USE OF FLY ASH AS MINERAL FILLER FOR BITUMINOUS PAVING MIXES

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Abstract

The increase of crude oil prices in recent years resulted in an increase in bitumen prices as crude oil is origin for bitumen, asphalt & in other hand the fly ash from the power generating plants causes severe disposal problems. The main purpose of this project is to study the possibility of using fly ash as mineral filler in Bituminous paving mixes where in general cement, stone dust are used. Fly ash obtained from Dr.NTTPS, Vijayawada, AP has been used in this present experimental work. Coarse aggregates of sizes 40mm, 20mm, 10mm, 6mm available at the crusher units nearby Ibrahimpatnam are used. For comparison, stone dust also used to prepare control mix. Marshall stability test is employed to determine the properties like stability, flow value,% air voids, voids in mineral aggregate(VMA), voids filled with bitumen(VFB) for a Dense Bituminous Macadam(DBM) mix of Grading I. The experimental work is carried out by using specifications from MORTH(Ministry of road transports & highways, specifications for road & bridge works,5th revision).By replacing the stone dust with fly ash at the levels 4%, 8%, 12% the results are compared. The variation of properties, optimum bitumen and fly ash contents are evaluated. It is observed that the mixes with fly ash as filler not differ much in properties when compared with control mix and satisfy desired criteria specified by a much higher margin. Hence, it has been recommended to utilize fly ash wherever available, not only reducing the cost of execution, but also partly solve the fly ash utilization and disposal problems.

Keywords: *DenseBituminousMacadam (DBM), Marshall Properties, Optimum bitumen content, Optimum fly ash content*

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1. INTRODUCTION

All over the world aggregates bound with bitumen are conventionally used in construction and maintenance of surface course of a flexible pavement. The surface course normally comprises of bituminous mixtures comprising of coarse aggregate, fine aggregate and filler heated to suitable temperature, mixed thoroughly with heated bitumen at required viscosity and then compacted. Bituminous concrete (BC) is a well graded mixture containing coarse aggregate (50-60%), fine aggregate (40-50%), filler (6-10%), bitumen (5-6%) of total mass of mix. One of the major concerns of mix design of bituminous mix is the type and amount of filler used which may affect the performance of the mix. Various studies have been conducted to study the properties of mineral filler; generally the material passing 0.075mm IS sieve, to evaluate its effect on performance of asphalt paving mixture in terms of consistency, void filling, Marshall Stability and mix strength.

Fly ash is one of the major waste by-products of coal based thermal power stations. At places around such plants, fly ash is not only abundantly available, it finds little use, for which it creates serious waste disposal problems. Hence, in this study, an attempt has been made to explore the use of fly ash, which is mostly passing0.075 mm sieve and has been considered to be filler in bituminous paving mixes by studying various fundamental engineering properties.

2. MATERIALS AND METHODOLOGY

2.1 Materials Used

2.1.1 Aggregates

Physical properties of coarse aggregate are given below For preparation of dense graded bituminous mixtures, the grading of aggregates was adopted as per MORTH (2013) for bituminous concrete given below(Table-1). Coarse aggregates consist of 40mm, 20mm, 10mm, 6mm IS sieve collected from a local source. The specific gravity of aggregates found in the laboratory was tabulated in Table 1.

Table-1: Specific Gravity of Aggregates

Aggregate size(mm)	Specific gravity
40	2.65
20	2.74
10	2.7
6	2.74

Other physical properties of coarse aggregates are given below.

For DBM of 75mm thickness, adopting Grade-I from MORTH

Table-2: Adopted aggregate gradation

Sieve Size (mm)	Percentage passing By weight (Specified range)	Percentage passing by weight (Adopted)
45	100	100
37.5	95-100	98.2
26.5	63-93	81.3
13.2	55-75	55.9
4.75	38-54	45.4
2.36	28-42	33.5
0.3	7-21	3.98
0.075	2-8	0.12

Table-3: Properties of Aggregates

Property	Test method	Test result
Aggregate Impact value (%)	IS:2386 (Part-IV)	17
Aggregate Crushing value (%)	IS:2386 (Part-IV)	20
Deval's abrasion value (%)	IS:2386 (Part-IV)	19
Flakiness index (%)	IS:2386 (Part-I)	11
Elongation Index (%)	IS:2386 (Part-I)	20
Water absorption (%)	IS:2386 (Part-III)	0.2

Fine aggregate comprises of stone dusts with fractions passing 4.75 mm and retained on 0.075 mm IS sieve were collected from a local crusher. Its specific gravity was found to be 2.65. In order to explore the use of fly ash a very fine waste product of thermal power station in bituminous paving mix, the same collected from local source has been used. For comparison point of view, stone dust collected from local sources has also been used in this study. The specific gravities of stone and fly ash used in this study were found to be 2.7 and 2.2, respectively portion of aggregates passing 0.075 mm is known as filler. Normally, cement and stone dust are used as filler.

