International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 34, Issue 01 and Publication Date: 28th June, 2022
An Indexed, Referred and Peer Reviewed Journal
ISSN (Online): 2347-601X
www.ijemhs.com

A Comparison of Coconut Fiber and Pet for Increasing Stone Matrix Asphalt Stability

Harish Malik[1], Shivani[2], and Anand Chawla[3]

[1]M.Tech Scholar, Department of Civil Engineering, Satpriya group of institutions, Rohtak, Haryana
harishmalik1501@gmail.com
[2]Assistant Professor, Department of Civil Engineering, Satpriya group of institutions, Rohtak, Haryana
shinu147@gmail.com
[3]M.Tech Scholar, Department of Civil Engineering, Satpriya group of institutions, Rohtak, Haryana
anandchawla08@gmail.com

Abstract

In this investigation, stone Matrix Asphalt blends performed better under large traffic loads in terms “of stress execution. It is less expensive than dense graded mixtures, and it is commonly employed as a surface-coarse mixture. This paper discusses a study that “was undertaken to examine the properties of a bituminous mix that had been amended using waste polythene and coconut fiber. The inclusion of PET has a considerable favorable influence on the qualities of SMA, and it can enhance the ecologically friendly and cost-effective re-use of waste material in industry, according to the final results. Based on the results, coconut could be employed as a stabilizing ingredient without altering the SMA mixture's design criteria. PET should be added at a rate of 6% by weight of bitumen, according to the findings. The maximum level of stability was achieved by using this optimal percentage of PET readings. The use of leftover polythene improves the engineering qualities of bituminous mix, according to calculations. In this study, we show how to use waste plastic and natural fiber to their full potential, as well as how to build a more durable surface course with enhanced pavement material.

Keywords: *Asphalt, polythene, coconut fiber, bituminous, PET, SMA.*

1. INTRODUCTION

Stone Matrix Asphalt mixtures perform better under large traffic loads and are less expensive than densely graded asphalt mixtures. They're mostly employed in pavement construction as surface-coarse mixtures. When compared to other Bituminous Concrete mixtures with a particular maximum aggregate size, Stone Matrix Asphalt has a larger percentage of coarse aggregate in its mixture. SMA mixtures are made up of two components. Coarse aggregate skeleton and increased bitumen content are two of them. The coarse aggregate skeleton offers Stone to Stone contact, which adds strength, and the increased bitumen concentration increases SMA's longevity”.

“When the mixture is heated during storage, trucking, and placing, gap gradation of a SMA may allow the binder and aggregate dust to drain To avoid drain down, a stabilizing ingredient is utilized. In general, some additives or blends of additives can improve the qualities of paving bitumen and bituminous mixes.

The ideal folio substance is dictated by keeping the recommended air voids content in the blend. The fiber is added to OBC and two other bitumen focuses nearest to it”.

2. OBJECTIVE

“For this, different Marshall tests of SMA blends with and without filaments with changing fastener focus are readied. Marshall Properties, for example, soundness, stream esteem, thickness, air voids are utilized to survey the ideal fastener substance and ideal fiber content for changed SMA blends. From there on, the channel down attributes for adjusted and unmodified SMA Blend have been examined. These chemicals are known as Bitumen Modifiers, and bitumen that has been premixed with them is known as Modified Bitumen. The additives are also known as stabilizers since they can be employed as a stabilizing agent. The stabilizers will prevent bitumen from draining from aggregates and increase fracture resistance, but this may vary depending on the type of additive and how it is added to the mix. Several articles explain several strategies for increasing the performance of bituminous mixes, including pavement bearing capacity, rutting resistance.

3. LITERATURE REVIEW

Rosli Hainan et al studied the Importance of Stone Mastic Asphalt in Construction. The first aim of this study is to provide an updated systematic review of the evaluation of stone mastic asphalt in construction. The second aim is to develop knowledge readers and researchers for advantages and disadvantages of stone mastic asphalt to help focus future research in this area. This paper has reviewed on stone mastic asphalt that addressed these major elements through interviews with a number of respondents and through an investigation of previous researches used SMA. It is concluded that SMA is appropriate asphalt in construction.

The use of SMA does not show any systemic safety issues. There are however institutional issues that influence the effective use. TEJA TALLAM et al studied the assessment of stone mastic asphalt Performance with the inclusion of fiber Material on resilient characteristics. The main objective of this study is to compare the inclusion of polyester fibers in SMA Mix for understanding the behaviour of resilient characteristics. Optimum binder content (OBC) of SMA Mix is arrived 6.5% and the corresponding fiber content (OFC) was arrived as 0.4% when performed through drain down test. Polyester fibers have good drain down characteristics and provide good homogeneous mixture compared with conventional SMA".

