International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 05, May-2019

Effect of Filler Combination on the properties of Bituminous Mixes

Dhiraj D. Aher[1], Prof. Abhishek M. Loya[2]

[1] PG student, Civil Engineering Department, SOET, Sandip University,
Nashik, Maharashtra, India.
[2]Assistant Professor, Civil Engineering Department, SOET, Sandip University,
Nashik, Maharashtra, India.

Abstract*— Fillers play an important role in the filling of voids and hence change the engineering properties of bituminous paving mixes. Conventionally cement, stone dust and lime are used as fillers. In India, concrete dust, marble dust and brick dust are considered to be cheaper and are available in large amount. In this investigation an attempt has been made to evaluate the effect of non-conventional and cheap fillers such as brick dust in bitumen paving mixes. This study deals with the combined effect of conventional and non-conventional fillers on the bituminous mixes for varying bitumen content of 4%, 5%, 6% & 6.5%. Various tests were conducted on aggregates and bitumen and the results were compared with the specifications. It has been observed that bituminous mixes with these conventional and non-conventional fillers result in satisfactory Marshall properties though requiring a same bitumen content, thus substantiating the need for its use. The study revealed that bituminous mix containing filler combination i.e (Brick dust + Hydrated lime) are suitable substitute to traditional filler and are acceptable materials for bituminous concrete of flexible pavement construction. The problem of disposal of waste materials such as marble dust, brick dust etc. is to be partly solve by this study.

Keywords— Voids**,** Bituminous paving mixes, Fillers, Brick dust, Hydrated lime, Marshall properties etc.

I. INTRODUCTION

India is fast growing country in all the sectors including transportation and industrialization. From recent few years, the population and industrialization of our country grow rapidly which increases the road traffic and demands the more network of roads for passenger and goods transportation. The main objective of highway authorities is to provide safe, smooth, and economical pavements that are capable of carrying the maximum loads. To achieve this objective filler is an one of constituent in an asphalt mixture, plays an important role in determining the properties and performance of the mixture, mainly its binding and interlocking effects.

Various studies have been conducted in the past by many investigators regarding the use of stone dust alone or in conjunction with lime or cement as a filler material for improving properties of bituminous mixes in many regions around the world. From recent study, we know that the use of these conventional filler in bituminous mixes cannot achieve economy during construction. Also the Marshall properties of it cannot be improve in great extent. The Marshall properties of bituminous mixes are mostly affected by filler percentage and its type. So the combined uses of conventional and non-conventional fillers in the bituminous mixes were studied to increase the Marshall properties for varying bitumen content. This study also focused on the economical consideration of the bituminous mixes.

II. RESEARCH OBJECTIVES

Following are the main objectives of our present study:
1) To determine the effect of filler type and content on the properties of bituminous mixture.
2) To determine the influence of filler combination on the properties of bituminous concrete with varying percentage of bitumen.
3) To check the suitability of filler composites in the bituminous mixes instead of traditional fillers.
4) To determine optimum binder content for this filler composites to satisfy economic considerations.
5) To use non-conventional or waste materials as fillers in the bituminous mixes which partly solve the problem of waste materials.

III. MATERIALS

Bituminous mixtures contain two main ingredients, which are aggregate (coarse and fine) and the binder. Various grades of each may be used in various proportions to produce mixes with different design properties. Fillers may also be included in the mix to change its physical characteristics. The following sections gives the details of the coarse aggregate, fine aggregate, bitumen and mineral fillers used in the study.

A. *Coarse aggregate*

The coarse aggregates should have good abrasion value, impact value and also crushing strength. The functions of coarse aggregates are to bear the stresses due to wheels and also resisting wear due to abrasion. That portion of the mixture which is retained on 2.36 mm (No. 08) sieve according to the Asphalt Institute is termed as coarse aggregates. Locally available Basalt rock was used as coarse aggregate which borrowed from stone crusher plant. Fig. 1 shows the appearance of coarse aggregates used for the study.

