bitumen

SI NO	Test Method	Standard results MoRTH-500 (IS:73)
1	Specific gravity test	1.02
2	Penetration test	Min 45 mm
3	Ductility test	Min 40 mm
4	Viscosity test	30 centi poise
5	Softening point test	45°c-55°c

III. **MINERAL FILLER***:* The Stone dust has been used as the mineral filler in the Dense Bituminous mixture grading requirement of mineral filler are followed as given in MoRTH-500. The gradation requirements of mineral filler are given in Table 3.

Table 3: Gradation details of Mineral Filler

IS SIEVE (mm)	Cumulative per cent passing by weight of total aggregates
0.6	100
0.3	95-100
0.75	85-100

IV. RESULTS AND DISCUSSION

A. Aggregates The aggregates were evaluated for various physical properties in accordance with the Indian Standard specifications. Table5 represents the test results of physical characteristics of aggregates used in the present dissertation work.

B. Binder Bitumen (VG-30) and (PMB-40) was used as binders in the mixture design of Dense Bituminous Macadam Mix throughout the dissertation work. Table6 gives the experimental results.

C. Mineral filler The Stone dust has been used as the mineral filler in the Dense Bituminous mixture

D. Additive Fly ash has been used.

Table 4: aggregate test results

SI NO	Aggregate tests	Results
1	Aggregate Impact Test	20.8%
2	Specific Gravity	2.6
3	Flakiness index Elongation index Combined index	13.80% 13.62% 27.42%
4	Abrasion test	24.81%
5	Water Absorption	0.2%
6	Crushing strength	28.46%

Table 5: Bitumen test results VG-30

SI NO	Test Method	Results
1	Specific gravity test	1.02
2	Penetration test	65mm
3	Ductility test	94mm
4	Viscosity test	30 centi poise
5	Softening point test	49°c

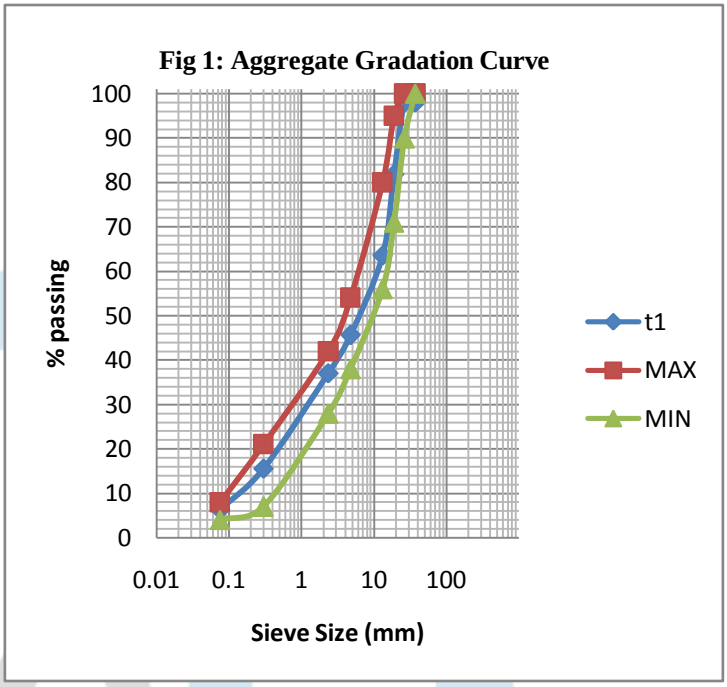
Table 6: Bitumen test results PMB-40

SI NO	Test Method	Results
1	Specific gravity test	1.02
2	Penetration test	45mm
3	Ductility test	104mm
4	Viscosity test	-
5	Softening point test	60°c

E. Aggregate Gradation

After the basic tests, the aggregates are further used in the determination of the proper blend to give a good mix consisting of different size of aggregates.The aggregate gradation is done by using Job Mix Formula Method to find the individual percentages of different sized aggregates to be used confirming to the upper and lower limits specified as per MoRTH table 500-10 grading-2. The gradation of aggregates for DBM-grade2 mix as shown in Table 7.