2.1.2 Bitumen

S 65 grade bitumen has been used as bitumen for preparation of bituminous mixture. The important physical properties are tabulated in Table-4.

Table-4: Physical Properties of Bitumen

Property	Test method	Test result
Penetration value at 25ºC (0.1 mm)	IS:1203-1978	67
Softening point (ºC)	IS:1205-1978	46.5
Specific gravity	IS:1202-1978	1.01
Flash and fire point	IS:1206-1978	325ºC, 340ºC

2.2 Preparation of Mix Specimens

The samples for bituminous concrete mixtures were prepared as per ASTM D1559-62 at different bitumen contents for each type of filler used. The mixture with stone dust was considered to be control specimens. The optimum bitumen content for each type of filler in bituminous concrete mix was done as per the normal procedure.

3. TEST PROGRAM

3.1 Marshall test

Marshall Test is a simple and low cost standard laboratory test adopted all over the world for design and evaluation of bituminous mixtures. This test has been fundamentally used in this study to evaluate the different mixture at different bitumen contents and the parameters considered are stability, flow value, unit weight, air voids, voids in mineral aggregates, voids filled with bitumen. The optimum bitumen content was selected to have maximum stability, maximum unit weight and median allowable limits for percentage air voids. The average of bitumen content corresponding to these three parameters is selected as optimum bitumen content. All the Marshall criteria of the mixes at OBC are checked with respect to the same given in MORTH (2013). Although Marshall Method essentially empirical, it is useful in comparing mixtures under specific conditions.

3.1.2 Marshall Properties

To find the optimum bitumen content three specimens for each combination having bitumen content in the order 4%,4.25%,4.5% were prepared and the average of these results has been reported. The results of Marshall Tests have been presented in Figures 1 through 6, in which the variations of Marshall Properties with respect to bitumen contents considered in this study are shown.

