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Use of Waste Material as Filler in Bituminous Mix Design

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Abstract: Bituminous concrete is a costlier and highest payment flexible payment layer. For satisfy the design requirements of stability and durability the bituminous mixes should be designed effectively. The ingredients of the mixture include dense grading of coarse aggregates, fine aggregates, fillers and bitumen binder. In this Study an attempt was made to find the effect of filler on the behavior of bituminous mixes. Fillers play an important role in the filling of voids and hence change the physical and chemical properties. Thus their effect is of utter importance. Bitumen in combination with filler forms mastic. This mastic can be seen as a constituent of mixture of asphalt that holds the aggregates together. An important role is played by the fillers that pass through 0.075mm sieve. With the increase in the amount of filler, Marshall Stability of the bitumen mix increases directly. Use of 4-8% filler in asphalt concrete is recommended by the Asphalt Institute. In India, waste concrete dust and brick dust are considered to be cheaper and are available in plenty. In this study an attempt was made to find the effect of fillers on the bitumen mixes. In this study, concrete dust and brick dust was used as filler. The properties of bituminous mixes containing these fillers were studied and compared with each other. For the purpose of comparison Marshall Method of mix design was used. In this study various tests were also conducted on aggregates and bitumen and the results were compared with the specifications. The study revealed that use of concrete dust and brick dust as filler improves the physical characteristics of bitumen. Marshall Stability and flow value of bitumen mix also improved.
Keywords: Fly ash ,Brick ash , Marshall Test, Stability, Air voids, Voids in mineral aggregates, unit weight.

I. INTRODUCTION

Highway construction activities have taken a big leap in the developing countries since last decade. Construction of highway involves huge outlay of investment.

Highway pavements can be categorized into two groups, flexible and rigid. Flexible pavements are those which are surfaced with bituminous (or asphalt) materials. These can be either in the form of pavement surface treatments (such as a bituminous surface treatment (BST) generally found on lower volume roads) or, HMA surface courses (generally used on higher volume roads such as the Interstate highway network). These types of pavements are called "flexible" since the total pavement structure "bends" or "deflects" due to traffic loads. A flexible pavement structure is generally composed of several layers of materials which can accommodate this "flexing". On the other hand, rigid pavements are composed of a PCC surface course. Such pavements are substantially "stiffer" than flexible pavements due to the high modulus of elasticity of the PCC material. Flexible pavements being economical are extensively used as far as possible. A precise engineering design of a flexible pavement may save considerable investment; as well as reliable performance of the in-service highway pavement can be achieved.

A. Objectives Of Bituminous Paving Mix Design

The overall objective of the design of bitumen pavement mixtures is to determine an economical blend of stone aggregate, sand and fillers such as fly ash and brick dust that yields a mix having ·

Sufficient bitumen to ensure a durable pavement. · Sufficient mix stability to satisfy the demands of traffic without distortion or displacement. · Sufficient void in total compaction mix to allow for a slight amount of additional compaction and traffic loading without flushing bleeding and lost of stability yet low enough to keep out harmful air and moisture. · Sufficient workability to permit sufficient placement of the mix without segregation.

II. MATERIALS

Bituminous mixture is generally composed of aggregate and bitumen. According to the size of the particles, the aggregates are generally divided into coarse aggregates, fine aggregates and filler fractions.

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The following sections covers the description of the coarse aggregate, fine aggregate, bitumen and mineral fillers used in the study.

A. Coarse Aggregate

Coarse aggregates should have good abrasion value, impact value and also crushing strength. The function of coarse aggregates is to bear the stresses due to wheels. Function of Coarse aggregates
is 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.

B. Fine Aggregate

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 2.36mm sieve and retained on 0.075 mm sieve were selected as fine aggregate. The source of fine aggregates used was River sand.

C. Filler

As the name indicates function of fillers is to fill up the voids.Fillers used may be brick dust, flyash, concrete dust.

D. Bitumen

Bitumen is used as a water repellant 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.

III. METHODOLOGY

This study consists of three stages: - characterization of materials, mixing of brick dust and concrete dust as filler, suitability of filler in the bituminous mixes. In the first stage, properties of aggregates, fillers and bitumen were established while in second stage brick dust and concrete dust were used as filler unanimously and in the third stage Marshall Mix design method was used to find stability,flow, air voids, VMA.

