Experimental Study on Effect of Fly Ash by Partially Replacing with Conventional Fillers on Bitumen Paving Mix

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Abstract - *Construction of highway involves huge outlay of investment. A precise engineering design may save considerable investment; as well as reliable performance of the in-service highway can be achieved. Two things are of major considerations in this regard – pavement design and the mix design. Our project emphasizes on the mix design considerations. A good design of bituminous mix is expected to result in a mix which is adequately strong, durable and resistive to fatigue and permanent deformation and at the same time environment friendly and economical. A mix designer tries to achieve these requirements through a number of tests on the mix with varied proportions of material combinations and finalizes the best one. This often involves a balance between mutually conflicting parameters. Bitumen mix design is a delicate balancing act among the proportions of various aggregate sizes and bitumen content. For a given aggregate gradation, the optimum bitumen content is estimated by satisfying a number of mix design parameters. Fillers play an important role in engineering properties of bituminous paving mixes. Fly ash, stone dust, cement and lime are used as fillers. An attempt has been made in this investigation to assess the influence of non-conventional and cheap fillers such as brick dust and fly ash in bitumen paving mixes. It has been observed as a result of this project that bituminous mixes with these Fly ash result in satisfactory Marshall Properties though requiring a bit higher bitumen content, thus substantiating the need for its use. Fly ash used in this investigation is likely to partly solve the solid waste disposal of the environment.*

Key Words: Fly Ash, Bituminous materials, Flexible pavement structures, Fillers.

1. INTRODUCTION

Highway constructions have taken a big jump in the developed countries since last year. Bituminous materials construct Flexible pavements surface. Bituminous surface treatment is characterized either by the low volume of pavement roads or the high volume of interstate highway network roads it received from the HMA surface. The pavement structure bends due to load or this type of pavement is called "flexible pavement". Flexible pavement structures are composed of multiple layers of material that can optimize this flexibility. The other side of the flexible pavement consists of a plain cement concrete surface.

Traffic density has been responsible for the increase of signs of distress such as bleeding, rot, malaise, routing, tremor and pit digging in cases of overloading of vehicles, commercial vehicles and pavements with significant changes in daily and weather temperatures, bituminous surfaces. Break down of appropriate material and bitumen binders have been found to result in longer wear life of the course, relying on the use of % of filler as fly ash.

1.1 Objectives of bituminous mix design

The design mix of bitumen pavements is intended to determine an economical mix of composite, sand and filler, using a variety of filler such as limestone, brick dust, and fly ash.

(i) Bitumen mix design Sufficient to insure a durable pavement.

(ii)Bitumen mix design to mix stability and satisfy the demands of traffic avoid any distortion and displacement.

(iii)Bitumen mix design to allow void a little amount in total mix for additional compaction and vehicle loading without bleeding and loss of stability without moisture and harmful air.

(iv)Bitumen mix design to permit sufficient workability to placement of the mixing without sample segregation.

1.2 Highway materials

Coarse aggregate

Coarse aggregate provide impact value, abrasion value and crashing strength. The total function of this type is to bear the stress coming from the vehicle load. Its wear resistance is due to abrasive action of the vehicle due to traffic load.

Fine aggregate

Fine aggregate crosses 75 µm strainer and 600 µm strainer and remains made of natural sand or broken stone. The fine aggregate function is to be fill voids of total samples.

Fillers

Filler is inert material that passes through a 75 µm IS strainer. Fillers are found in many types such as limestone, stone dust, brick dust, dust, cement, fly ash and pond ash. The function of filler is to remove air vessels from the total sample and bituminous surface.

Bitumen

Bitumen is used as binding material and water proofing material is used as the top layer of flexible pavement.

Table no. 1 Gradation of aggregates used in bitumen concrete mix design are as per IRC grade II in the Table as given

Grading	II(mm)
Nominal size of aggregate	13
Layer thickness of Flexible Pavement	30-45
IS sieve	Cumulative % by weight of aggregate passing
19 mm 13.2 mm 9.5 mm 4.75 mm 2.36 mm 1.18 mm 0.6 mm 0.3 mm 0.15 mm 0.075 mm	100 79-100 70-88 53-71 42-58 34-48 26-38 18-28 12-20 4-10
Bitumen binder content by mass of dry mix of mix design	5 - 7

2. Review of Literature

John Francis McLaughlin &William Harmer Goetz (1957 John studies were conducted in which it was investigated that mechanically fly ash is used as a filler for bitumen concrete admixture. He divided his study into three parts of three stages, a comparison of fly ash in the first phase and limestone dust filler in bituminous concrete mixtures through the use of Marshall Stability test.