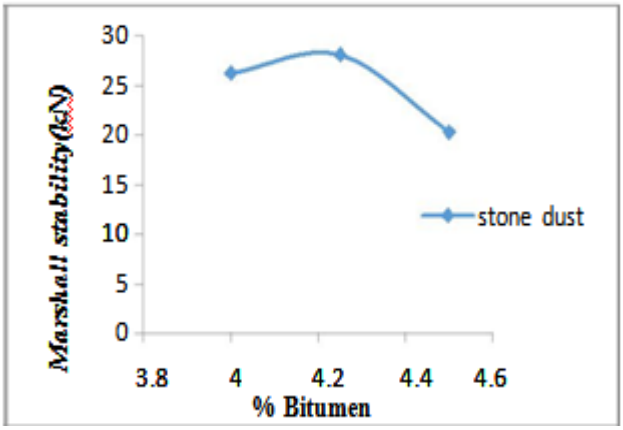

Chart-1: Variation of Marshall Stability with bitumen content

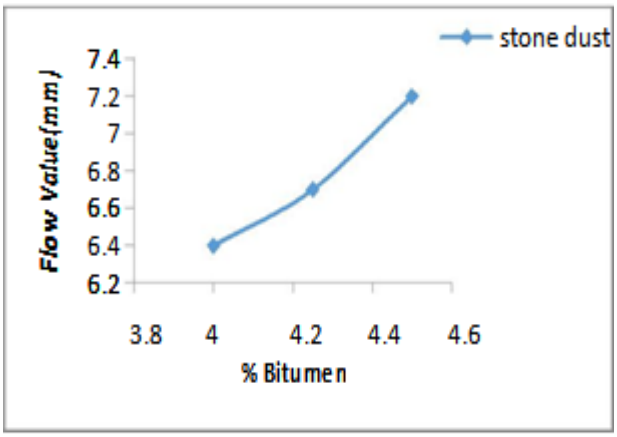

Chart-2: Variation of flow value with bitumen content

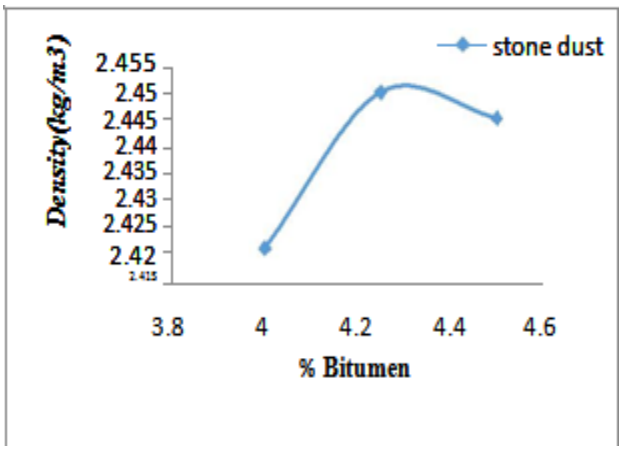

Chart-3: Variation of Density with bitumen content

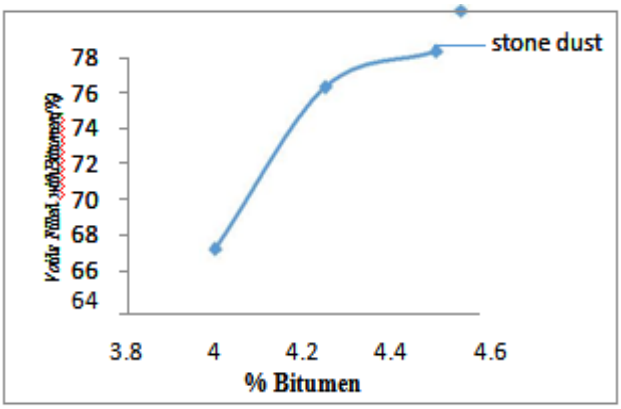

Chart-4: Variation of voids filled with bitumen with bitumen content

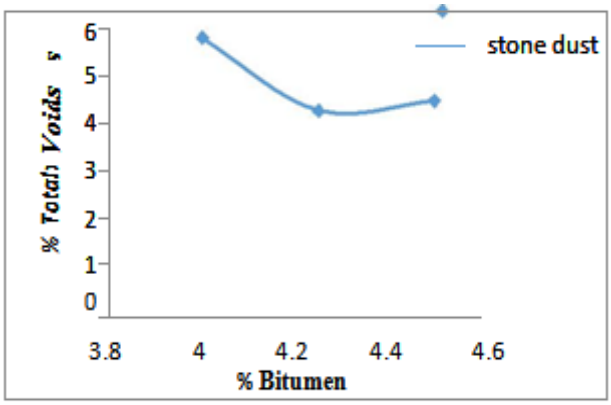

Chart-5: Variation of air voids with bitumen content

From the above charts:1 to 5

- Maximum stability at 4.25% bitumen
- Maximum bulk density at 4.25%
- %air voids is minimum at 4.25 %

3.2 Marshall Test with Fly ash as Filler

As the optimum bitumen content is selected as 4.25% the test mix is preparing by replacing dust with fly ash in the order 4%,8%,12% to find optimum fly ash content. The test results are tabulated below in table-4.The variations of Marshall properties are shown from charts:6 to 10.

Table 4: Results of Marshall test

S.NO	1	2	3	4
Fly Ash content (%)	0	4	8	12
Stability(kn)	28.09	30.315	29.67	29.88
Flow(mm)	4.7	3.3	4.1	5
Density(kg/m3)	2.45	2.46	2.34	2.31
VMA(%)	15.85	14.31	25.87	36.65
VFB(%)	74.42	66.78	71.89	74.69