A. Laboratory Tests for the Properties of Materials

Tests were performed to determine the Crushing Value, Aggregate Impact Value, Los Angles Abrasion value, Specific gravity, Elongation index, Flakiness index, and Water absorption of aggregates and results are summarized in Table 1.

Table 1 Different Test Results of Aggregates

Properties Tested	Test Result
Specific gravity	2.64
Impact Strength (%)	20.1
Abrasion Strength (%)	19.4
Crushing strength (%)	19.11
Water Absorption (%)	3.05
Elongation index (%)	35.16
Flakiness index (%)	25.22

B. Properties of Bitumen

Softening point, penetration value, specific gravity, ductility value and viscosity were determined and the results are summarized in table 2.

Table No. 2 Different Test Results of Bitumen

Properties Tested	Test Result
Softening Point Test temp. ^{0}C	85.32
Penetration Test (mm)	47
Specific Gravity Test	1.02

C. Mixing of Materials

About 1200 gm of sample aggregates were taken and kept in oven until it dried. Heating of aggregates was done up to 135^{o}C before the addition of bitumen.

Bitumen mix was added varying from 4.5 to 6% at an increment of 0.5%. Also the fillers, concrete dust and brick dust were mixed as per design. For each binder content 3 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. For the determination of stability and flow value on Marshall Apparatus, sample was immersed in water bath at 60^{o}C for 40 minutes before testing.

IV. RESULTS AND DISCUSSIONS

The results of the Marshall test of specimens prepared with Flyash and brick dust as filler for varying bitumen contents have been presented in tables 3 and 4 respectively.

Table 3 Marshall Properties of Specimens with Filler flyash

Bitumen % / Marshall Properties	5	5.5	6	6.5
Stability (kN)	18.64	22.06	23.52	21.39
Flow value (mm)	1.95	2.4	2.8	3.50
Unit wt (g/cc)	2.08	2.09	2.10	2.07
% air void	8.17	6.69	4.18	4.5
VMA (%)	18.27	17.88	16.42	17.5

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Table 4 Marshall Properties of Specimens with Filler Brick Dust.

Bitumen %	4.5	5	6	6.5	7	8
Marshall Properties						
Stability (KN)	15.69	16.67	19.35	19.42	20.6 6	17.66
Flow value (mm)	1.8	2.4	3.20	3.72	4.57	5.3
Unit wt (g/cc)	2.245	2.27	2.27	2.29	2.3	2.32
% air voids	9.13	7.6	6.2	5	3.9	2.4
VMA(%)	19.1	18.35	19.35	19.8	19.5	20.4

A. Fly ash and Brick dust specimen Marshall Curves

1) Marshall Stability

Fig 1 shows the variation of Marshall Stability with bitumen content where it is seen that as usual the stability value increases with bitumen content initially and then decreases. Maximum stability value of 23.2 kN is observed at 6% bitumen content in case of fly ash as a filler but in case of brick dust a maximum stability value of 20.58 kN is obtained at 7% bitumen content in case of brick dust as a filler. A lower value of stability in case of brick dust specimen in comparison with fly ash may be attributed due to higher bitumen content.

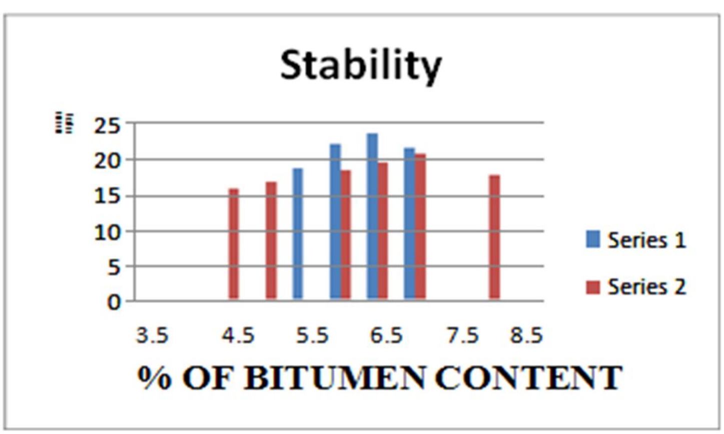

Fig: 1 Marshall Test Curves for Stability (fly ash and brick dust)
(Series 1 – fly ash: Series 2 – brick dust)

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2) Marshall Flow value (mm)

Fig 2 shows the variation of Marshall flow value with % of bitumen content where it is seen that usually an increasing trend is followed with increase in bitumen content and on comparing fly as and brick dust results graphically it can be seen that brick dust specimens are found to display a higher flow value in comparison with fly ash specimen , from here we can speculate that this might be due to a higher bonding in specimens with fly ash as filler in comparison with specimens having brick dust as filler material.

