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STUDY ON THE MARSHALL PROPERTIES WITH SUNHEMP AND KENAF AS STABILIZER ADDITIVES IN STONE MASTIC ASPHALT

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Abstract: Stone Mastic Asphalt (SMA) is a gap graded mix of aggregate comprising of 80% of coarse aggregate by weight, 8 % to 12% amount of filler by weightand fibre content by weight based on the Draindown Value. Fibre helps in bonding and interlocking the ingredients of SMA. Also, fibre influences the properties of the mix significantly. The present study discusses the effective utilization of the two fibres namely Sunhemp and Kenaf. From the results it was obtained that the addition of 0.3% of fibre content improved the Marshall properties.

Keywords: Fibre,Sunhemp, Kenaf, Draindown, Stability.

1. INTRODUCTION

Stone mastic Asphalt (SMA) is the combination of the coarse aggregate, fine aggregate along with bitumen as a binder. SMA was successfully installed in many of the countries because of its better properties in Surface layer or Wearing Course. SMA is a composition of 70% to 80% of coarse aggregates, filler of 8% to 12%, bitumen as a binder of 6.0% to 7.0% and fibre content of 0.3% to 0.5%. Aggregate gradation, binder, filler are used for the determination of the marshall parameters. The addition of fibre helps in better interlocking of the ingredients and helps in increasing the marshall properties in terms of stability. Fibre also shows the affect on the binder properties. It also helps in the reduction the draindown value. Two types of fibres such as Sunhemp and Kenaf has been utilized for the study of the Marshall parameters in the SMA.

The study on the various fibres as the stabilizer additive in SMA was studied

Ganapathi M. et al. (2012) examined the SMA properties with the addition of recycled crumb rubber with Low Density Polyethylene flakes. It showed that 15% of Crumb Rubber and 30 % of LDPE by the weight of the bitumen (60/70 Penetration Grade)showed the better properties in SMA.

BaghaeeMoghaddam T. et al. (2012) has studied the effect of the addition of the Waste polyethylene Terephthalate in SMA within the range of 0% to 1.0% at an increment of 0.2%. From the results it was obtained that the addition of 0.4% Polyethylene Terephthalate increased the SMA Properties in terms of Stability.

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Thanh D V. et al. (2013) has studied the utilization the three different fibres like lignin, mineral and polyster in SMA. It was found that mineral fibre showed the better properties compared to lignin and polyester fibres.

Pankaj P. Shedame. et. al, (2014) has investigated about the use of the Low Density Polyethylene (LDPE) in bituminous road construction. It was found that the 0.76% of the plastic waste utilization by total weight of the aggregates has the significant improvement in the volumetric Properties of the bituminous mixes.

UdayaBhanu.V. et al. (2019) has examined the two types of Glass fibres like Glass-C and ARGF in SMA. It was obtained that Glass –C fibre showed the better properties when compared with ARGF.

In this experimental investigation the effective utilization of the two fibres namely Sunhemp and Kenaf were examined. The amount of fibre is 0.3% of weight of aggregate showed the better properties in stability and draindown.

2. MATERIAL PROPERTIES AND CHARACTERIZATION OF MATERIALS

2.1 Characterization of Materials

Fine and Coarse aggregate as well as stone dust as the filler, Sunhemp and Kenaf as the Stabilizer additives are used as the ingredients for the experimental investigation. The aggregate size is varying from 75 µ to 13.2 mm. The physical properties of the aggregates are mentioned in the below Table – I.

Table – I Properties of Aggregates

Test	Test Method	Result
Impact Value	IS: 2386 (Part-I)	15.7%
Crushing Value		16.31%
Abrasion Value		17.79%
Attrition Value		11.65%
Combined Flakiness and Elongation Value		26.7%
Specific Gravity	IS: 2386 (Part-III)	2.65
Water Absorption		0.1%

The bitumen grade is VG – 30, it was obtained from HPCL, Vishakhapatnam. The specific gravity obtained was 1.02. The properties of the Bitumen are mentioned in the below Table – II

Table – II Properties of Bitumen

Test	Test	Result
Penetration	IS: 1202 - 1972	63mm
Softening Point	IS: 1205 - 1978	49
Ductility	IS 1208 - 1978	90mm

The fibres such as Sunhemp and Kenaf are used in the investigations which were bought from the Go Green Products, Pvt. Ltd, Chennai. The Properties are mentioned below in the Table-III.

Table-III Properties of Fibres

Property	Sunhemp	Kenaf
Tensile Strength	421-800 MPA	876-948 MPA
Elongation of Break	1.62%	1.57% - 1.8%
Diameter	0.8 – 1.2 mm	0.8 – 1.2 mm
Density	1.57 gm/Cm^3	1.34 – 1.45 gm/Cm^3
Young's Modulus	21 – 72 GPA	42 – 48 GPA
Melting Point	135^{0}C	160^0 – 260^{0}C

2.2 Gradation of Aggregates and SMA Specimen Preparation.

For the gradation of aggregates SMA-13 was considered as per IRC-SP: 79-2008.

