Investigation of impact of Fly Ash as a Filler in bituminous Mix- An overview

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Abstract— In bituminous paving mixture, normally cement and stone dust are utilized as filler material. For comparison, cement used to prepare control mix. Marshall Stability test is employed to find stability, flow value, % air voids, (VMA) voids in mineral aggregate and (VFB) voids filled with bitumen properties for a bituminous paving mixture. The work is carried out by using specifications as per MORTH (Ministry of road transports & highways, specifications for road & bridge works, 5th revision). By replacing the cement with fly ash at the levels 25%, 50%, 75%, 100% the results are compared. The difference of properties like optimum bitumen contents and optimum fly ash contents are determined. It has been recommended to use of fly ash, not only reducing the cost of execution, also solve utilization of fly ash and its disposal problems.

Key words: Aggregate, Optimum bitumen content, Optimum fly ash content

I. INTRODUCTION

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].

A major concern of paving mix design of bituminous mix is that the type and amount of filler that may used which affect the performance of the mix. Many studies have been conducted to study the properties of filler, the portion of passing 0.075 mm is known as filler [2]. Generally, ordinary Portland cement and stone dust are used as filler in bituminous paving mixes. In order to investigate the use of fly ash a very fine waste product from thermal power station in bituminous paving mix, the same composed from confined source has been used. For comparison point of view, ordinary Portland cement collected from local sources has also been used in this study. The specific gravities of ordinary Portland cement and fly ash used in this study were found to be 3.16 and 1.5 respectively. Fly ash is the main solid dissipate taken out from coal-fired power plant. In India, the yearly release of fly ash is more than 0.3 billion tons, and is major industrial waste residue. Utilization of fly ash comprehensively is an important technical economic policy in the country like India for economic construction.

II. MATERIALS AND METHODOLOGY

A. Aggregates

Coarse aggregates which have the sizes of particles belong to a particular sieve is known as single size aggregates. For example, 20 mm single size aggregate mean the largest part of which passes 20 mm IS sieve and its mostly fraction is retained on 10 mm IS sieve. In bituminous paving mixes coarse aggregate has been identified by the portion of the mixture which is retained on 2.36 mm sieve. Here basalt rock was utilized as coarse aggregate. Coarse aggregate was crushed by hand and brought to the sizes about 25.0 mm or less [3]. Physical properties of coarse aggregate are given below (Table-2). For preparation of bituminous paving mixture the grading of aggregates was adopted from MORTH (2013) [15] given below (Table-1).

Fig. 1: Adopted coarse aggregate

Sieve Size (mm)	Percentage passing by weight (Specified)	Percentage passing by weight (Selected)
26.5	100	100
19	90-100	98
9.5	60-80	77
4.75	35-65	52
2.36	20-50	45
0.30	3-20	18
0.075	2-8	6

Table 1: Adopted aggregate gradation

Parameters	Test method	Test 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

Table 2: Physical properties of aggregates

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 [2]. Its specific gravity was found to be 2.5

B. Bitumen

80/100 grade bitumen has been used for preparation of bituminous mixture. The major physical parameters of bitumen are given below (Table-3)**.**

Parameters	**Test method**	**Test result**
Penetration value at 25ºC (0.1 mm)	IS:1203-1978	91
Specific gravity	IS : 1202-1978	1.09
Softening point (ºC)	IS:1205-1978	49
Ductility	IS1202:1978	88

Table 3: Physical properties of bitumen

C. Preparation of mix specimens

The specimen for bituminous paving mixtures was prepared as per ASTM D1559-62 (American Society for Testing and Materials, 1989) [14] 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 types of filler in bituminous paving mix was done as per the normal procedure [1].

Fig. 2: Preparation of mix

D. Laboratory Tests

Marshall Test adopted all over the world for evaluation and design of bituminous mix. This test is a simple and low cost standard laboratory 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 was selected on the basis of maximum stability, maximum unit weight and median allowable limits for percentage air voids. The optimum bitumen content is selected as the average of bitumen content corresponding to these three parameters. All the criteria of the Marshall mixes at OBC are checked with respect to the given in MORTH (2013) (Ministry of Road Transport and Highways, 2013). This Marshall Method is essentially empirical, and useful in comparing mixtures under specific conditions.

E. Marshall test with ordinary Portland cement

Three specimens for different bitumen content were prepared and the average of these results has been reported. To find the optimum bitumen content six specimens with each mixture having bitumen content in the order 3.5%, 4%, 4.5%, 5%, 5.5%, 6% were prepared. From test, it shows Marshall Stability increases with bitumen content up to 5% and then these two parameters are decreased. The variations are only marginal and the discrepancy, particularly, stability to be considered is not significant.

F. Marshall Test with Fly ash as Filler

As the optimum bitumen content was found at 5% bitumen content, the test mix is now prepare by replacing cement with fly ash in the order 25%, 50%, 75% and 100% by weight to find optimum fly ash content.

Fig. 3: Specimen prepare by replacing cement with fly ash in the order 25%, 50%, 75% and 100%

III. Discussion

This test shows, Marshall Stability was maximum at 75% fly ash content. And unit weight was also maximum with fly ash content at 75%. For a desirable pavement, % air voids should be minimum, at 75% fly ash content total voids are minimum. Hence 75% fly ash content is optimum fly ash content.

IV. Conclusions

For comparison purposes, fillers normally used, like ordinary Portland cement (OPC) and fly ash have been considered as control specimens and replaced 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 here fly ash content at 75% as optimum fly ash content [3]. The values of parameters i.e. Vv, VMA and VFB in those cases fly ash was found out to be within required specifications. This study not only constructively utilizes the waste fly ash in road construction industry but also successfully enhanced the important properties which

will finally have superior and long living roads. This study give a positive impact on the environment, it will also reduce the quantity of waste by incineration and land filling. This is not only adding value to waste but also will develop a technology, which is ecological.

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