"It is observed from test results that resilient modulus increased with the addition of polyester fibers by 18% and tensile strength ratio by 1.2%. This indicates that fiber inclusion provides better cracking resistance when compared with conventional SMA Mix

. Mohammad Altaf Bhat et al studied the Effect of Fillers on Bituminous Mixes. To 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. K.Karthik et al studied the carbon fiber modified bitumen in bituminous macadam. In the present study, an attempt has been made to study the effects of use of a mineral fiber called Carbon fiber is used as an additive in Dense Bituminous Macadam (DBM).

An experimental study is carried out on conventional bitumen and fiber modified binder. Using Marshall Procedure, Optimum Fiber Content (OFC) and Optimum Binder Content (OBC) for DBM are found respectively. Detailed laboratory investigations will be carried out by preparing asphalt concrete mixtures by adding carbon fiber with dosages of 0.5%to 2.5% by weight of binder. Volumetric properties of the mixes will be determined and various strength tests such as marshal stability will be conducted. In the present paper, an approach was developed to mix carbon fibers and bitumen which guarantees the uniform fiber distribution.

In Flexible pavement construction, modified bitumen can be used with fibres, Chemicals, Waste materials etc. for improving its properties. The most suitable fibres are used to improve its properties, i.e.

Marshall Mix design, Viscosity, Ductility, and Specific Gravity. According to literature, Forta Fi- fibre is most advantageous for improving bituminous properties so here it is checked for its feasibility in our country to improve different bituminous property. 1%, 2 %, and 3 % of Forta Fi by its weight of Conventional bitumen mix is studied. Mixing Forta fi in various proportion like 1%, 2% and 3% in bituminous mix , the penetration value is increasing up to 1% of plain bituminous mix to 5% in case of binding containing of Forta fi. But in case of adding 3% fibre in bituminous mix, penetration value is exceed, so 3% fibre of binding containing is not suitable for bituminous mix. The viscosity value of bituminous mix increases in wide range up to 17% of plain bituminous mix to 64% in case of binding containing 1%,2% and 3% of Forta fi".

4. MATERIALS

A. Stone Matrix Asphalt

When compared towards "other Bituminous Concrete mixtures with a particular maximum aggregate size, Stone Matrix Asphalt (SMA) contains a higher percentage of coarse aggregate. Stone to stone contact is provided by SMA mixes, which provides excellent rut resistance and lowers the customers' reliance on the kind and amount of binder. SMA mixtures are made up of two components: a coarse aggregate skeleton and more bitumen. The coarse aggregate skeleton offers Stone to Stone contact, which adds strength, and the increased bitumen concentration increases SMA's longevity. When the mixture is heated during storage, trucking, and placing, gap gradation of a SMA allows the binder and aggregate dust to drain.

B. Coconut Fiber

The Coconut fibers have the highest toughness amongst natural fibers. They has enough potential to be used as reinforcement in low-cost concrete structures, especially in tropical earthquake regions. It is observed that CFRC with a fiber length of 5 cm and a fiber content of 5% has the best properties. The steps involved in the preparation of coconut fibers are":

- "initially it was dried directly in sun light till it becomes dry
- Then these coconut were chopped off to size of one to two inch
- To ensure the brittleness nature of coconut, kept the chopped coconut in oven at a constant temperature of 50 to 60 C for an hour.
- High convergence of coarse total expands stone-to-contact and interlocking in the blend which gives quality and the rich mortar folio gives toughness. It gives a higher impervious to rutting".

C. Polyethylene terephthalate

"The world's most powerful The manufacturing of polyethylene terephthalate (PET) for bottle production accounts for around 30% of global demand. The biggest environmental issue is the vast number of bottles made of polyethylene terephthalate (PET) that are discarded in household waste and landfills. Every year, more than 1 million m3 of landfill area is required for the disposal of these bottles due to their enormous volume. The experimental investigation was carried out to prove the possibility of employing PET waste in asphalt concrete mixes as aggregate replacement in concrete in order to reduce the environmental effects of PET disposal. For waste PET granules with a diameter of around 3mm, which would replace a portion of mineral coarse aggregates with a diameter of 2.36-4.75mm?