Fig. 1 Appearance of coarse aggregates

B. *Fine aggregates*

Voids which remain in the coarse aggregates are filled by the fine aggregates. So the function of fine aggregates in to fill the voids of coarse aggregates. Fine aggregates consist of crushed stone or natural sand. Aggregates that passed through 2.36 mm sieve and retained on 0.075 mm sieve were selected as fine aggregate. Fig. 2 shows the appearance of fine aggregates used for the study.

Fig. 2 Appearance of fine aggregates

C. *Fillers*

Fillers play an important role in the filling of voids and hence change the engineering properties of bituminous paving mixes**.** In this study, fillers used are brick dust and marble dust as non-conventional fillers. Also concrete dust and hydrated lime are used as conventional fillers. These materials finer than 0.15 mm & 0.075 mm size sieves were used in the bituminous mixes for comparison and also for economy point of view.

a) Brick dust

It is a dust of pounded or broken bricks. Brick dust finer than 0.15 - 0.075 mm size sieve were used in the bituminous mixes which was obtained from brick moulding mill. Fig. 3 shows the appearance of brick dust.

Fig. 3 Appearance of brick dust

b) Hydrated lime

Hydrated lime is a type of dry powder made from limestone. It is created by adding water to quicklime in order to turn oxides into hydroxides. The hydrated lime used as filler was procured in 25 kg bag from a reputable chemical store which was stored in a cool & dry place away from weathering effects. Fig. 4 shows the appearance of hydrated lime.

Fig. 4 Appearance of Hydrated lime

c) Stone dust

Locally available stone dust was used as filler which obtained from stone crusher plant having frictions finer than 0.15-0.075 mm during the crushing process. Fig. 5 shows the appearance of stone dust.

Fig. 5 Appearance of stone dust

D. *Bitumen*

Bitumen is used as a water repellent and adhesive material. 80/100 grade of bitumen was used in this study. Same bitumen was used for all the mixes so the type and grade of binder was kept constant. Fig. 6 shows the appearance of 80/100 grade bitumen.

Fig. 6 Appearance of 80/100 grade bitumen

IV. EXPERIMENTAL METHODOLOGY

This attempt mainly consist of three stages- In the first stage, properties of aggregates, fillers and bitumen were established while in second stage stone dust (as single filler) and (Brick dust + Hydrated lime) were used as filler composites by using adopted gradation and in the third stage Marshall mix design method was used to find stability value, flow value, unit weight values, % air voids & % VMA.

A. Laboratory tests for the properties of materials

As the bituminous mix is consists of different materials and hence its engineering properties are depends on the materials used for its preparation. Therefore, it is necessary to check its various physical properties and this are within the standard limit laid by various road organizations such as IRC, BIS and MORTH. This section cover the laboratory test results of aggregates, bitumen and filler materials.

a) Laboratory test results of aggregates

TABLE I
LABORATORY TEST RESULTS OF AGGREGATES

Sr. No.	Test Conducted	Results obtained	Specification	Code for testing
1	Aggregate impact value test	20.60%	Max 24%	IS:2386 (Part IV) – 1963
2	Aggregate crushing value test	26.90%	Max 30%	
3	Aggregate abrasion value test	20.25%	Max 30%	
4	Flakiness index test	25.11%	Max 25%	IS:2386 (Part I) – 1963
5	Elongation index test	34.97%	N.R	
6	Specific gravity test of coarse aggregates	02.62	2.5-3.0	IS:2386 (Part III) – 1963
7	Specific gravity test of fine aggregates	02.55	2.5-3.0	
8	Water absorption test of coarse aggregates	01.15	Max 2%	

b) Laboratory test results of 80/100 bitumen

TABLE III
BASIC LABORATORY TEST RESULTS OF 80/100 BITUMEN

Sr. No.	Test Conducted	Results obtained	Code for testing
1	Ductility test	*82mm*	IS:1208 – 1978
2	Penetration test	*87.28mm*	IS:1203 – 1978
3	Softening point test	*46.90ºC*	IS:1205 – 1978
4	Specific gravity test	*1.01*	IS:1202 – 1978

c) Laboratory test results of fillers

TABLE IIIII
LABORATORY TEST RESULTS OF FILLERS

Sr. No.	Test Conducted	Results obtained	Code for testing
1	Specific gravity test of brick dust	02.36	IS:2386 (Part III) – 1963
2	Specific gravity test of hydrated lime	02.25	
3	Specific gravity test of stone dust	02.50	