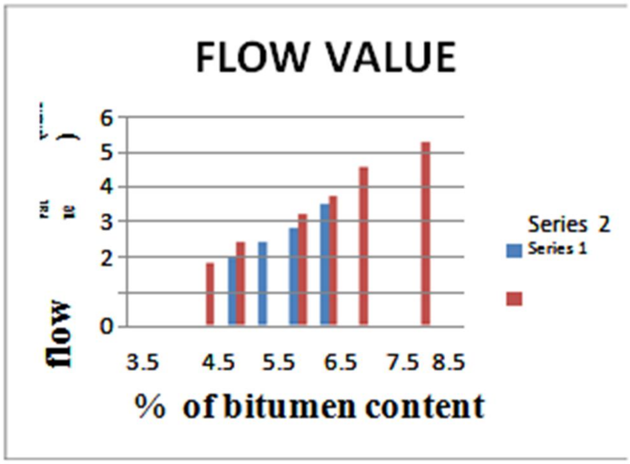

Fig :.2 Marshall test curves for Flow value (fly ash and brick dust)
(Series 1 – fly ash: Series 2 – brick dust)

3) Marshall Unit weight curves (g/cc)

Fig 3 displays the graphical representation of unit weights for variation in % of bitumen content for Marshall Specimens having fly ash and brick dust as fillers. In this figure brick dust specimens are found to display a higher unit weight in comparison with fly ash as filler due to lesser no of air voids in case of specimens having brick dust as filler, this may be due to brick dust acting as a filler material having better ability to fill up air voids than fly ash. In fly ash specimens maximum unit weight obtained is 2.10 g/cc at 6% bitumen content whereas in case of brick dust specimens it is 2.33 g/cc at 8% bitumen content showing an increasing trend in brick dust specimens which might tend to reduce at higher percentage of bitumen content.

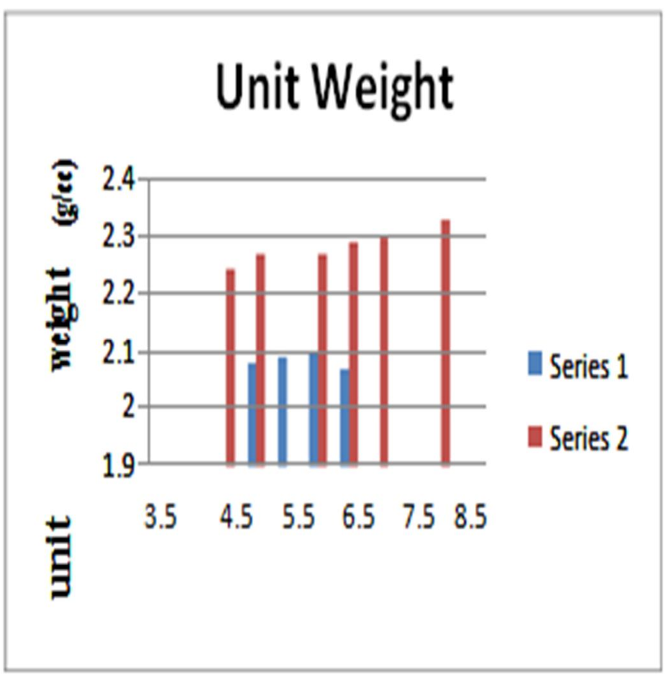

Fig 3 Marshall test curves for Unit Weight (g/cc) (fly ash and brick dust)

4) Marshall air voids (%) curve (fly ash and brick dust)

Fig 4 shows the variation of air voids with variation in percentage of bitumen content with the minimum percentage of 4.13 % air voids being obtained at 6% bitumen content, however the curve obtained in brick dust specimen is found to have a decreasing trend displaying a greater bonding between brick dust and bitumen thus showing a decreasing trend in case of air voids with increase in bitumen content.