5.METHODOLOGY

D. Gradation on aggregates

The aggregates' gradation is an important consideration in the creation of SMA Mix. The SMA Mix gradation was chosen based on the thickness of the layer. According to the clause of the MoSRT&H specification in the Fourth Revision, this investigation was carried out for a 50mm thick layer of SMA. The trial and error method was used to accomplish individual grading and proportioning of selected component aggregates. Various constituent materials, including 80% 9.5 mm nominal size aggregate, 15% crushed stone dust, and 5% hydrated lime, were mixed together to get the desired grading of SMA.

B. Aggregate Impact Test

To estimate the impact resistance of an aggregate, test has been carried out in Aggregate Impact Testing apparatus. The test consists of a specimen of aggregates passing 12.5 mm sieve and retained on 10 mm sieve has taken for the analysis and it is filled into a cylindrical mould 10.2 cm internal diameter and 5cm height. The impact is provided by dropping a hammer. The test sample dried in an oven for 4 hrs for temperature 100C to 110C and cooled. The aggregates are filled up to about one — third full in thecylindrical measure and tamped 25 times with rounded end of tamping rod. Further quantity of aggregate is then added up to about two — third full in cylindrical and 25 strokes of the tamping are given. The measure is now filled with aggregate to overflow, tamped 25 times The hammer is raised until above the upper surface of the lower face in the cupis 38cmand allowed to fall freely on the aggregates. Thetest sample is compacted for 15 blows with the interval of 1 second. The crushed aggregate is taken and sieved through 2.36mm sieve until no bulky amount passes. The fractions passing sieve is weighed accurate to 0.1 gm. The fraction retained on sieve is also weighed and the total fractional weight of the passing and retained on the sieve is added and it should not be less than the original weight of the sample by greater than one gram. if the total weight is less than the original by over one gram, the result should berejected and a fresh test has carried out. The above test is repeated on fresh aggregate sample.

used to accomplish the desired SMA grading

Fig 1: Aggregate Impact Test

C. Aggregate Abrasion Test

This test has been conducted to find the abrasion value of the aggregate. The Los Angeles abrasion testing apparatus used is shown in the figure 4.4. The test procedure is explained below. clean aggregates has taken for the analysis and dried in oven at 105 C to a significantly constant weight. Select suitable charge depending upon the grading of test sample as given in the table. By keeping the test sample on Los Angeles abrasion testing machine and rotate the machine at the speed of 20 to 33 rpm. For grades A, B, C and D – total revolution are taken were 500 and for grades E, F and G total revolutions were taken as 1000. Taken the sample from the machine after completion of total revolutions, and sieve it through 1.70 mm sieve and wash the material coarser than 1.70 mm and dry the sample at 110 c in oven to a extensively constant weight. Then, calculate the differences between original and final weight of sample and express this as a percentage of original weight of test sample".

Table 1: Abrasion test with no of spheres

Gradation	Spheres numbers	Weight (g)
A	12	5013
B	11	5003
C	8	3336
D	6	2506
E	12	5006
F	12	5004
G	12	5012

D .Marshall Test

"Marshall stability test has been conducted for bituminous mixture to find the resistance to plastic flow of cylindrical specimens as per ASTM D 1559. Initially heat the both weighed aggregate sample and the bitumen up to 170°C and 163°C respectively. Then, Mix both the materials and transfer to the mould. with a standard hammer ,75 blows were given on the specimen mix from the height of 45cm. After that reverse the specimen and again 75 blows were given. Take the specimen along the mould and allowed to cool. Extrude the specimen and cured for overnight. Specimens were prepared with an increment of 0.5% and keep the mould in the water bath at a temperature of 60°C for half an hour. Then the stability of the mould on the Marshall Stability apparatus has been arrived".

Fig 2: *Marshall test*

Fig 3: *Ductility test*

TESTS ON BITUMEN

E. Ductility Test

“To determine the Ductility which is one the important property of bitumen measures deformation or elongation. The standard sample material will be elongated without breaking and measured in cm. the standard Dimension of the briquette has been prepared for 1 cm^2. The test has”,

Powder of fibre (g)	Dosage by weight of mix (%)				
	0.00	0.20	0.40	0.60	0.80
0.2	24.8	31.5	29.5	28.4	28
0.4	24.8	29.6	29.2	27.8	27.5
0.6	24.8	26	25.4	25	23.5
0.8	24.8	25.9	25.2	24.8	22.2

been carried out at the temperature 27 C ata pull of 50 mm/min. The “sample was heated to the optimum and filled in the mould. Cut off the additional bitumen and leveled the surface with hot knife. Then the sample was kept in water bath about 90 minutes. The mould sides were removed and clips were hooked before testing proceeds. The ductility value were influenced by various factors such as pouring temperature, test temperature, rate of pulling etc. In the wet technique, the blending was finished by direct mixing the annihilated polymer with hot bitumen at 160 deg. C. In the dry method, a novel framework was used to use more elevated level of waste plastics in road advancement and using this methodology a substitute procedure was used.

