International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 07 | July - 2021 ISSN: 2582-3930

USING CONCRETE AND BRICK DUST AS FILLER MATERIAL TO INCREASE THE MARSHAL PROPERTIES OF BITUMINOUS MIX

Harish Kumar[1], Pardeep[2]

[1]Harish Kumar Dept of civil Engineering, Sat Priya Institute of Engineering & Technology, Haryana, India
[2]Pardeep Dept of civil Engineering, Sat Priya Institute of Engineering & Technology, Haryana, India

---

Abstract – Aggregate, filler and bitumen are used in bituminous mix. Voids in mix is filled with fine aggregate but some time all voids are not filled with aggregate. So that to fill that voids we use filler material. On adding fillers, physical and chemical properties of bituminous mix changes. In this study, I am going to talk about changes in Marshall properties using brick and concrete dust. As per the Asphalt institute guidelines, only 4 to 8 % of filler material can be used in bituminous mix. In this study also tests were carried out on aggregates and bitumen. The results obtained were compared with the specifications laid down by BIS, MORTH and IRC in order to find whether the materials were within the specified limits. Samples were prepared with varying bitumen content using brick dust and concrete dust as filler.

Key Words: Marshall properties, Brick dust, Concrete dust, Bitumen

1. INTRODUCTION

A well designed bituminous mix will withstand heavy traffic loads under the adverse conditions. It will also fulfill the structural and pavement surface characteristics. The objective of the design of bituminous mix is to establish an economical mix through several trial mixes. The gradation of aggregates and the binder content should be such that the resultant mix should satisfy the following conditions.

1. Sufficient binder so as to make sure that the pavement is durable by providing a water proofing coating on the aggregate particles and binding them together under compaction.
2. Sufficient stability so as to provide the resistance against deformation under sustained or repeated loads. The binder in the mix develops interlocking and cohesion between the aggregates thus providing resistance against.
3. Sufficient flexibility to avoid early cracking due to repeated deformation by the traffic and also to intercept shrinkage cracks at low temperatures. Proper amount and grade of bitumen ensures the sufficient flexibility.

1.1 Marshall Mix Design Method

The Marshall Mix Design method was developed by Bruce Marshall of the Mississippi Highway Department in 1939. This test procedure is used in d evaluating and designing bituminous paving mixes and is extensively used in routine test programs for the paving jobs. Marshall Method of designing mixes has two major features namely, density–voids analysis and stability – flow test. Strength which is defined as the maximum load carried by a compacted specimen at a standard test temperature of 60°C, is measured in terms of Marshals Stability of the blend following the specification ASTM D 1559 (2004).

1.2 Objectives of the study

Aim of the present study is to find the behavior of bituminous mixes when different fillers are added in it. Various studies pertaining to using of fillers in bituminous mixes were studied. In the present study brick dust and concrete dust is used as filler. Accordingly the properties of bituminous mixes containing filler like waste concrete dust and brick dust is studied and compared with each other mixes. For the purpose of comparison Marshall Method of Mix design was used.

2. LITERATURE REVIEW

All over the world most commonly used pavement in flexible pavement is bituminous pavement. It consists of mixture of bitumen and aggregates. These materials when mixed are laid in layers and compacted. Due to increase in traffic loads and increase in traffic volume present life of pavement should be sufficiently long. Considering this a lot of work has been conducted in the past in order to improve the various parameters of pavement. The present study deals with reviewing of the works carried out earlier in the past with regard to addition of fillers in mixes. After going through number of researches it was seen that fillers play vital role and improve various properties of mix. One of the main advantages was seen of solving the problem of waste disposal. Higher filler concentration results in stronger pavement. However excessive addition of filler weakens the mixture.

1. In 2015 stone dust and fly ash were used as fillers and compare with each other. It was observed that Marshall Stability was higher for the sample containing stone dust as filler. Further with the increase in the percentage of bitumen content flow value also increased. In case of fly ash it was observed that with increase in percentage of bitumen content volume of voids decreased
2. In 2015 sewage sludge ash was used as mineral filler in bituminous mixes. The study showed that buy using 2-3% SSA waste satisfactory results are obtained. It was further concluded that using SSA maintains adequate level of cohesion and adhesion in mixture. Further using SSA does not increase the permanent deformation in bituminous pavements.
3. In 2011 waste polymer was used as filler in bitumen. Evaluation of various properties was done and compared with the standard bitumen. It was concluded that using polypropylene as filler was not suitable and the properties of bitumen are not improved. It was further observed that various difficulties were observed mixing resulting in poor cohesion.

