Investigating an Effect of Fly-Ash as Filler on the Performance of Dense Bituminous Macadam

Bonny M. Bhut[1] Prof. Jigar Sathawara[2] Dr. H. R. Varia[3]
[1]PG Student [2]Assistant Professor [3]Prof. & Head of Department
[1,2,3]Department of Civil Engineering
[1]Tatva Institute of Technological Studies, Modasa, Gujarat India
[2]Gov. Engineering College, Modasa, Gujarat, India [3]AIIE College, Ahemdabad, Gujrat, India

Abstract— Bituminous mixes are used in flexible pavement construction. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together, laid down in layers and then compacted. Fly-ash is disposed very casually, which may cause serious health and pollution problems. Which may lead to adverse effects on the environment. To deal with this problem, here to investigating an effect of use fly-ash as an alternative to conventional material in dense bituminous macadam layer of flexible pavement. In Literatures, there are various tests which have been carried out by replacing fine aggregate fly-ash. The results obtained by laboratory investigation indicate major gain in strength with substantial saving in cost. Marshall Stability Test is a very important test for the bituminous mixes in flexible pavement.

Key words: Marshall Test, OBC (Optimum Bitumen Content), Fly-Ash, Bituminous Concrete, Marshall Stability, Binder

I. INTRODUCTION

Road transport is the second important mode of transport in India. It covers every corner of the country which the railway transport even could not cover. Road transport provides the basic infrastructural facilities to both the agricultural and industrial sector of the country. In India, road transport carries approximately 85% of passenger traffic and 70% of freight transport. But the construction of highways involves huge amount of the investment and mainly sixty percent of the highway project cost is associated with the pavement construction. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements. Around ninety percent of the Indian Highways have a covered surface with bituminous layers which are constructed and maintained by using naturally available road aggregates and bitumen, a petroleum product, which being mixed at high temperatures to produce hot mix asphalt.

II. MATERIALS AND METHODOLOGY

A. Materials Used

1) Aggregates

The Coarse aggregates shall consist of crushed rock, crushed gravel or other hard material. The aggregate shall satisfy the physical requirements of MORTH, Clause 507.2.2

Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on the 75 micron sieve.

Property	Test Method	Results	Specifications
Aggregate Impact Value, %	IS: 2386 Part IV	11.1	24% max.
Water Absorption, %	20mm	IS: 2386 Part III	1	2% max.
	10mm		1.23	
	6mm		1.34	
	Stone Dust		1.40	
Specific Gravity	20mm	IS: 2386 Part III	2.83	2 – 3
	10mm		2.79	
	6mm		2.69	
	Stone Dust		2.62	
Apparent Specific Gravity	20mm		2.91	-
	10mm		2.89	-
	6mm		2.79	-
	Stone Dust		2.71	-
Abrasion value%		IS: 2386 Part IV	16.34	Max. 35

Table 1: Aggregate Testing

IS Sieve size	% Passing				Graded % Passing	Requirement
	20 mm	10mm	6mm	Stone Dust		
mm	40 %	10%	23 %	27%		
37.5	40	10	23	27	100	100
26.5	40	10	23	27	100	90-100
19	33	10	23	27	93	71-95
13.2	5.7	9.6	23	27	65.2	56-80
9.5	1.1	7.2	23	27	58.3	-
4.75	0.3	0.4	16.2	27	43.9	38-54
2.36	0.0	0.0	7.6	26.9	34.4	28-42
1.18	0.0	0.0	2.6	20.8	23.4	-
0.600	0.0	0.0	1.1	16.3	17.4	-
0.300	0.0	0.0	0.8	8.1	8.9	7-21
0.150	0.0	0.0	0.6	4.8	5.4	-
0.075	0.0	0.0	0.0	2.9	2.9	2-8

Table 2: Gradation Of aggregate

2) Bitumen

Bituminous materials or asphalts are extensively used for roadway construction, primarily because of their excellent binding characteristics and water proofing properties and relatively low cost. 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.