B. Preparation of specimen

1200 grams of aggregates blended in the desired proportions is measured and heated in the oven to the mixing temperature. Heating of aggregates was done up to 140ºC before the addition of bitumen. Bitumen mix was added varying from 4.5 to 6% at an increment of 0.5%. Also the fillers i.e stone dust and (brick dust + hydrated lime) were mixed as per design. The mixture thoroughly mixed by hand mixing with trowel maintains the temperature of mix up to 154ºC - 160ºC. For each binder content and composites 4 samples were prepared by compacting to 75 blows on both sides of sample in Marshall compactor. Then the sample was de-moulded and the weight of sample in air and in water was noted down to determine the bulk density of mix. Also the average thickness and diameter of the specimen are noted. For the determination of stability and flow value on Marshall apparatus, sample was immersed in water bath at 60ºC for 40 minutes before testing. The specimens are taken out one by one, placed in the Marshall test head and the Marshall stability and flow values are noted.

V. RESULTS AND DISCUSSIONS

A. *Results of the Marshall test of specimens prepared with Stone dust and (Brick dust + Hydrated lime)*

The results of the Marshall test of specimens prepared with Stone dust and (Brick dust + Hydrated lime) as filler composites for varying bitumen contents i.e 4%, 5%, 6%, 6.5% have been presented in tables IVV and V respectively.

TABLE VV
AVERAGE MARSHALL PROPERTIES OF SAMPLES WITH STONE DUST

Bitumen % → / Marshall Properties ↓	4%	5%	6%	6.5%
Stability value (kN)	17.23	18.81	20.10	19.167
Flow value (mm)	1.29	1.325	2.095	2.160
Unit wt. (gm/cc)	2.057	2.070	2.098	2.160
Air Voids (%)	14.671	12.904	10.466	7.208
VMA, %	22.900	23.254	23.078	21.291

TABLE VIV

AVERAGE MARSHALL PROPERTIES OF SAMPLES WITH (BRICK DUST + HYDRATED LIME)

Bitumen % → / Marshall Properties ↓	4%	5%	6%	6.5%
Stability value (kN)	19.16	19.71	22.51	22.37
Flow value (mm)	1.975	2.225	3.087	3.212
Unit wt. (gm/cc)	1.902	1.975	2.016	2.076
Air Voids (%)	19.498	15.276	12.423	9.214
VMA, %	27.107	25.154	24.519	22.711

a) ***Marshall stability curves for specimens with Stone dust and (BD + HL) filler composite.***

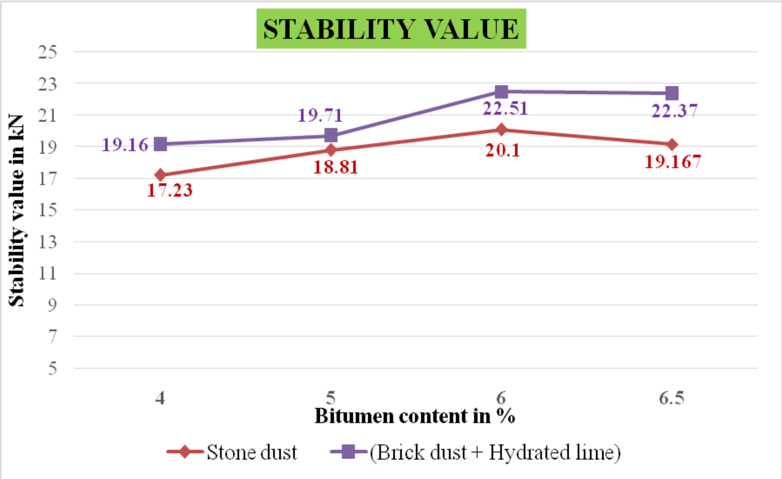

Fig. 7 Variation of Stability With Bitumen content in %.