Table 7:AGGREGATE GRADATION			
Material A: 19mm-12.5mm: 53% Material B: 12.5mm-2.36mm: 2% Material C: 2.36mm-0.075mm: 43% Material D: 0.075-PAN : 2%			
MoRTH specification			
Upper limit	Lower limit	Middle limit	Trail mix
100	100	100	98
100	90	95	98
95	71	83	82
80	56	68	64
54	38	46	46
42	28	35	37
21	7	14	16
8	4	6	6



F. **Marshall Stability Test for various paving mixes**

. Following tables gives the average Marshall stability values for different paving mixes.

Table 8: Marshall Stability resultsof VG-30 paving mix

% of Bitumen	Bulk density gm/cc	Gt	Gb	Air voids	Vb %	VMA%	VFB	Stability Kg	Flow mm
4.5	2.28	2.43	2.31	4.93	9.93	14.86	66.82	839.046	1.9
4.6	2.29	2.43	2.32	4.59	10.31	14.89	69.20	1031.04	2.20
4.8	2.29	2.42	2.31	4.43	10.46	14.88	70.27	783.32	3
5.0	2.26	2.41	2.33	3.38	11.02	14.40	76.50	678.05	3.9
5.2	2.25	2.41	2.34	2.64	11.33	13.97	81.08	667.49	4.7