The second and third stages involved the use of ASTM direct compression testing of bituminous concert mixes. The conclusions made are given below. The mixture containing fly ash had sufficient stability as measured by the Marshall Stability test. Stripping resistance of fly ash mixtures as measured by ASTM D-1075 compared to the results of mixtures containing limestone dust.

Abdul Rahman Saleh[1986] Studies for use of fly ash in bitumen concrete mixes, it was concluded that air voids in aggregates were found to be very useful in determining how well fly ash used in bituminous concrete mixes.

Cross, Stephen A [1995] Characterized by use of fly ash on bituminous concrete mixes, based on test results it was concluded that fly ash reduces the permeability of cold recycle mixes thereby increasing the resistance of the mixture to the damaging effects of moisture loss is Fly ash increases the strength of the mix and reduces the ability of wheel path routing.

Chan, J S et.al [1996] Effect of fly ash on the properties of bitumen concrete mixes is characterized. Fly ash in the form of mineral filler not only increased the stripping resistance value, but did not greatly reduce the performance of bitumen concert mixes except in terms of fly depth and seasonality apart from fly ash.

Kavussi, A [1997] Study the role of fly ash in bituminous concrete mixtures. Four types of filler (limestone, quartz, fly ash and kaolin) with different physical and chemical properties were described. Fillers were determined using several different physical properties tests. For the filler and fly ash tested in this research, the maximum stiffness corresponds to an area of filler / bitumen ratio between 0.25 and 0.75.

Raymond T. Hemmings [2000] The feature is that when fly ash is used more than 45% by volume or more than 70% by weight. The mechanical properties of bitumen concrete mixtures are greatly increased, such as tensile and tear strength while reducing the cost to produce bitumen concrete mixes

3. Design and Implementation

Bitumen and fly ash filled the all voids, strength of the mix therefore reduces then the load is transmitted by hydrostatic pressure through bitumen.

3.1 Soften point test

This test conduct with ring and ball apparatus and use steel balls its dia. 9.5 mm and weight 3.50 and use brass ring its depth 6.4 mm and internal dia. 17.5 and outside dia. 20.6.heat the bitumen sample and keep the sample brass ring and use stir and remove air. Increases temp. and recorded melting point of sample of soften point.

3.2 Bituminous concrete mix design

In this project Marshall Method of mix design is adopted. Purpose of bituminous concrete mixing design is to provide an economical mixture of pavement of highway work. And also consider the cost of project and life cycle of project. First to be considered cost of project is less and second life cycle of project is high and durable. Marshall methods is common to use find the properties of bituminous concrete as like stability, flow value, VMA and VFB.

3.3 Aggregate impact value

These tests are used to measure the abrasion resistance of aggregate. The impact machine is most widely used to determine abrasion resistance. Aggregate sample of impact test passing through 12.5mm sieve and retained 10mm sieve and temping of sample 25 times in 3 layers then put the mould in machine and applied the load and after crushed aggregate sieving 2.36 is sieve and calculate the value of aggregate impact test.

3.4 Fly Ash

In this project use fly ash as filler. Fly ash is available industrial waste. Fly ash can be use bituminous concrete mix of flexible pavement. Fly ash is a fine particle passing 0.3 mm sieve. Fly ash use economical consideration of flexible pavement and cost effective filler. In this project fly ash can be use 2% to 8% of bituminous concrete of total mix. Fly ash is provide proper binding in mixing and remove air voids. Fly ash is acceptable in bituminous paving mix of flexible pavement.

