Impact of Fly Ash on the Properties Bituminous Mix

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ABSTRACT *Bituminous mix Design is estimated to result in a mix which is sufficiently durable, strong, and to fatigue resistive and permanent deformation, at the same time eco friendly and economical. A mix maker tries to achieve those requirements by a number of tests on the mix with different proportions of material and finalizes the perfect one. This involves a perfect balance between mutually conflicting properties. Design of bitumen mix is a slightly balancing act among the proportions of different aggregate sizes and bitumen content. For a specified aggregate gradation the optimum bitumen content (OBC) is determine by a number of mix design parameters. In bituminous mix fillers play an key role in engineering parameters of bituminous paving mixes. Generally stone dust, lime and cement are used as fillers. An effort has been made in this experiment to assess the impact of non-conventional and easily available fillers such as cement and fly ash in bitumen paving mixes.*

Key Words: *Bitumen, Optimum bitumen content, Optimum fly ash content.*

I. INTRODUCTION

Pavement construction technology has taken a big jump in the developing countries since last 10-20 years. Highway construction contains vast outlay of investment. Fundamentally, pavements can be classified into two groups are flexible and rigid. Flexible pavements consist of surface with bituminous or asphalt materials. These pavements are called "flexible" because of the total pavement structure "bends" or "deflects" due to different traffic loads. The structure of flexible pavement is normally composed of a number of layers of materials which can accommodate this "flexing". While a rigid pavement is composed of a PCC surface course. Such rigid pavements are substantially "rigid" than flexible pavements because of the high modulus of elasticity of the PCC material. Flexible pavements are economical are broadly used as far as possible. A precise design of a flexible pavement may save extensive investment; as well as consistent performance of the service in highway pavement can be achieved

Fly ash is one of the residues taken out from combustion and consists of the fine particles with the flue gases. It is waste material and is dumped on the land. Therefore public road industry is capable of utilize waste material in high margin if their effect on pavement performance proves to be precisely, inexpensively and environmentally satisfactory. Fly ash has successfully been utilized as filler in bitumen paving mixes for a long time and has the advantage of increasing the resistance of bitumen mixes. Aggregates bound with bitumen are properly used all over the world in construction and maintenance of surface course of flexible pavement. Here surface course normally consist of bituminous mixtures of coarse aggregate, fine aggregate and filler heated to appropriate temperature, mixed with bitumen at required viscosity and then compacted. A bituminous paving mixture may be dense graded, gap graded or uniformly graded, containing coarse aggregate (50-60%), fine aggregate (40-50%), filler (6-10%), and bitumen (5-6%) of total mass of mix [1].

II. METHODOLOGY

A. Aggregates

Physical parameters of coarse aggregate are given below (Table-2). For preparation of bituminous paving mixture the grading of aggregates was taken as per MORTH (2013) given below (Table-1). Coarse aggregates consist of stone chips up to 4.75 mm IS sieve collect from a local resource. Its specific gravity found in the laboratory was 2.68 [1, 2].

TABLE I: ADOPTED AGGREGATE GRADATION

Sieve Size (mm)	Percentage passing by weight (Specified)	Percentage passing by weight (Adopted)
26.5	100	100
19	90-100	97
9.5	60-80	77
4.75	35-65	55
2.36	20-50	45
0.30	3-20	18
0.075	2-8	6

TABLE II: PHYSICAL PROPERTIES OF AGGREGATES

Parameters	Test method	result
Water absorption	IS 2386-part 3	2.5
Aggregate Impact value	IS 2386-part 4	7.5
Aggregate Crushing Value	IS 2386-part 4	20.5
Flakiness index (%)	IS 2386-part 1	24.22
Elongation index (%)	IS 2386-part 1	29.10

Fine aggregate comprises of river sand with fractions passing 4.75 mm and retained on 0.075 mm IS sieve were collected from local crusher. Its specific gravity was found to be 2.5.