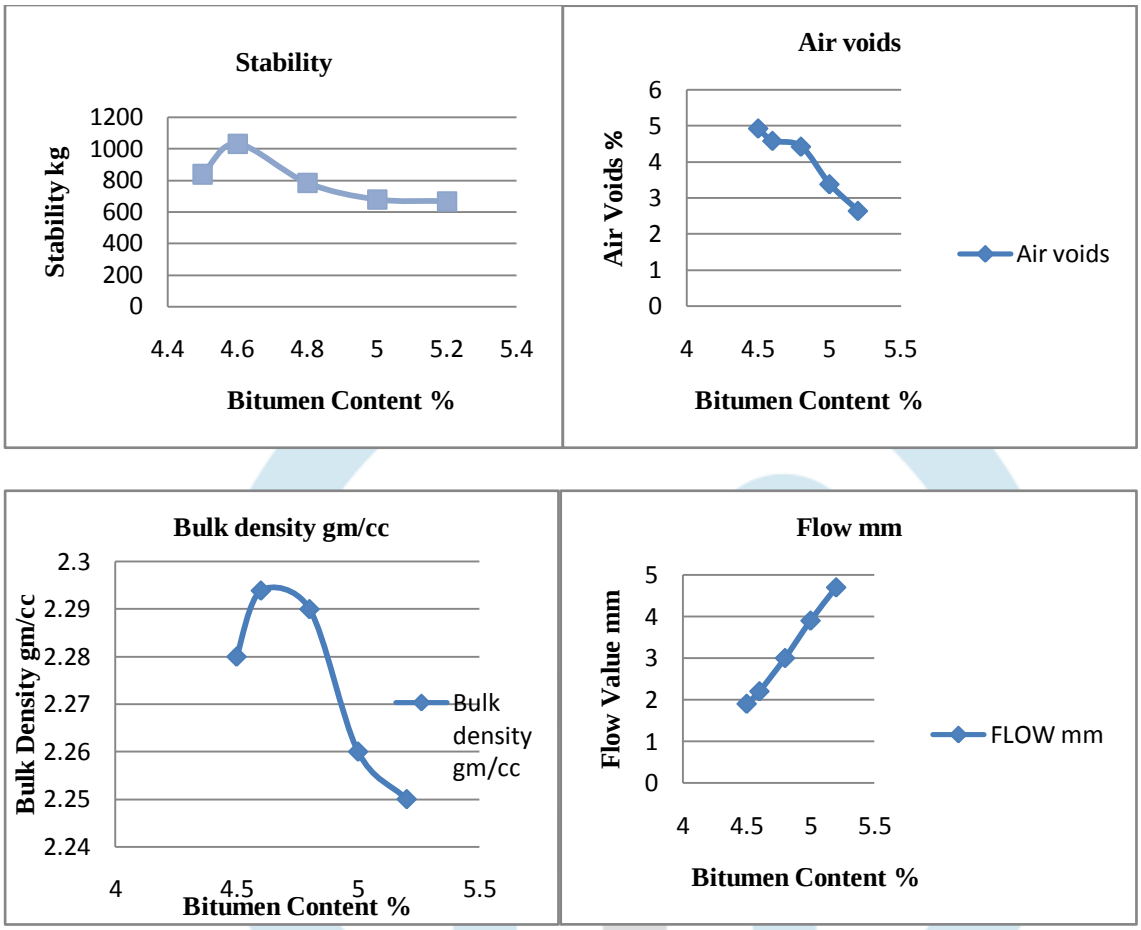


Figure 2: Volumetric properties VG-30 paving mix

Table 9: Marshall Stability results of VG-30 paving mix

% Bitumen by weight of mix	Bulk density gm/cc	Gt	Gb	Air voids	VB	VMA%	VFB	Stability Kg	Flow mm
4	2.255	2.37433	2.23118	6.02879	8.43348	14.4623	58.3137	1637	2.25
4.5	2.241	2.35373	2.2167	5.82208	9.40341	15.2255	61.761	1785	2.5
5	2.247	2.3402	2.21099	5.52105	10.4297	15.9508	65.3869	2165	2.62
5.5	2.276	2.32844	2.20745	5.19627	11.4727	16.6689	68.8266	1439	2.87
6	2.356	2.31515	2.20959	4.55941	12.5379	17.0973	73.3326	1198	3
6.5	2.377	2.29408	2.20495	3.88531	13.5107	17.396	77.6655	1182	3.25
7	2.359	2.27964	2.2167	2.76092	14.6275	17.3884	84.1221	1149	3.5