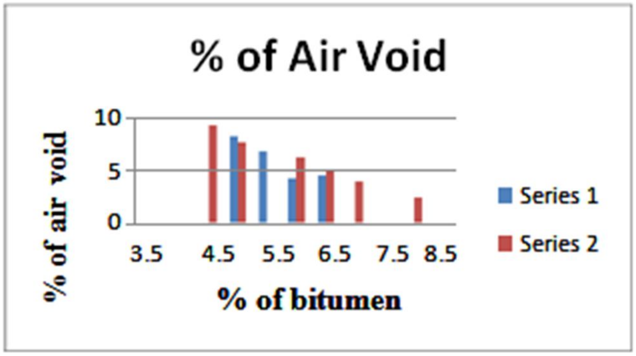

Fig.4 Marshall test curves for Air void (%)(fly ash and brick dust)
(Series 1 – fly ash: Series 2 – brick dust)

5) Marshall's VMA (%) curve (fly ash and brick dust)

In fig .5 Brick dust specimens are found to be displaying higher values of VMA than fly ash specimens but in fig 4 they are found to display lesser amount of air voids thus leading to the conclusion that brick dust absorbs higher amount of bitumen in comparison with fly ash specimens.

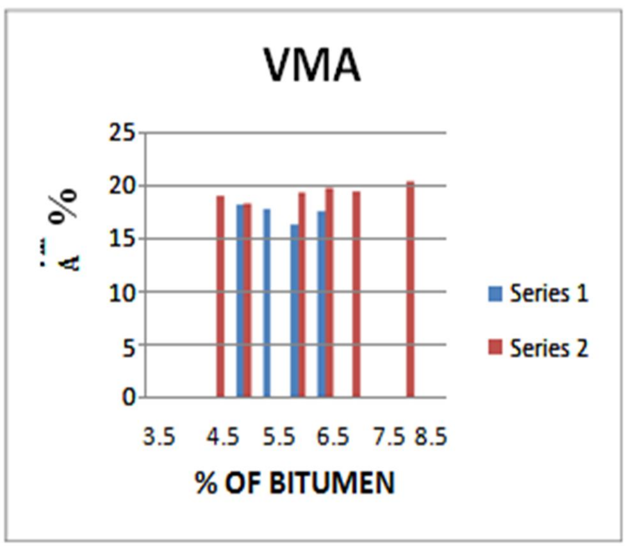

Fig 5 Marshall test curves for VMA (%)(fly ash and brick dust)
(Series 1 – fly ash: Series 2 – brick dust)

B. Comparison with Conventional Mixes

Marshall Properties between conventional fillers such as cement and lime (ref. Das and Pandey) and nonconventional fillers fly ash and brick dust

In table no 5 it is found that brick dust and fly ash are found to require higher percentage of bitumen content in comparison with conventional fillers such as cement and lime

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Table no 5

Parameters	Flyash	Brick dust	Cement	Lime
Optimum Bitumen Content, %	6%	7%	5.13%	5.38%
Stability (kN)	21.58	19.23	10.69	11.48
Flow value (mm)	4.56	2.8	4.7	3.7
Unit wt (gm/cc)	2.3	2.1	2.42	2.41
% of air void	3.9	4.18	3	4.7
VMA(%)	19.5	16.41	14.8	15.6

V. CONCLUSIONS AND FUTURE SCOPE

A. *Conclusions*

1) Bituminous mixes containing fly ash and brick dust as fillers are found to have Marshall properties almost nearly same as those of conventional fillers such as cement and lime.
2) Bituminous mixes containing fly ash as filler displayed maximum stability at 6% content of bitumen having an increasing trend up to 6% and then gradually decreasing, the unit weight/ bulk density also displayed a similar trend with flow value being satisfactory at 6% content of bitumen.
3) Bituminous mixes containing brick dust as filler showed maximum stability at 7% content of bitumen displaying an ascending trend up till 7% and then decreasing, the flow value showed an increasing trend and similar was the trend shown by unit weight/bulk density, the percentage of air voids obtained were seen to be decreasing with increase in bitumen content thus from here we can see that at 7% bitumen content we are obtaining satisfactory results.
4) These mixes were seen to display higher air voids than required for normal mixes
5) Higher bitumen content is required in order to satisfy the design criteria and to get usual trends.
6) From the above discussion it is evident that with further tests fly ash and brick dust generated as waste materials can be utilized effectively in the making of bitumen concrete mixes for paving purposes.
7) Further modification in design mixes can result in utilization of fly ash and brick dust a fillers in bituminous pavement thus partially solving the disposal of industrial and construction wastes respectively.
8) Though cement and stone dust being conventional fillers however fly ash and brick dust can be utilized in their place effectively thus solving the waste material disposal substantially resulting in utilization of industrial space being consumed in disposal of industrial wastes.
9) The cost effectiveness of these non conventional filler specimens can be realized after performing a cost analysis of these non conventional materials against the conventional specimens resulting in reduction of the construction costs considerably.
10) It is evident that with further tests fly ash and brick dust generated as waste materials can be utilized effectively in the making of bitumen concrete mixes for paving purposes.