Table 2: *Stability with different fiber dosages and powder`*

F. Softening point test

The Softening point test has been conducted by ring ball apparatus to find the degree of softening as shown in figure 4. The bitumen was heated at 100 C and mix it to homogenous state. Then, pour the bitumen into the brass ring and remove the excess bitumen with the help of hot knife. A brass ring has sample of bitumen and steel ball was placed upon sample of bitumen. Then, liquid medium was heated at a rate of 5°° C per minute. Noted the temperature when the softened bitumen reaches the metal plate at a specified distance below. Usually, higher softening pointdenoted lower temperature explores and chosen for hot climates

C .Voids in Coarse Aggregates Vs Binder Content

Change in Voids of Coarse Aggregates for Mix withdifferent dosage of fibers in the SMA mixes has been discussed. The VCA_{MIX} vary from 33% to 35% for the various dosage of the fibers. The Voids in the Coarse Aggregates under Dry Ridded Condition is found to be 48%.As per specification requirement, Mineral Aggregatesvoids for Mix is less then Voids of Mineral Aggregates of dry ridded Condition .This shows presence of the better Stoneon stone contact in the mix”.

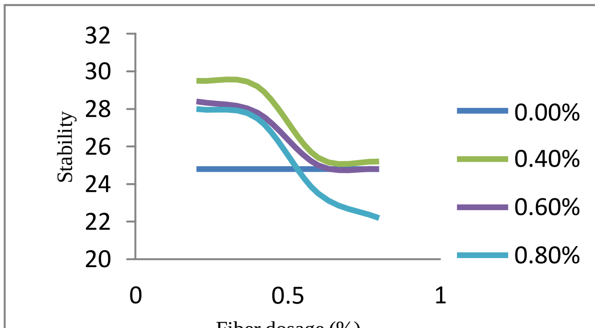

Fig 4: *Variation of stability with different fiber dosages and powder*

International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 34, Issue 01 and Publication Date: 28th June, 2022
An Indexed, Referred and Peer Reviewed Journal
ISSN (Online): 2347-601X
www.ijemhs.com

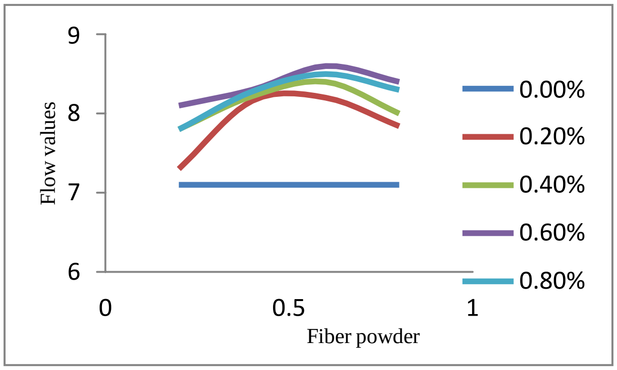

***Fig 5.* Variation of flow values through dissimilar fiber dosagesand precipitate**

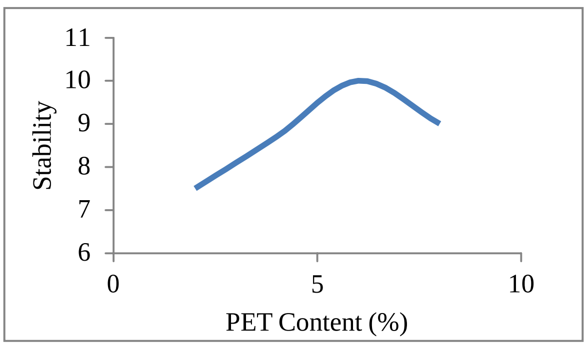

***Fig 6:* Difference of constancy by different fraction of PET**

D . Dynamic creep test

"The accumulated strain is in the range of 3% and the permanent deformation is in the range of 1-2 mm which the samples tested at 50ºc. This indicates high resistance to permanent deformation of modified mix and resistance to rutting potential".