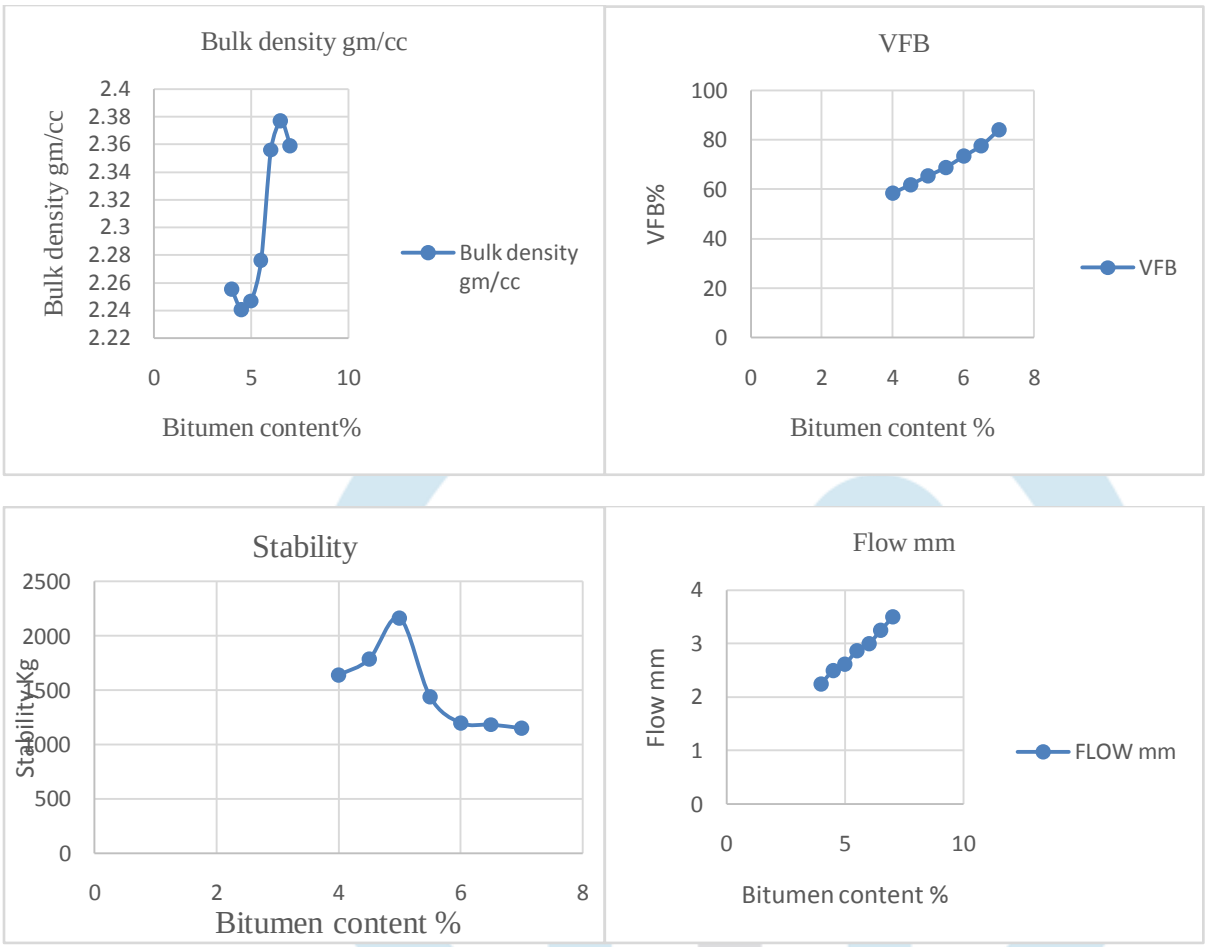


Figure 3: Volumetric properties PMB-40 paving mix

Table 10: Marshall Stability resultsof VG-30 paving mix with fly ash as additive

Fly ash(%)	OBC(%)	Stability(kg)	Flow(mm)	VMA	VFB	Air voids(%)	density(gm/cc)	Gt	Gb	Vb
2	4.65	1254.77	2.98	12.672	80.543	3.6810755	2.466	2.387	2.2999	10.209
4	4.65	1260.37	2.86	12.499	80.462	5.0993563	2.422	2.3884	2.2665	10.1669
6	4.65	1285.32	2.86	12.54	80.905	4.2594489	2.395	2.402	2.3002	10.1455
8	4.65	1608.45	2.81	12.422	80.332	5.8309616	2.443	2.3774	2.2387	9.9804
10	4.65	1237.85	2.66	12.568	80.44	4.5880853	2.457	2.4045	2.29403	10.1107
12	4.65	1123.93	2.34	12.531	80.645	4.6343759	2.426	2.4097	2.298	10.1057