4 In 2008 plastic was used as filler in bituminous mixes. In this study results showed that plastic increases the melting point of bitumen and makes the road flexible during winters. The study revealed that using plastic in high temperature areas increases the life of road by about 70%. Further it also showed that problem of big potholes in rainy areas can be solved to a huge extent.

5 In 2008 for the purpose of modification in bituminous concrete waste plastic material was used. In order to find the optimum binder content Marshall Method was used. Different samples were prepared for varying bitumen content and varying weight of aggregates. Bitumen content was varied from 5 to 6.5 percent by weight of aggregate with increment of 0.5%. Waste plastic was varied from 6% to 18% by weight of bitumen with increment of 4%. It was observed that the Marshall Stability value increased. For the mix with 10%, 14%, 18% waste it increased by 18%, 25% and 45%.

3. EXPERIMENTAL PROGRAM

3.1 Bitumen Tests

Various tests pertaining to bitumen were performed. Softening point test, penetration test, specific gravity test, ductility test and viscosity test were carried out and compared with the specifications laid down by BIS, IRC and MORTH. All the tests were carried out in laboratory and results were calculated. Procedure and Results along with the specifications laid down by BIS, IRC and MORTH are described in the below section.

3.1.1 Viscosity Test

Inverse of fluidity is viscosity. It is the property of liquid that retards its flow due to internal friction. Higher the viscosity slower is the movement of liquid. Viscosity was measured by orifice type viscometer. 50 ml of the sample was taken and was allowed to flow through orifice of the test cup at a temperature of 50°C. Time taken by the sample to pass through the orifice was recorded and the viscosity was calculated.

Fig. 1 Standard Viscometer

3.1.2 Specific Gravity Test

Specific gravity can be defined as the ratio of mass of given volume of bitumen binder to the mass of an equal volume of water, temperature of both being specified at 27°C. Specific gravity was determined by using a Pycnometer. Specific gravity bottle was cleaned, dried and weighed along with the stopper. It was filled with fresh water, stopper was placed and the same was kept in water container for half an hour at a temperature of 27°C. The bottle was then removed and cleaned from outside and was then weighed. Bottle was emptied. Then the bituminous material was heated to a pouring temperature and was poured in the above bottle. The material was filled up to the half. The bottle was allowed to stand for half an hour (so as to prevent the escape of gases), cooled to 27°C and was then weighed. The remaining space was then filled with distilled water at 27°C, stopper was placed and then placed in water container at 27°C. Then the bottle containing bituminous material and water was removed, cleaned from outside and then again weighed.water, temperature of both being specified at 27°C. Specific gravity was determined by using a Pycnometer.

Fig. 2 Specific Gravity Apparatus

3.2 AggregatesTests

Various tests pertaining to aggregates were performed. Crushing test, Abrasion test, specific gravity test, elongation test, flakiness test, impact values test and water absorption test were carried out and compared with the specifications laid down by BIS, IRC and MORTH. All the tests were carried out in laboratory and results were calculated. Procedure and Results along with the specifications laid down by BIS, IRC and MORTH are described in the below section.

3.2.1 Shape Test

The particle shape of the aggregate mass is determined by the percentage of flaky and elongated particles in it. Aggregates which are flaky or elongated are detrimental to higher workability and stability of mixes. The flakiness index is defined as the percentage by weight of aggregate particles whose least dimension is less than 0.6 times their mean size. Test procedure had been standardized in India (IS:2386 part-I)
The elongation index of an aggregate is defined as the percentage by weight of particles whose greatest dimension (length) is 1.8 times their mean dimension. This test is applicable to aggregates larger than 6.3 mm. This test is also specified in (IS:2386 Part-I). However there are no recognized limits for the elongation index.