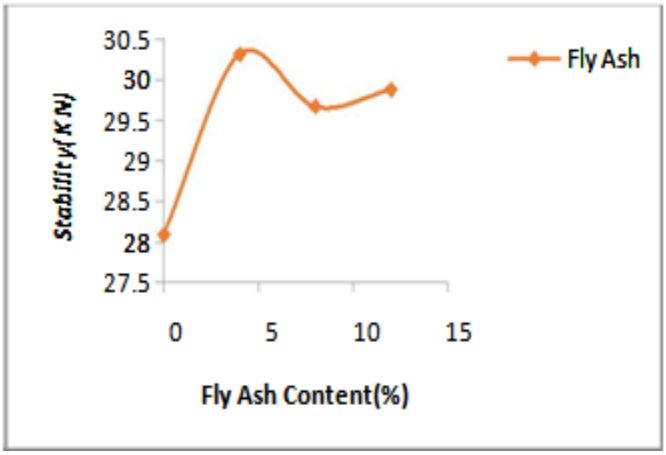

Chart-6: Variation of Marshall Stability with Fly Ash content

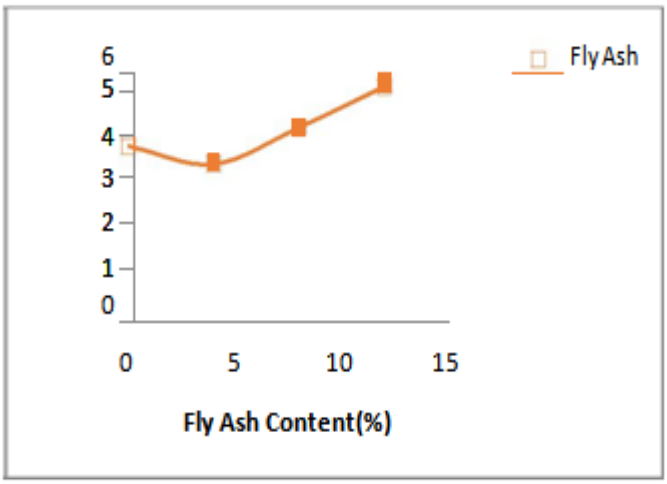

Chart-7: Variation of flow value with Fly Ash content

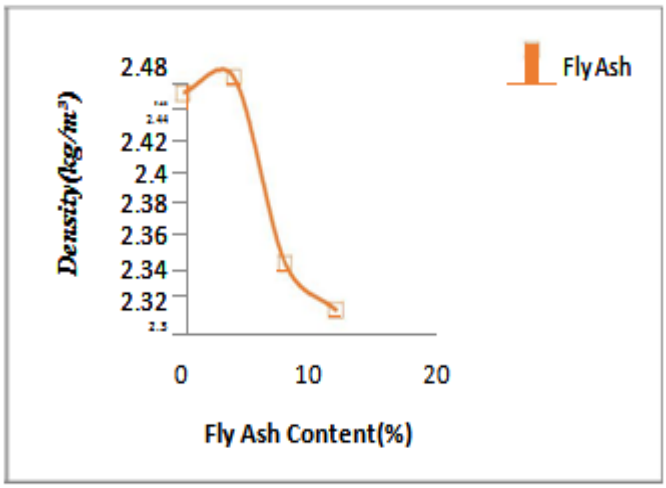

Chart-8: Variation of Density with fly ash content

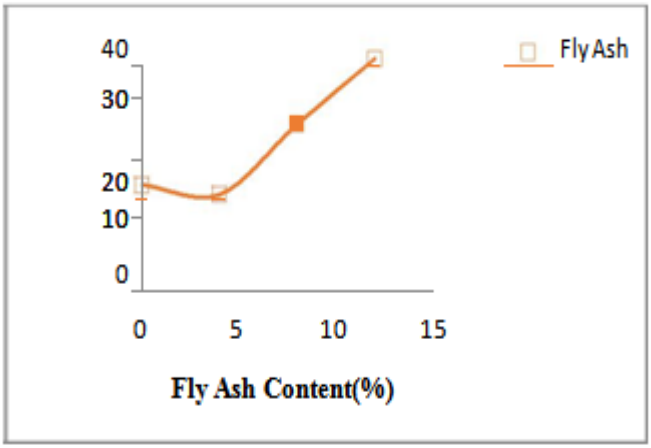

Chart-9: Variation of air voids with fly ash content

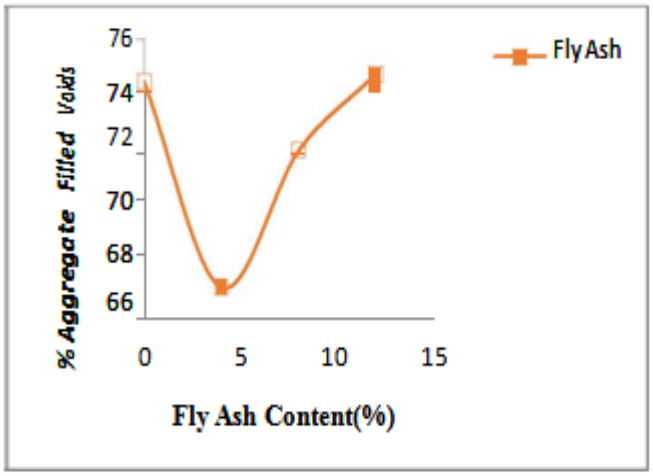

Chart 10: Variation of voids filled with bitumen with fly ash content

4. DISCUSSION

Stability reaches maximum at 4% fly ash content due to decrease of compressive stress subsequently. Flow value reaches minimum at 4% and then increases but it is not recommendable. Density decreases with fly ash content, at 4% voids are filled to maximum extent. For a desirable pavement, voids should be minimum. At 4% fly ash % total voids are minimum. With increase of fly ash, requirement of bitumen is more from chart10 but it is not desirable .Hence 4% fly ash content is optimum.

5. CONCLUSION

From the above study we adopt 4.25% of bitumen content as optimum for DBM. Marshall Properties of 4 -12% of fly ash content are within desirable limits for 4.25% of bitumen content. 4% of fly ash content gives best results. So we can adopt 4% as optimum.

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