Fig. 7 shows the variation of Marshall stability with different bitumen content in % for specimens with stone dust and (BD + HL) filler composites. In this fig, filler composites such as (BD + HL) are found to have given a higher stability value at same bitumen content in comparison with stone dust as a conventional filler. Also filler composites shows same trend for Marshall stability as that of conventional filler. Maximum stability values of 22.51 kN and 20.1 kN are observed at 6% bitumen content in case of both the (BD + HL) and stone dust respectively. From this we can say that the conventional fillers can be replaced easily by filler composites in the bituminous mixes.

b) ***Marshall flow value graph for specimens with Stone dust and (BD + HL) filler composite.***

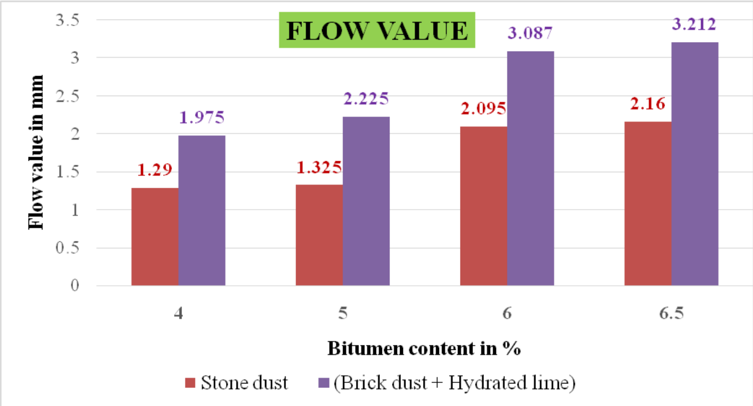

Fig. 8 Variation of Flow value With Bitumen content in %.

Fig. 8 shows the variation of Marshall flow values with different bitumen content in % for specimens with stone dust and (BD + HL) filler composites. In this fig, filler composites such as (BD + HL) are found to have given a higher flow value at same bitumen content in comparison with stone dust as a conventional filler. From this higher deformation values it can be concluded that filler composite specimens might be having lower values of modulus of elasticity. Maximum flow values are observed at 6.5% bitumen content in case of both the (BD + HL) and stone dust. So the conventional fillers can be easily replaced by filler composites in the bituminous mixes.

c) ***Marshall unit weights curves for specimens with Stone dust and (BD + HL) filler composite.***

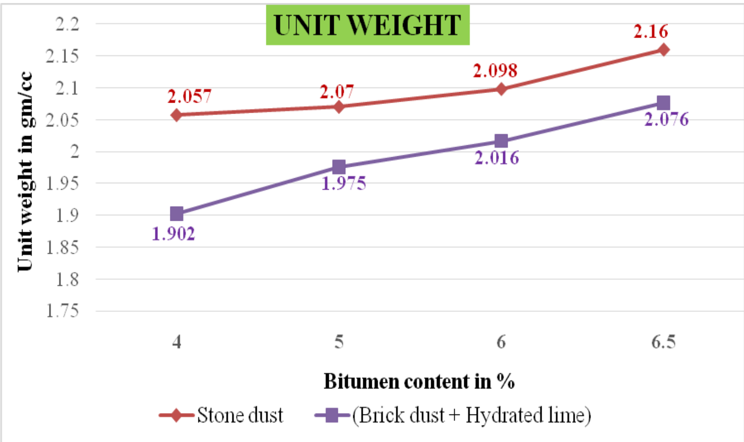

Fig. 9 Variation of Unit weight With Bitumen content in %.