The mixes of Stone mastic Asphalt were casted as per the standard specifications of AASHTO MP8. The two fibres were used for the two different mixes. The percentage addition of fibre is based on the draindown test for both the fibres. The optimum bitumen content for the addition of fibre was obtained from the nominal mix. The specimens of nominal mix were prepared of 1200gm of

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aggregate, heated to a temperature of 175-190^{0}C and % binder of amount of aggregates (say 5.0%, 5.5%, 6.0% and 6.5%) heated to a temperature of 120^{0}C to 125^{0}C.

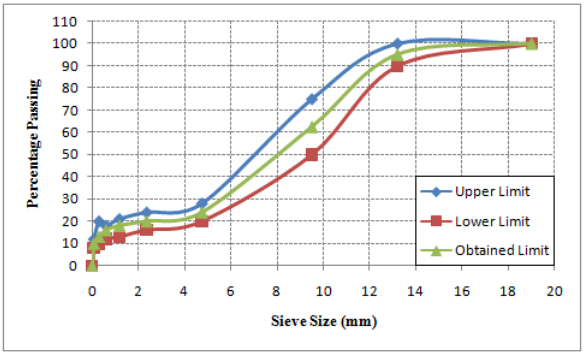

Figure 1: Gradation of Aggregates

The bitumen and aggregates are properly mixed at a temperature of 154^{0}C to 160^{0}C. the moulds are pre heated, the mix is placed in the mould and is compacted by rammer with 75 blows on each side. The procedure is repeated for the all percentages of bitumen and the Optimum Binder Content is obtained.

3. ANALYSIS OF RESULTS

3.1 Marshall Stability Test

This test helps to determine the stability and flow value for the specimens. The parameters to be considered in this experimental investigation are Stability, Flow, Percentage Air Voids (%Vv), Percentage Voids in Mineral Aggregates(%VMA), and Percentage Voids Filled with Bitumen(%VFB).

3.2 Draindown Test

The Draindown test was conducted as per ASTM D 6390 (2005) for the gradation mix obtained with 7% binder content. This experiment was conducted at a temperature of 160^{0}C. The percentage addition of fibre is 0.1%, 0.2%, 0.3%, 0.4% and 0.5%.

From the results of the Draindown test it was obtained that 0.3% Fibre addition for the both fibres gave the drain down value less than 0.3.so the Optimium Stabilizer Additive content for both the fibres is 0.3%. The Draindown values for the fibres at 0.3% are, for Sunhemp it is 0.21 and for Kenaf it is 0.23. The graph for Draindown is shown in the below Figure 2.

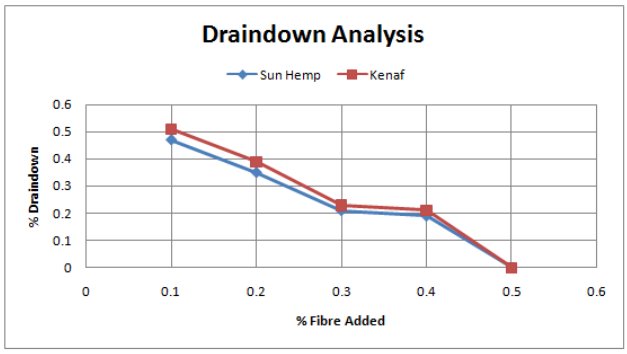

Figure 2: Draindown of fibres

3.2.1 Stability

The below figure 3 represents the variation in the stability values for the Unmodified mix compared with the fibres. The maximum stability obtained for all the mixes at 6% binder.

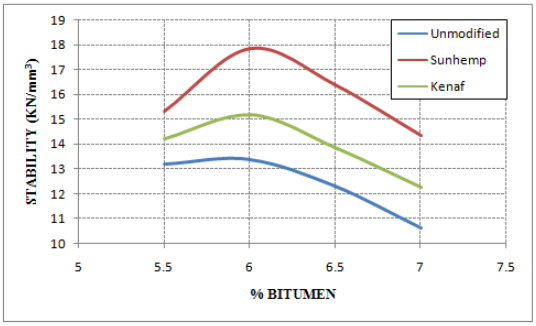

Figure 3: Comparision of Stability

The stability value for all the mixes increased upto 6% and then gradually decreased. The maximum stability obtained for Sunhemp and Kenaf are 17.85kN and 15.19kN. When compared with unmodified, Sumhempshowed

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25.04% increment, where asKenaf showed 11.92% increment.

3.2.2 Flow

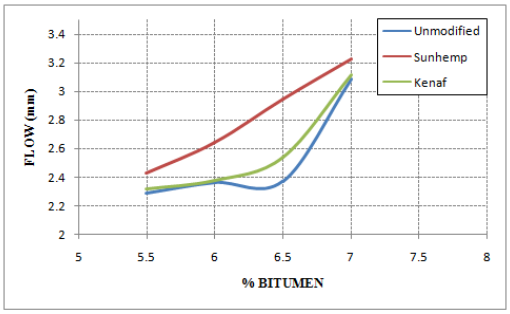

Figure 4: Comparision of Flow

Figure 4 representing the variation in the flow values for the mixes compared with fibres. From the graph it can be observed that as the binder content increases the flow value increases. The flow value for Sunhemp is ranging from 2.43mm to 3.23mm. The flow value for Kenafis ranging from 2.32mm to 3.12mm. The mix with Sunhemp showed the higher flow value compared to unmodified and Kenaf.