Fig 7: *Dynamic Creep Test*

ANALYSIS OF EXPEREMENTAL RESULTS

"The OBC was about 6.5 percent binder. The property at OBC is given in Table 5.6. It can also be seen that VCA (mix) of all the SMA mixes are less than equal to VCA and VMA are most than 17 percent. Thus, SMA mixes designed are having good stone-on-stone contact.

A. Design of SMA

Design of SMA done with the available aggregates in Chennai region fulfilled the minimum design criteria of SMA, 80 percent of 9.5 mm nominal size aggregate, 15 percent of stone dust, 5 percent of hydrated lime and coconut at the rate 0.6 percent by weigh of mix were mixed together to get desired grading of SMA. It can be seen from Table 5.5 thatmastic asphalt", , Faculty of Engineering, Universityof Malay

B. Plastic Materials

1) Before adding aggregate to the mixture, it was heated to 200 C for a period of approximately 2 h. The weight of aggregate for each sample was 1100 gr.
2) The bitumen contents used in the mixture was varied between 5% and 7% (5%, 5.5%, 6%, 6.5% and 7%) by the weight of aggregate .The selected bitumen was heated to 150 C for about 1 h beforemixing with the aggregate.
3) The combination of aggregate, bitumen and filler was mixed at a temperature of 160 ± 5 C for around 5 min.
4) PET was introduced into the combination and blended with it for about 2 min. The percentage of the added PET varied between 2% and 10% (2%, 4%, 6%, 8%, 10%) by weight of bitumen.
5) The Marshall Compactor was used for the compaction stage of the process with 50 blows applied to the top and bottom side of the mixture at 145 C

6. CONCLUSION

The Tensile strength values were obtained to be in the range 85-93% which is more than 85% as 11specified for aSMA mixture.

The SMA mixes designed with optimum has good stone contact. The design criteria of SMA mixwere satisfied by 17% voids in mineral aggregate and 3-5% air voids.The Drain down values were in the range of 0.04% to 0.17% by weight of mix. The volumetric and Marshall properties of PET-mixture show the acceptable trends and could satisfy the standard requirements. Dynamic Creep Modulus of the SMA Mix with the optimum dosage of the coconut shows resistance to rutting potential

Based on the above performance, coconut could be used as stabilizing additive without affecting the design criteria of SMA mixture. The maximum level of stability of PET was found at 6% by weight of bitumen. It is calculated that useof waste polythene results in improved engineering properties of bituminous mix. Therefore this study explores the utilization of waste plastic and also provides an opportunity to construct an improved pavement material in surface course thus", making it more durable.

References

[1] AbdelazizMahrez, Mohammed RehanKarim and HerdaYatiBtKatman, (2005) "Fatigue and deformation properties of glass fiber reinforced Bituminusmixes",Journal of the Eastern Asia Society for Transportation Studies, Vol: 6, pp 997-1007.

[2] Esmaeil Ahmadinia, Majid Zargar (May 2011) "Using waste plastic bottles as additive for stone

[3] Pa.Suriya and Gopiprasath P published a paper titled on "Stabilization of soft soil using stonecolumn –The review" in the International Journal of industrial pollution and control, (2014) /33(s2)/ pp 1214-1217

[4] Pa.Suriya, Nemalipurikirankumar, Ponkarthik.J, Praveen.S published a paper titled on "Performance of Clay Soil With Different Materials In Stone Column" in Journal of Chemical and Pharmaceutical Research (ISSN : 0975 – 7384), 14(S1), 2016, 348-35.

[5] Ratnasamy Muniandy and Bujang, B.K. Huat,(2016) "Laboratory diameteral fatigue performance of Stone Matrix Asphalt with Cellulose Oil Palm Fiber", American Journal of Applied Sciences 3(9): 2005-2010.

[6] Punith, V, S., Sridhar, R., Sunil Bose, Kantha Kumar, K., and Veeraragavan, A., (2014),"Comparative studies on the behavior of Stone Matrix Asphalt and Asphalt Concrete Mixtures utilizing Reclaimed Polyethene", Highway Research Bulletin No: 71,pp, 61-71.

[7] Pa.Suriya and Gopiprasath P published a paper titled on "Stabilization of soft soil using stonecolumn –The review" in the International Journal of industrial pollution and control, (2014) /33(s2)/ pp 1214-1217.

[8] AbdelazizMahrez, Mohammed RehanKarim and HerdaYatiBtKatman, (2005) "Fatigue and deformation properties of glass fiber reinforced Bituminusmixes",Journal of the Eastern Asia Society for Transportation Studies, Vol: 6, pp 997-1007.