Fig. 9 shows the variation of Marshall unit weight values with different bitumen content in % for specimens with stone dust and (BD + HL) filler composites. In this fig, we find that filler composites specimens have lower value of unit weight in comparison with stone dust as a conventional filler. It might be due to higher number of air voids in filler composites specimens in comparison with stone dust as a conventional filler. Both (BD + HL) and stone dust shows higher value of unit weight at 6.5% bitumen content.

d) ***Marshall air voids curves for specimens with Stone dust and (BD + HL) filler composite.***

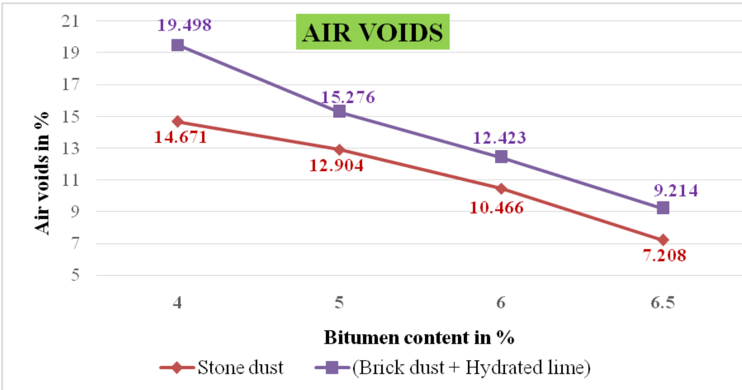

Fig. 10 Variation of Air voids With Bitumen content in %.

Fig. 10 shows the variation of Marshall air void values with different bitumen content in % for specimens with stone dust and (BD + HL) filler composites. This graph shows that specimens with filler composites display a higher number of air voids in comparison with stone dust as conventional filler still then these fillers composites are found to have given satisfactory results. The minimum air voids are observed at the 6.5% bitumen content in both the (BD + HL) and specimens with stone dust.

e) Marshall VMA value graph for specimens with Stone dust and (BD + HL) filler composite.

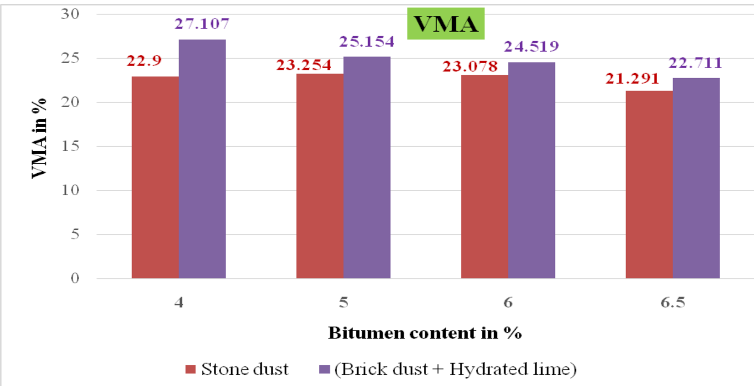

Fig. 11 Variation of VMA With Bitumen content in %.

Fig. 11 shows the variation of Marshall VMA values with different bitumen content in % for specimens with stone dust and (BD + HL) filler composites. The % VMA curves showing that specimens with filler composites display higher VMA in comparison with stone dust as conventional filler. The minimum VMA values are observed at the 6.5% bitumen content in both the (BD + HL) filler composites and specimens with stone dust. The results of the VMA for filler composites are also satisfactory compare with conventional fillers.

B. ***Comparison of Marshall results for finding optimum binder content.***

TABLE VIIV

COMPARISON OF MARSHALL RESULTS FOR FINDING OPTIMUM BINDER CONTENT.