3.2.3 Airvoids

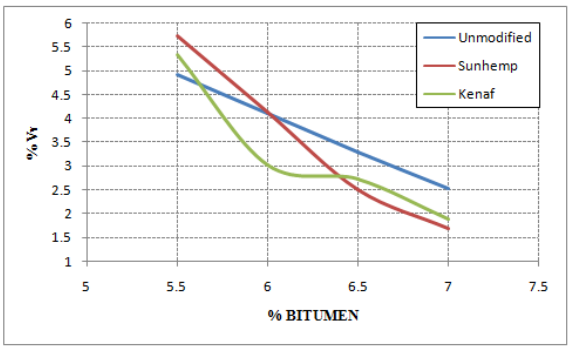

Figure 5: Comparision of Airvoids

Figure 5 representing the variation in the Airvoids compared fibres. The results showed that as there is increase in the binder content the % Airvoids reduced. The addition of fibres helped to decrease the more percentage of Airvoids compared the unmodified. For the Sunhemp the recuctiojh of Airvoids is from 5.74% to 1.68% and for Kenaf it is from 5.33% to 1.89%. From the above graph it was clearly noticed that the addition of Sunhemp decreased the maximum % of Airvoids.

3.2.4 Percentage Voids in Mineral Aggregates

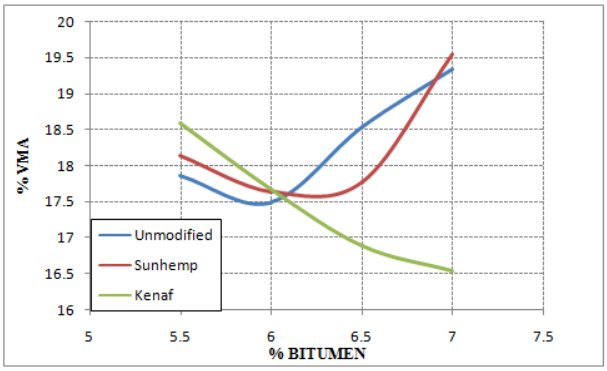

Figure 6: Comparision of VMA

Figure 6 representing the variation in the percentage Voids in the Mineral Aggregates compared with the fibres. In case of Sunhemp there is a decrease in the VMAupto 6.0% i.e., from 18.14% to 17.64% and then increase upto 7.0% i.e., upto 19.55%. In case of Kenaf there is a continuous decrement in the % VMA from 18.59 to 16.54.

3.2.5 Percentage Voids Filled with Bitumen

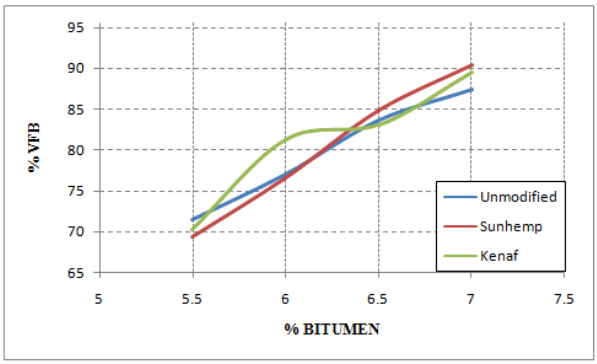

Figure 7: Comparision of VFB

Figure 7 representing the variation in the Percentage Voids Filled with Bitumen compared with fibres. From the results it as clearly observed that for all the cases there is an increase in the percentage

Voids Filled with Bitumen. The reason behind the increase in the VFB may be that the increased binder content along with the fibre fills the airvoids that are present in the mix. The increment range for the Sunhemp is from 69.35% to 90.36%. The range of increment for Kenaf is 70.25% to 89.55%.

4. CONCLUSION

From the experimental analysis, the Marshall parameters of the Stone Mastic Asphalt (SMA) like Stability, Flow, Air Voids, Percentage Voids in Mineral Aggregates and Percentage Voids Filled with Bitumen are analyzed by comparing the properties of the Unmodified Mix with the Fibre addition mixes of Sunhemp and Kenaf. From the obtained results the following conclusions were suggested.

- From the obtained Draindown results it can be concluded that 0.3% fibre addition for the Sunhemp and Kenaf as the Optimum Fibre Addition.
- The strength parameter Stability obtained for Sunhemp is 17.85kN and for Kenaf is 15.19kN.
- Stability for the mix with Sunhemp showed 25.04% increment and with Kenaf showed an increment of 11.92% when compared with the unmodified mix.
- The utilization of Sunhemp and Kenaffibres in SMA increased the % VFB compared with the Unmodified Mix.
- Sunhempfibre exhibited the better Marshall properties compared to the Kenaffibre.

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