Property	Test method	Test result

Penetration value at 25ºC /100gm/5sec	IS:1203-1978	66.6mm
Softening point (ºC)	IS:1205-1978	48.9
Specific gravity	IS:1202-1978	0.99
Viscosity at 60ºC, Poise	I.S. 1206-1978	2717
Ductility	IS:1208-1978	88 cm

Table 3: Bitumen Testing

3) Fly-Ash

Fly ash is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the gases. This ash is divided in to two part. Ash that falls in the bottom of the boiler is called bottom ash. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. There is a two types of fly ash class c and class f.

Sr.No	Test Details	Test Method	Test Results	Requirements as per IS 3812 (Part-1)
1	Consistency	I.S 1727-1967	30.5 %	-
2	Specific Gravity	I.S 1727-1967	2.30	-
3	Soundness by Le-chatlier Method	I.S 1727-1967	1.0 mm	-
4	Fineness – By Blain's air	I.S 1727-1967	350m2/kg	Shall not less than 320 m2/kg
	Permeability Method			

Table 4: Fly ash Testing

B. Preparation of Mix Specimens

The coarse aggregate, fine aggregate, and the filler material should be proportioned so as to fulfil the requirements of the relevant standards. The required quantity of the mix is taken so as to produce compacted bituminous mix specimens of thickness 63.5 mm approximately. 1200 gm of aggregates and filler are required to produce the desired thickness.

III. TESTING

A. Marshall Test

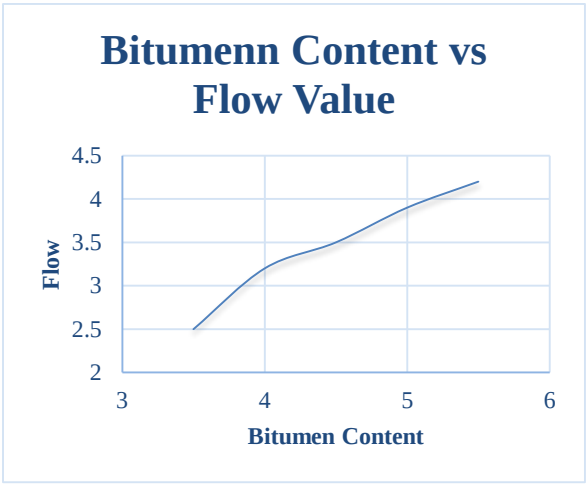
In this method, the resistance to plastic deformation of a compacted cylindrical specimen of bituminous mixture is measured when the specimen is loaded diametrically at a deformation rate 53 of 50 mm per minute. There are two major features of the Marshall method of mix design. (i) density-voids analysis and (ii) stability-flow tests. The Marshall stability of the mix is defined as the maximum load carried by the specimen at a standard test temperature of 60°C. The flow value is the deformation that the test specimen undergoes during loading up to the maximum load.