B. Bitumen

VG 10 grade bitumen has been used as bitumen for preparation of bituminous mixture. The important physical properties are given below (Table-3).

TABLE III: PHYSICAL PROPERTIES OF BITUMEN

Parameters	Test method	result
Penetration value at 25ºC (0.1 mm)	IS:1203-1978	67
Specific gravity	IS : 1202-1978	1.01
Softening point (ºC)	IS:1205-1978	49
Flash and fire point	IS:1206-1978	325ºC, 340ºC

C. Preparation of mix specimen

The specimen for bituminous paving mixtures was prepared as per ASTM D1559-62 (American Society for Testing and Materials) [12] at different bitumen contents for both type of filler used. The mixture with ordinary Portland cement was considered to be control specimens. The optimum bitumen content for both type of filler in bituminous paving mix was done as per the normal procedure

D. Marshall Test

Marshall Test has been fundamentally preferred in this test to evaluate the mixture at different bitumen contents and the properties considered are stability, flow value, unit weight, % air voids, voids in mineral aggregates, voids filled with bitumen. Optimum bitumen content (OBC) was selected on the basis of maximum stability, maximum unit weight and minimum allowable limits for percentage air voids. All the criteria of the Marshall mixes at OBC are checked with respect to the given in MORTH (2013) [13]. This Marshall Method is essentially empirical, and useful in comparing mixtures under specific conditions

1) *Marshall Test with ordinary Portland cement:* Three specimens for different bitumen content were prepared and the average of these results has been reported [3]. To find the optimum bitumen content five specimens for every combination having bitumen content in the order 4%, 4.5%, 5%, 5.5%, 6% were prepared, Marshall stability value and unit weight increase with bitumen content up to 5% after which these two parameters decrease [1,2]. The variations are only marginal and the discrepancy, particularly, stability to be considered is not significant.