Fig. 3 Flakiness and Elongation Test Apparatus

3.2.2 Specific Gravity Test

The specific gravity and water absorption of aggregates are important properties that are required for the design of concrete and bituminous mixes. The specific gravity of a solid is the ratio of its mass to that of an equal volume of distilled water at a specified temperature. Because the aggregates may contain water-permeable voids so two measures of specific gravity of aggregates are used: apparent specific gravity and bulk specific gravity.

Specific gravity = $W_3 / (W_3–(W_1–W_2)$

Water Absorption = $(W_3 – W_4) / W_4)$ X100

3.3 Marshall Mix Design

Marshall Method of mix design has been adopted in this project. Accordingly aggregates with the grading 2 of IRC and bitumen 80/100 having properties as described in the preceding paragraphs have been used. The objective of bituminous paving mix design is to develop an economical blend of aggregates and bitumen. In the developing of this blend the designer needs to consider both the first cost and the life cycle cost of the project.

Fig. 4 Marshall Stability Test Apparatus

4. RESULTS AND DISCUSSIONS

This chapter includes the test results obtained after the laboratory testing of the bituminous mixes with modified Marshall Method by using of fillers with different percentage of bitumen content. The results were obtained to determine the Optimum Binder Content (OBC) by performing the Stability-Flow analysis and Volumetric analysis for the prepared samples.

4.1 Test Results of Marshall Bitumen Mixes

The results of the Marshall test of individual specimens and average Marshall Properties of specimens prepared with concrete dust and brick dust as filler for varying bitumen contents have been presented in tables 1 and 2 respectively.

Table 1 Marshall Properties of Specimens with Filler Concrete Dust.

Bitumen content %	Unit weight kg/m^3	Stability kn	Flow value mm	Air void %	VMA %
5	2365	10.9	3.20	5.9	18.35
5.5	2375	11.3	3.40	5.6	17.85
6	2390	11.9	3.65	4.3	17.20
6.5	2400	12.7	3.95	4.1	16.85

Table 2 Marshall Properties of Specimens with Filler Brick Dust

Bitumen content %	Unit weight kg/m^3	Stability kn	Flow value mm	Air void %	VMA %
5	2320	14.21	2.5	7.95	18.28
5.5	2335	15.12	2.33	7.35	17.95
6	2348	16.65	3.45	6.35	17.35
6.5	2361	17.95	4.10	5.5.	16.63

4.2 Marshall Flow Value Curves

The graphical representation of flow value for variation in bitumen content from 5% to 6.5% for samples containing brick dust and concrete dust as filler is shown in Fig 3. From the graph it is seen that as usual with the increase in the bitumen content flow value increases. It is seen that specimen with concrete dust as filler has lesser flow value than specimen with brick dust as filler. In case of the specimen with concrete dust as filler maximum flow value is observed at 6.5% bitumen content. Flow value of specimen with concrete dust as filler is 4.10mm. Also in case of the specimen with brick dust as filler maximum flow value is observed at 6.5% bitumen content. Flow value of specimen with brick dust as filler is 3.95mm.

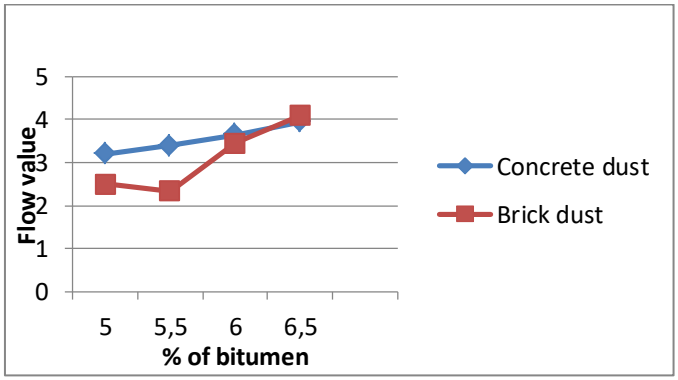

Chart 1 Variation of Flow Value With %age of Bitumen.