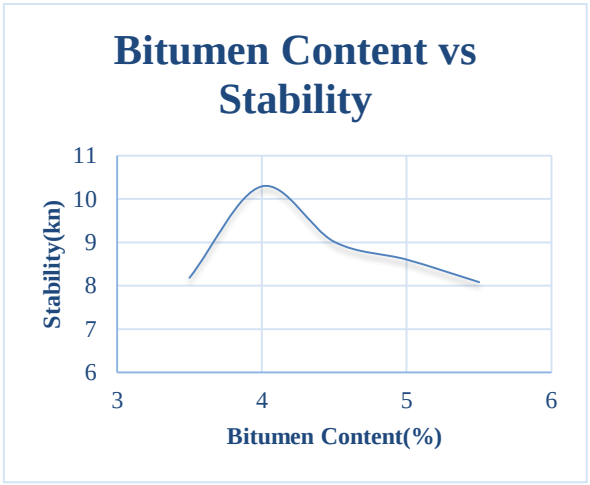
1) Marshall Properties

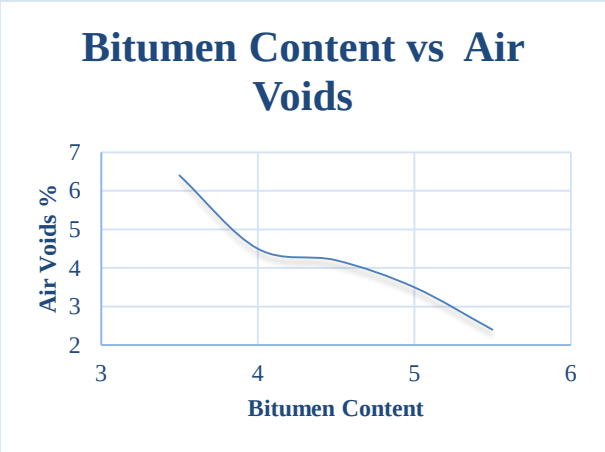
To find the optimum bitumen content three specimens for each combination having bitumen content in the order 3.5%,,4%,4.5%,5% and 5.5% were prepared and the average of these results has been reported. The results of Marshall Tests have been presented in graph 1 through 6, in which the variations of Marshall Properties with respect to bitumen contents considered in this study are shown.

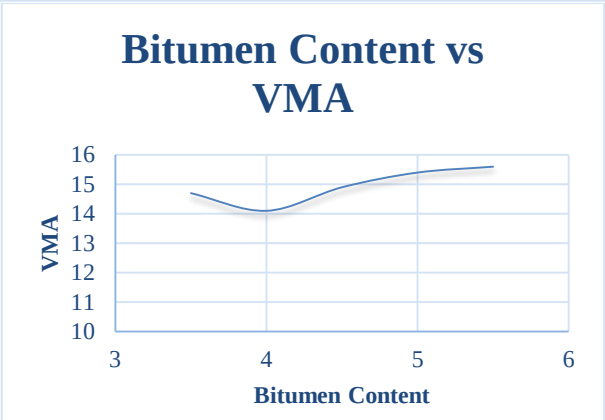
Sr. No.	% Bitumen	Gm	% Air Voids	% VMA	% VFB	Stability (Kn)	Flow (mm)
1	3.5	2.49	6.4	14.7	56.5	8.18	2.5
2	4.0	2.52	4.5	14.1	68	10.29	3.2
3	4.5	2.51	4.2	14.9	71.8	9.01	3.5
4	5.0	2.51	3.5	15.4	77.3	8.60	3.9
5	5.5	2.52	2.4	15.6	84.6	8.08	4.2

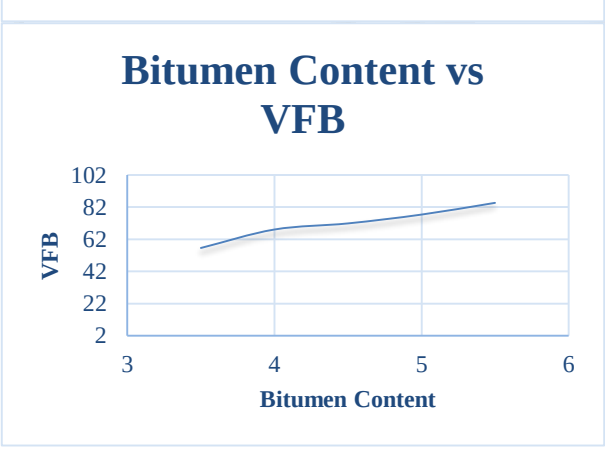
Table 5: DBM Mix Parameters at Different Binder Content