4. TESTING AND DEPLOYMENT

4.1 Aggregate test

Table 2: Water absorption test of coarse aggregate

Description/Trail No:	I	II	III	MEAN
A. Empty Wt. of Pycnometer	501.0	501.0	501.0	
B. Wt. of Pycnometre + Sample	1420.0	1412.0	1425.0	
C. Wt. of Pycnometer + Sample + Water	2135.0	2130.0	2138.0	
D. Wt. of Pycnometre + filled with water	1550.0	1550.0	1550.0	
E. Wt.of Saturated surface dry sample	919.0	911.0	924.0	
F. Wt.of Oven dry sample	914.0	905.5	918.5	
G. Bulk Specific Gravity (OD) : F/(E-(C-D))	2.737	2.736	2.734	2.736
H. Bulk Specific Gravity (SSD) : E/(E-(C-D))	2.751	2.752	2.750	2.751
I. Apparent Specific Gravity : F/(F-(C-D))	2.778	2.782	2.779	2.780
J. Water Absorption : ((E-F)/F X 100) %	0.55	0.61	0.60	0.59

Table 3: Water absorption test of fly ash

Description/Trail No:	I	II	III
A. Empty Wt. of Pygnometer	501.0	501.0	501.0
B. Wt. of Pycnometre + Sample	1142.0	1060.0	1120.5
C. Wt. of Pycnometer + Sample + Water	1953.0	1902.0	1940.0

D. Wt. of Pycnometre + filled with water	1550.0	1550.0	1550.0
E. Wt.of Saturated surface dry sample	641.0	559.0	619.5
F. Wt.of Oven dry sample	633.0	552.0	611.0
G. Bulk Specific Gravity (OD) : F/(E-(C-D))	2.660	2.667	2.662
H. Bulk Specific Gravity (SSD) : E/(E-(C-D))	2.693	2.700	2.699
I. Apparent Specific Gravity : F/(F-(C-D))	2.752	2.760	2.765
J. Water Absorption : ((E-F)/F X 100) %	1.26	1.27	1.39

Table 4: Marshall Properties Comparison of fly ash

Optimum Bitu Content,	4.5%	5%	5.5%	6%
Stability (kN)	13.9	14.3	16.7	17.3
Flow value (mm)	2.2	2.7	3.6	3.7
% of air void	6.5	5.8	5.2	4.1
VMA(%)	14.06	15.81	15.70	18.2
VFB%	68	71	69	69

Table 5: Max specific gravity of bituminous concrete mix when binder content 6%

DESCRIPTION	
1. Weight of Empty flask (gm)	1212.5
2. Weight of Flask + Mix (gm)	2482.5
3. Weight of Flask + Mix + Water (gm)	4077.0
4. Weight of Flask + Water (gm)	3331.5
5. GMM = {(2)-(1)} / [{(4)-(1)}-{(3)-(2)}]	2.421

Table 6: Max specific gravity of bituminous concrete mix when binder content 5.5%

DESCRIPTION	
1. Weight of Empty flask (gm)	1212.5
2. Weight of Flask + Mix (gm)	2516.5
3. Weight of Flask + Mix + Water (gm)	4097.5
4. Weight of Flask + Water (gm)	3331.5
5. GMM = {(2)-(1)} / [{(4)-(1)}-{(3)-(2)}]	2.424

Table 7: Max specific gravity of bituminous concrete mix when binder content 4.5%

DESCRIPTION	Weight
1. Weight of Empty flask (gm)	1212.5
2. Weight of Flask + Mix (gm)	2470.5
3. Weight of Flask + Mix + Water (gm)	4072.0
4. Weight of Flask + Water (gm)	3331.5
5. GMM = {(2)-(1)} / [{(4)-(1)}-{(3)-(2)}]	2.431

Take a 1200gm aggregate sample and heat it to 154–160 ° C. Sample bitumen is 175 –190 ° C. Heat is both Aggregates and Bitumen have a uniformly uniform gray color. The Marshall Mold diameter 100 mm and 64 mm height has been compressed with 75 warps towards each face. The mold is taken at a temperature of 27 ° C for 12 hours. It is continuously immersed in a 60 degree temporary water bath for 30 minutes.

The load is applied at a rate of 50 mm per minute. The maximum load is applied then the sample fail is recorded this is called the Marshall Stability value. And lower dial gauges show the flow value as.

5. Conclusion

Bitumen mixes containing fly ash as fillers found to have Marshall Properties almost nearly. Bitumen mixes containing fly ash as fillers displayed max stability at 6% bitumen content. And air voids also decrease at 6 %.

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