4.3 Marshall Air Void Curves

The graphical representation of Marshall Air void for variation in bitumen content from 5% to 6.5% for samples containing brick dust and concrete dust as filler is shown in Fig 4. From the graph it is seen that with the increase in the bitumen content air void decreases. It is seen that specimen with concrete dust as filler has lesser air void than specimen with brick dust as filler. In case of the specimen with concrete dust as filler minimum air void is observed at 6.5% bitumen content. Air

void of specimen with concrete dust as filler is 4.1%. Also in case of the specimen with brick dust as filler minimum air void is observed at 6.5% bitumen content. Air void of specimen with brick dust as filler is 5.50%.

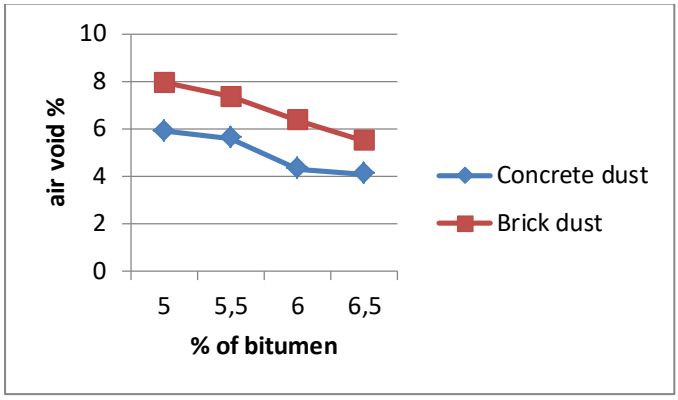

Chart 2 Variation of Air Void With %age of Bitumen.

5. CONCLUSIONS AND FUTURE SCOPE

5.1 Conclusions

The specimen with brick dust as filler is found to have nearly same Marshall Properties as that of the specimen with filler concrete dust.

The specimen with concrete dust as filler is found to have maximum unit weight at bitumen content of 6.5%. Unit weight of that particular sample at 6.5% bitumen content is found to be 2400 kg/m^3. Further it is shown that with the increase in bitumen content unit weight goes on increasing.

For the specimen with brick dust as filler it is found to have maximum unit weight at bitumen content of 6.5%. Unit weight of that particular sample at 6.5% bitumen content is found to be 2361 kg/m^3. Further it is shown that with the increase in bitumen content unit weight goes on increasing.

1 For both the samples containing brick dust as filler and concrete dust as filler satisfactory results are obtained at bitumen content of6.5%.
2 Both the bituminous mixes displayed higher air voids and VMA than required for normal mixes.
3 It is also found that in order to satisfy the design criteria bitumen content is to be increased.
4 One of the advantages of using these as fillers is of reducing the problem of disposal of industrial wastes; with in turn help in reducing pollution and making environment

5.2 Future Scope

1 Also waste plastic in the form of molten polythene can be used as binding material.
2 We can also use fine ground slag as filler in bituminous mixes. Further it can also be used for the purpose of soil Stabilization.
3 Mill tailings which is waste product of Mineral processing industry can also be used as aggregate in bituminous mixes, thus reducing the disposal problem.
4 Cement kiln dust which is waste product of Cement industry can also be used as filler in bituminous mixes. Further it can also be used as a material in soil stabilization.
5 Waste tyres which also is a waste product generated in Automobile industry can be used as a raw material in rubber modified bitumen.
6 China clay generated from Bricks and tile industry can be used as aggregates in the bituminous mixes.
7 Non-ferrous slag which is also a waste can also be used as aggregate in the bituminous mixes.

References

1 Surendra “use of polythene for modification of bituminous concrete” International journal of Engineering and Technology2008.
2 Panda and Mazumdar, “Utilisation of reclaimed polyethene in bituminous paving mixes”, Materials in civil engineering2002
3 C.E.G. Justo, Dr. A. Veeraragavan Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads(2002).
4 J. Mater. “Coal Ash Utilization In Asphalt Concrete Mixtures” Civ.Eng.11, 295(1990)
5 Rosner. J. C., Chehovits, J. G., and Morris, G. R. (1989). "Fly ash as a mineral filler and anti strip agent for asphalt concrete." Challenge ofchange-6th Int. Ash Utilization Symp. Proc., U.S. Dept. of Energy, Morgantown