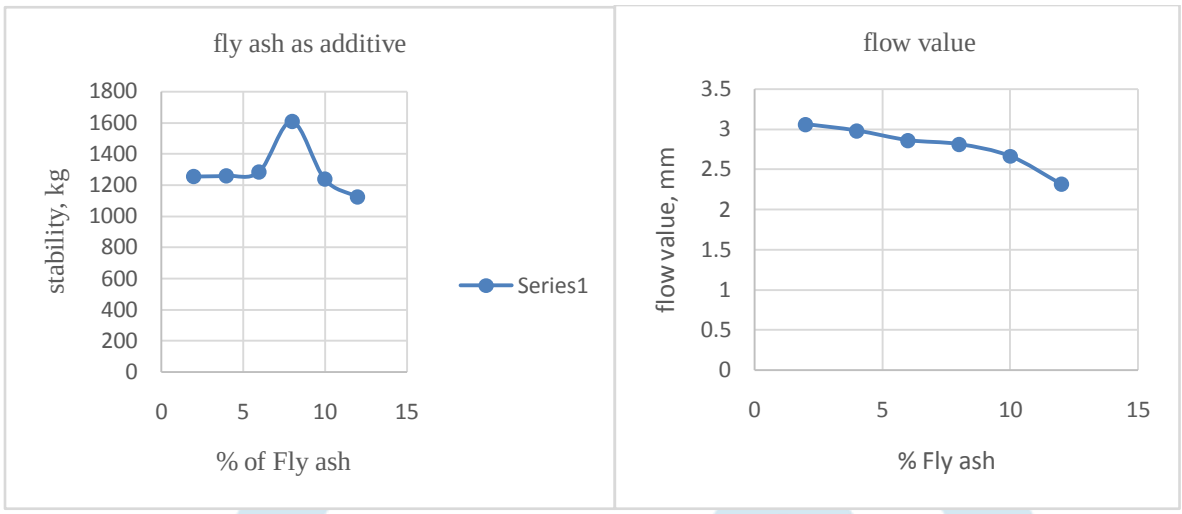


Figure 4: Volumetric properties VG-30 paving mix with fly ash as additive

G. **Immersion wheel tracking**The test results of rutting for 50mm thickness specimens for conventional, VG-30 paving mix with optimum fly ash and PMB-40 paving mix. The graphical representation of Rut depth v/s Number of Passes for 60mm thickness specimen.

Table 4.11: Immersion Wheel Tracking Characteristics

Thickness	60mm
Type of Moulds	• Conventional Mould • PMB40 Paving Mix Mould • 8% of fly ash as additive in VG30 Paving Mix
Binder Content	VG-30 and PMB40
Tyre Pressure	7.2 Kg/cm^2
Speed of Wheel	25 Passes per Minute

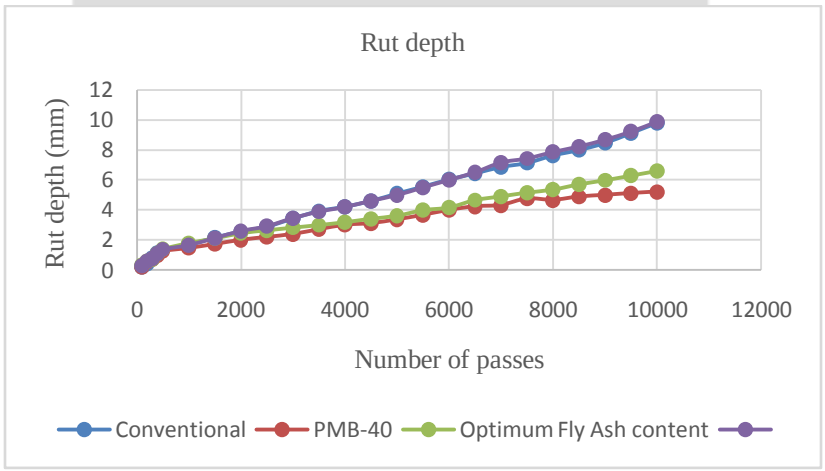


Fig 5: Rutting Characteristics for Various Mixture of 60mm thickness

H. Cost analysis of Bituminous Coarse

Cost analysis for bituminous pavement is done with road details include length of 1000m and carriage width of 5.5m for varying depth between conventional PMB-40 and VG-30 DBM mix of thickness 100mm(BC=40mm, DBM=60mm)

Table 12: Estimated cost of various paving mix

Sl no	Type of paving mix	Estimated cost(lakhs)
1	VG-30	Rs67,23,627
2	PMB-40	Rs88,61,807
3	VG-30 with fly ash as additive	Rs67,30,227
4	Mix with reduced thickness	Rs63,78,447

CONCLUSIONS

The followings are the conclusions based on test results:

A. The aggregates and binder content test results are well in conference with specifications as per IRC: SP: 79: 2008.
B. The stability of the Marshall mix with different proportion of bitumen shows the good results against the minimum Marshall strength of 9KN.
C. Maximum Marshall stability1608.45kg is obtained by adding 8% of fly ash as modifier to VG-30 paving mix. Whereas for VG-30 paving mix maximum stability without adding fly ash was 1031.04 kg.
D. For PMB-40 the maximum stability is 2432.58 kg.
E. In the performance evaluation i.e Immersion wheel tracking test conventional mix have the rut depth of 9.78 mm by the end of 10000 passes for conventional mix.
F. The rut depth of 5.21 mm is recorded for PMB-40 paving mix at the end of 10,000 passes.
G. For VG-30 with 8% fly ash addition the rut depth was 6.59 mm is recorded at end of 10000 passes.
H. In paving mix with fly ash as additive having the cost of construction which is slightly higher than the VG-30 paving mix but by using fly as additive it is possible to reduce the thickness by 10mm in DBM so this can reduce the cost of construction.

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