B. *Future Scope*

1) Pavement mixes with brick dust and fly ash as fillers using modified binders such as CRMB (60).

2) Indirect tensile test of bituminous mixes can give us an idea about the tensile strength of the bituminous mixes.
3) Repeated load testing can give us an overview about the fatigue failure resistance of the specimem

REFERENCES

[1] G.Zamare and Amit Gawande. Zamare., V.C Renge., Saurabh Tayde, G. Bharsakale.. (2012) "An overview on waste plastic utilization in asphalting of roads", Journal of Engineering Research And Studies (JERS), Vol.III, Issue II, pp 01-05
[2] Ganesh Tapkire, Satish Parihar, Pramod Patil, Hemraj R Kumavat, "Recycled Plastic used in Concrete Paver Block" International Journal of Research in Engineering and Technology eissn: 2319-1163, Vol: 03 special issue: 09, NCETCE-2014.
[3] P K Jain, Shanta Kumar & J B Sengupta, "Mitigation of rutting in bituminous roads by use of waste polymeric packaging materials" Indian Journal of Engineering & Materials Sciences Vol. 18, June 2011, pp. 233-238
[4] madan mohan reddy ,k,ajitha .B and bhavani.R(2012) "Melt- Densified Post-Consumer Recycled Plastic Bags Used as Light Weight Aggregate in Concrete", International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue, pp.1097-1101.
[5] Dr.prahallada M.C and Dr.prakash K.B "strength and workability characteristics of waste plastic fibre reinforced concrete produced from recycled aggregates"international journal of engineering research and applications(IJERA) ISSN:2248-962
[6] Puttaraj Mallikarjun Hiremath, Shanmukha shetty, Navaneeth Ral.P.G, Prathima.T.B, "UTILISATION OF WASTE PLASTIC IN MANUFACTURING OF PLASTIC-SOIL BRICKS'' International Journal of Technology Enhancements And Emerging Engineering Research, ISSN 2347-4289, Volume 2.
[7] Dr.R.Kumutha and Dr.K.Vijai,"Use of waste material in paver blocks" in the year 2015.
[8] Dr. A.K.MishraVishal kumar, , "Utilization of waste material in pavement blocks" in the year 2016.
[9] Al-Hadidy A.I., Yi-qiu Tan (2009), "Effect of polyethylene on life of flexible pavements", Construction and Building Materials, Vol. 23.
[10] Annette R. Hill, Andrew R. Dawson, Michael Mundy.,(2001), "Utilisation of aggregate materials in road construction and bulk fill", Resources, Conservation and Recycling, Vol. 32, School of Civil Engineering, University of Nottingham, Australia, pp 305–320.
[11] Bandopandhyay T. K., (Jan. - Mar. 2010), "Construction of Asphalt Road with Plastic Waste", Indian Center for Plastic in Environment (ICPE), ENVIS – Eco-Echoes, Vol.11, Issue 1.
[12] Dhodapkar A N., (Dec. 2008), "Use of waste plastic in road construction", Indian Highways, Technical paper, journal, P No.31-32.
[13] Dun Qiao.,(2010), "Utilization of sulfate-rich solid wastes in rural road construction in the Three Gorges Reservoir", Resources, Conservation and Recycling, Vol.54, College of Materials Science and Engineering, Chongqing University, China, pp 1368–1376.
[14] S.Vanitha,V.Natarajan and M.Praba,"Utilization of waste plastics as a partial replacement of coarse aggregate in concrete blocks" in the year 2015.
[15] S F Wong,"Use of recycled plastic in a pavement system" in the year 2010.