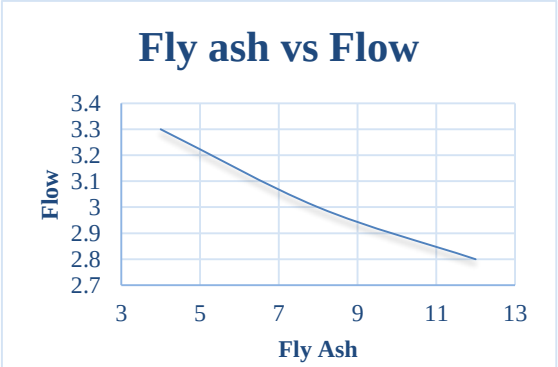


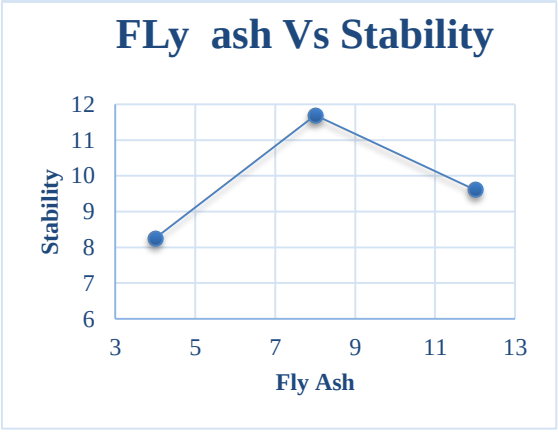












B. Marshall Test with Fly ash

Now optimum bitumen content is selected as 4% .Bituminous mix is prepared by replace stone dust with fly ash. Here stone dust is replaced by 4%.8% and 12% of fly ash.

Sample No	% Bitumen by total Wt. of mix	% fly-ash by	Stability (KN)	Flow (mm)
1	4	4.00	8.26	3.3
2		8.00	11.70	3.0
3		12.00	9.61	2.8

Table 6: Stability and flow value for Different Fly ash content

IV. CONCLUSION

S.NO	1	2	3	4
Fly Ash content (%)	0	4	8	12
Stability(kn)	10.29	8.26	11.70	9.61
Flow(mm)	3.2	3.3	3	2.8

The stability value highest at 4.0% bitumen. Variation of stability and flow of bituminous mix with percentage replacement of fine aggregates by Fly-ash with 4%, 8% and 12% Fly-ash. The stability value increased by 4.0% Bitumen and 8% Fly-ash replacement and decreased by 12% fly-ash replacement. In this experimental work, it is observed that the 8 % of stone dust can be volumetrically replaced by Fly-ash in DBM layer having 4 % optimum bitumen content gives the best stability value. When the Fly-ash percentage goes on increasing beyond 8% decrease in stability is observed clearly indicating negative results from excess use of fly-ash

REFERENCES

[1] IS: 1202, 1978. Methods for Testing Tar and Bituminous Materials: Determination of Specific gravity. Bureau of Indian Standards, New Delhi, India.
[2] IS: 1203, 1978. Methods for Testing Tar and Bituminous Materials: Determination of Penetration. Bureau of Indian Standards, New Delhi, India.
[3] IS: 1205, 1978. Methods for Testing Tar and Bituminous Materials: Determination of Softening Point. Bureau of Indian Standards, New Delhi, India.
[4] IS: 1206, 1978. Methods for Testing Tar and Bituminous Materials: Determination of Viscosity. Bureau of Indian Standards, New Delhi, India.

[5] IS: 2386 (Part I). 1963. Methods of test for aggregates. Bureau of Indian Standards, New Delhi, India.
[6] IS: 2386 (Part III). 1963.Methods of test for aggregates. Bureau of Indian Standards, New Delhi, India.
[7] IS: 2386 (Part IV). 1963. Methods of Test for Aggregates Bureau of Indian Standards, New Delhi, India.
[8] Katara, S.D., Modhiya, C.S., Raval, N.G., (2014) "Influence of Modify Bituminous Mix with Fly Ash "International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-2, Issue-April 2014
[9] Durga, B.P., AJAY, P.V.K., Dedeepya, K., Shabuddin, A., Rao, K.S., (2015) "Use of fly-ash as a mineral filler for bituminous paving" IJRET: International Journal of Research in Engineeringand Technology eISSN: 2319-1163 | pISSN: 2321-7308.
[10] Debashish, K., Panda, M., Giri, J.P., (2014) "Influence of fly-ash as a filler in bituminous mixes" VOL. 9, NO. 6, JUNE 2014 ISSN 1819-6608 ARPN Journal of Engineering and Applied Sciences ©2006-2014 Asian Research Publishing Network (ARPN).
[11] Lunagaria, M.H., and Gatesi Jean De Dieu (2015) "Utilization of High Calcium Fly Ash as Filler Materials in Concrete Bituminous Mixes for Flexible Pavement " IJSRD - International Journal for Scientific Research & Development| Vol. 2, Issue 11, 2015 | ISSN (online): 2321-0613.