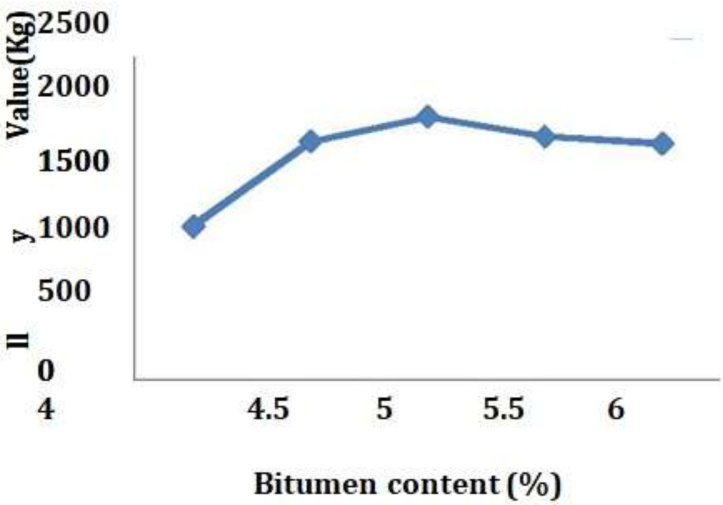

Fig.1 Variation of Marshal Stability Value with different bitumen content

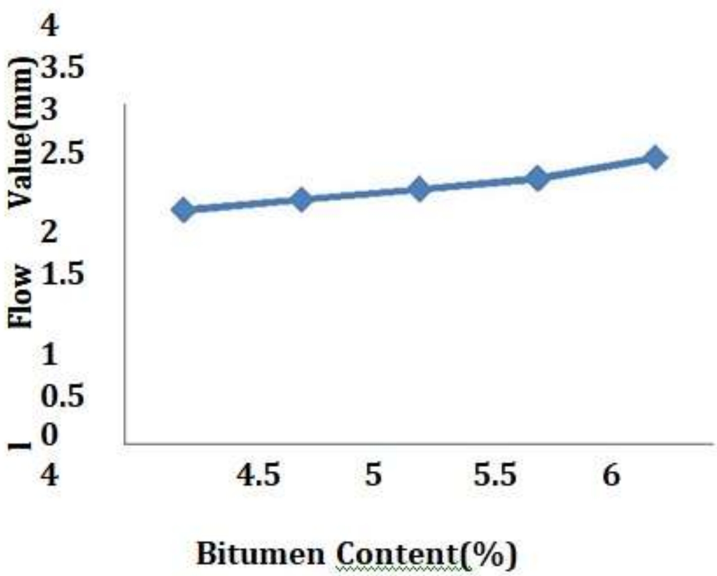

Fig.2 Variation of flow value with different bitumen content

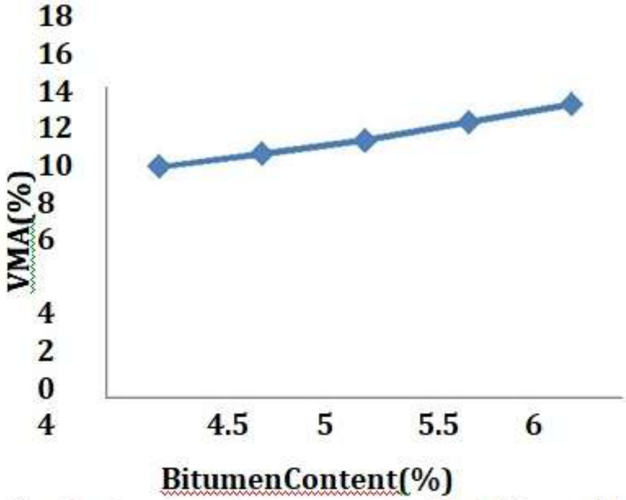

Fig.3. Variation of voids in mineral aggregates with different bitumen content

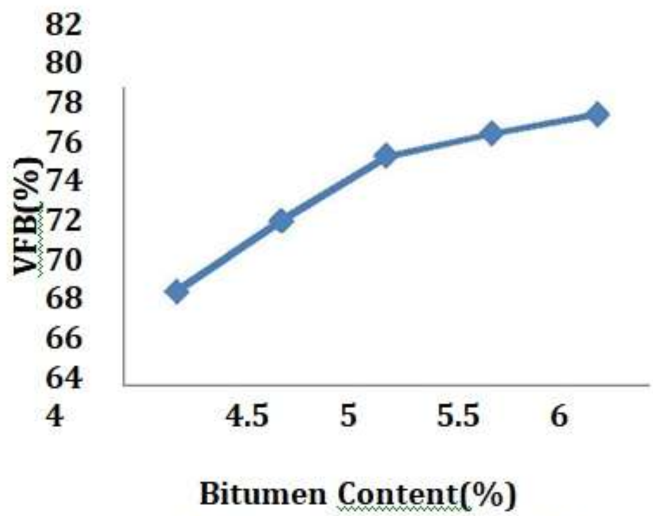

Fig.4 Variation of voids filled with bitumen with different bitumen content

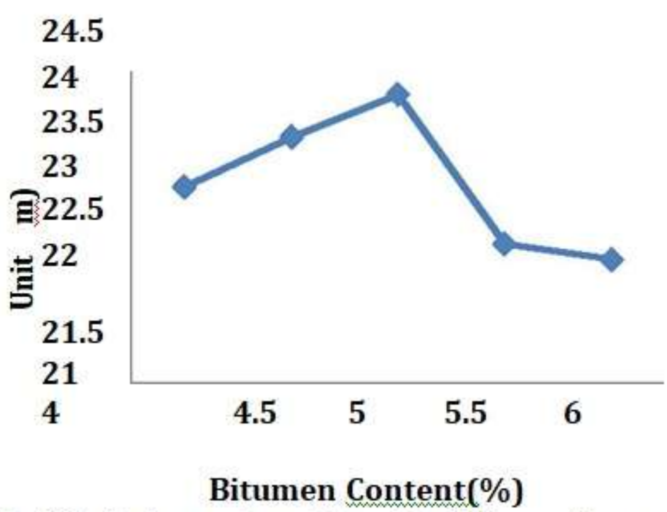

Fig.5 Variation unit weight with different bitumen content

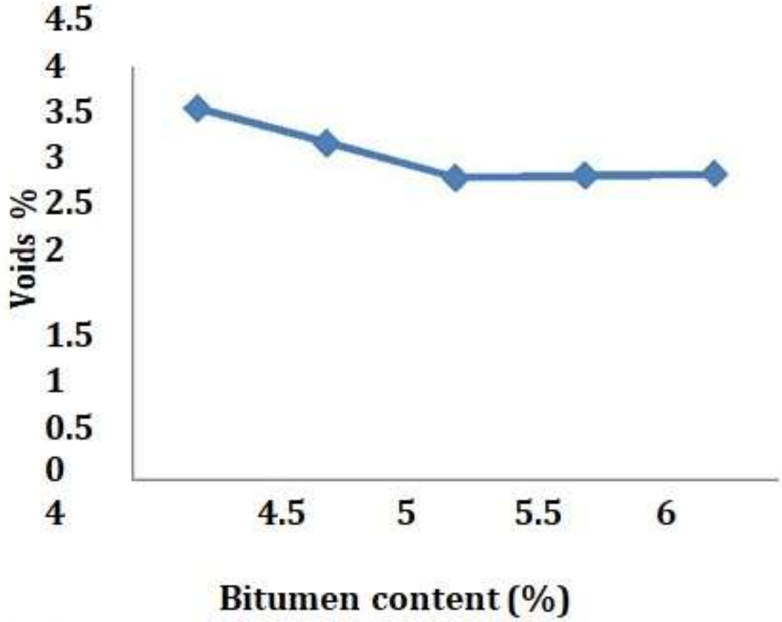

Fig.6 Variation of air voids % with different bitumen content

From the above figure: 1 to 6

a) Maximum stability at 5% bitumen
b) Maximum unit weight at 5% bitumen
c) %air voids is minimum at 5 % bitumen

2) *Marshall Test with Fly ash as Filler:* Optimum bitumen content (OBC) was selected at 5% bitumen content, the test mix is now preparing by replacing ordinary Portland cement with fly ash in the order 25%, 50%, 75% and 100% to find optimum fly ash content

TABLE IV: MARSHALL TEST RESULT WITH FLY ASH

Fly Ash content (%)	**Stability (kn)**	**Flow (mm)**	**Unit Weight (kn/cu.m)**	**VMA (%)**	**VFB (%)**
25	1230.76	3.25	23.50	16.46	65.85
50	1423.07	3.375	23.7	15.86	67.07
75	1692.23	3.4	24.61	16.06	67.8
100	1000	3.45	23.36	16.79	64.26

III. DISCUSSION

Therefore Marshall Stability reaches highest at 75% fly ash content because of decrease of compressive stress subsequently. Unit weight was maximum with fly ash content at 75%. For a desirable pavement, %

air voids should be minimum. At 75% fly ash % total voids are minimum. Hence 75% fly ash content is optimum.

IV. CONCLUSIONS

In this test, the impact of fly ash as a waste by-product of coal based power station, as filler on bituminous mix in terms of various engineering properties, has been investigated. For comparison purposes, fillers normally used, like ordinary Portland cement (OPC) and fly ash have been considered as control specimens. From the above study we select 5% bitumen content as optimum for bituminous paving mixes. Marshall Properties of 25%, 50%, 75% and 100% of fly ash content are within desirable limits for 5% optimum bitumen content. 75% of fly ash content gives best results. So we can adopt 75% as optimum fly ash content.

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