Sr. No.	Marshall Parameters → / Filler ↓	Maximum stability value	Maximum flow value	Maximum unit weight	Minimum air voids	OBC
1	Stone dust	6.0%	6.5%	6.5%	6.5%	6.375%
2	(B.D + H.L)	6.0%	6.5%	6.5%	6.5%	6.375%

VI. CONCLUSIONS

From above experimental work we conclude that -

a) Bituminous mixes containing (brick dust + hydrated lime) as filler composites displayed maximum Marshall stability at 6% content of bitumen having an increasing trend up to 6% and then gradually decreasing to 6.5%. But the maximum unit weight or bulk density and flow value are displayed at 6.5% content of bitumen having an increasing path from 4%.
b) Bituminous mixes containing stone dust as single filler displayed maximum Marshall stability at 6% content of bitumen having an increasing trend up to 6% and then gradually decreasing to 6.5%. But the maximum unit weight or bulk density and flow value are displayed same trend as that of filler composites.
c) The minimum air voids are also showed at 6.5% content of bitumen having a decreasing trend in case of bituminous mixes with filler composites and conventional filler.
d) It is found that bituminous mixes containing 6.375% of bitumen content which is OBC gives the satisfactory results in both the filler combinations and stone dust as conventional filler.
e) From the above work we can say that (brick dust + hydrated lime) as filler composites can be utilized effectively in the making of bitumen concrete mixes for paving purposes instead of conventional fillers. Also the problem of disposal of waste materials such as brick dust etc. can be solved by this study.

REFERENCES

[1] Vishal Sharma, Satish Chandra and Rajan Choudhary"Characterization of Fly Ash Bituminous Concrete Mixes" Journal Of Materials In Civil Engineering © Asce / December 2010 / 1209.

[2] Afifa Rahman, Syed Ashik Ali, Sajal Kumar Adhikary and Quazi Sazzad Hossain, "EFFECT OF FILLERS ON BITUMINOUS PAVING MIXES: AN EXPERIMENTAL STUDY", Journal of Engineering Science 03(1), 2012 121-127.

[3] Mr. Sagar K. Sonawane, Dr. M. R. Vyawahare and Mrs. C. A. Chitkeshwar, , " Influence of Filler Combination on the Bituminous Mixes ", International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 5, Issue 5, May 2018.

[4] Dipu Sutradhar, Mintu Miah, Golam Jilany Chowdhury & Mohd. Abdus Sobhan, "Effect of Using Waste Material as Filler in Bituminous Mix Design", American Journal of Civil Engineering, Vol. 3, No. 3, 2015, pp. 88-94.

[5] Eng.Noor M. Asmael, "EFFECT OF MINERAL FILLER TYPE AND CONTENT ON PROPERTIES OF ASPHALT CONCRETE MIXES", Journal of Engineering, No. 3, Vol. 16, Sept. 2010.

[6] Prof. S. B. Patil, Avinash A. Khot & Dhanshri P. Yadav, "Effect of Filler and Aggregate on Bituminous Paving Mixes", International Research Journal of Engineering and Technology (IRJET), Volume: 03, Issue: 05, May-2016, pages: 2372-2375.

[7] Suched Likitlersuang, Thanakron Chompoorat, "Laboratory investigation of the performances of cement and fly ash modified asphalt concrete mixtures", International Journals of Pavement Research and Technology 9 (2016) 337–344, 12 August 2016.

[8] Mohammad Altaf Bhat, O.P Mittal, "Effect of Fillers on Bituminous Mixes", International Journal of Advanced Research in Education & Technology (IJARET), Vol. 3, Issue 2 (April - June 2016).

[9] Raja Mistry, Tapas Kumar Roy, "Effect of using fly ash as alternative filler in hot mix asphalt", ELSEVIER, Perspectives in Science (2016) 8, 307-309.

[10] D S V Prasad, M.Anjan Kumar, G V R Prasada Raju, V. Kondayya "A Study on Flexible Pavement Performance with Reinforced Fly ash Sub base" International Journal of Earth Sciences and Engineering 4ISSN 0974-5904, Volume 04, No 06 SPL, October, pp. 403-408(2011).

[11] Dr. P. K. Jain, "Plastic Waste Modified Bituminous surfacing for rural Roads" Workshop on Non-Conventional Materials Technologies Central Road Research Institute, New Delhi,18th February,(2012).