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MODELING MARSHALL STABILITY OF COIR FIBER REINFORCED ASPHALT CONCRETE

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ABSTRACT:*Flexible pavements with bituminous surfacing are widely used in India. Exponential increase in traffic, overloading of commercial vehicles and significant variations in daily and seasonal temperatures have shown some limitations of conventional bitumen performance. Early developments of distress symptoms like cracking, rutting, raveling, undulations, shoving and potholing of bituminous surfacing have been reported for flexible pavements. Modified bitumen by using waste materials is presently safer and more environment friendly binder for enhancing properties of road. The aim of the project is to study the performance of waste materials. The normal bitumen is modified using different waste materials are glass fibers, coir fiber. In this study fibers are added to bitumen is 1%, 2%, 3%, 4% and 5%.Different combinations are used in this study like coir fibers, glass fibers. The result that modified bitumen using coir fibers shows better results in ductility. It will increases with increase in percentage and also other combinations leads to changes properties of bitumen by increasing the stability, ductility, and hence it also reduce aging effect on bitumen. The improvement of modified bitumen depends upon the type and percentage of waste fibers.*

Key words: **Waste Fibers, Asphalt Mixture, Optimum Binder Content, Bulk Density, Stability, Flow.**

1. INTRODUCTION

Fibers have been extensively used to increase rheological properties of engineering materials for a long times. They said well known that modified bitumen considerably increases rheological properties of bitumen used within bituminous pavements suffering from different kinds of distresses like low temperature cracking, rutting, fatigue, etc,. Cellulose fiber, which forms three dimensional reinforcements within the bitumen, is also alternative modifier for bitumen and highway materials. The prime role of the bitumen modifier is to increase resistance of asphalt to permanent deformation at high road temperatures without adversely affecting the properties of bitumen or bituminous materials.(Huseyin Akbulut 2011)The waste plastic partially replaced the conventional material to improve desired mechanical characteristics for particular road mix. They said present paper developed techniques to use plastic waste for construction purpose of roads and flexible pavements have reviewed. In conventional road making process bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made, which can be used as a top layer coat of flexible pavement. This waste plastic modified bitumen mix show better binding property, stability, density and more resistant to water.(AmitGawande et al., 2012),This research has accomplished a comparative rheological test on the unmodified and nanoclay modified bitumen. The results show that compared to unmodified bitumen, the nanoclay modification leads to changes in rheological parameter by increasing stiffness and decreasing the phase angle hence; it can also reduce aging effect on bitumen. Further, the comparison of the rutting parameter shows that the nanoclay modification could increase the rutting resistance of bitumen where the improvement is dependent upon the type and amount of nanoclay. They said tests performed on bitumen samples proved that the nanoclay modifications help increase the stiffness and aging resistances. They studied the effect of mineral fillers on properties of SMA mixtures. They chose eight mineral fillers on the basis of their performance, gradation etc. They evaluated the properties of SMA mixtures in terms of drain down of the mastic, rutting, low temperature cracking, workability, and moisture susceptibility. (Mogawer et.al., 1996) They used waste marble dust obtained from shaping process of marble blocks and lime stone as filler and optimum binder content was determined by Marshall Test and showed good result. (Mustafa Karasahin)They utilized municipal solid waste incinerator (MSWI) fly ash as a partial replacement of fine aggregate or mineral filler in stone matrix asphalt mixtures. They made a comparative study of the performance of the design mixes using Super pavement and Marshall Mix design procedures. They studied effect of using waste glass power as mineral filler on Marshall property of SMA by comparing with SMA where lime

stone, ordinary Portland cement was taken as filler with varying content (4-7%). (Jony Hassan etal., 2010)They studied on SMA using different type of filler, stabilizer and concluded that Drain down in SMA is effected by type of filler, type of stabilizer , amount of stabilizer (higher the amount of stabilizer lower the drain down).Optimum binder content of SMA mixes is greater than DGM. (Brown 1994) They studied Utilization of waste fibres in stone matrix asphalt mixtures. They used carpet fibre and polyester fibres and waste tires to improve the strength and stability of mixture compared to cellulose fibre. They found waste tire and carpet fibre are effective in preventing excessive drain down of SMA mixture also found that tensile strength ratio of mixes more than 100% , it means fibre don't weaken the mixture when expose to moisture. Addition of tire and carpet fibre increases toughness of SMA. They found no difference in permanent deformation in SMA mix containing waste fibres as compared to SMA mix containing cellulose or mineral fibre. (Bradely et al., 2004

2. Methodology

2.1 Materials

Materials used in this study include 30/40 penetration grade base bitumen. The polymer used for modification is mixing of glass and sisal fibers. The glass fiber has length of 3mm and sisal fiber length of 12mm and diameter of 0.86mm.

2.2 Sample Preparation

Samples were prepared using melt blending technique. The bitumen about 400gm was heated in oven till fluid condition and polymer was slowly added, while the speed of the mixer was maintained at 140 rpm and temperature was kept between 180°C and200°C. The concentration of coir fiber used, were 2%, 4%, 8%, 12% and 16% by weight of blend. Mixing was continued for 1 hr to produce homogenous mixtures. The modified bitumen was then sealed in containers covered with aluminum foil and stored for further testing. Empirical test such as penetration, softening point and viscosity were then conducted on the prepared samples.

2.3 Laboratory testing

Test on the prepared samples were conducted according to ASTM method to characterize the properties of PMBs. The different percentage of coir fiber concentration provides a wider range of results which helps in analyzing each type of the coir fiber blend at particular concentration. The rheological test includes penetration at 25ºC, softening point and Marshall Stability. The test results of base bitumen are presented in tables.

2.4 Penetration (ASTM D-5)

The standard 100g, 25°C and 5sec penetration test was performed both on base bitumen and PMB with the concentration of polymer varying between 2%, 4%.8%, 12%, 16% by weight of the bitumen. The results of the test are shown in Table 2.

2.5 Softening Point (ASTM D-36)

Ring and ball is the standard test to determine the consistency of the bitumen, which represent the temperature at which a change of phase from solid to liquid occurs. It is the temperature at which standard 3/8 inch steel ball weighing 3.55gm fall and touches the base plate which is 2.5mm away.

2.6 Marshall Stability Test

Stability is an important property of the bitumen mixture in the wearing course design. It shows the ability to resist shoving and rutting under traffic. Marshall Stability test of PMB was performed in a Marshall testing machine at a constant rate of 51mm/min. five specimens were immersed into a water bath at 60ºC and were tested after 1 hr and the average compressive load required to break the sample was determined and corrected by multiplying with a stability correction factor to get the initial stability to get the final stability.

Chart-1: Coir fiber

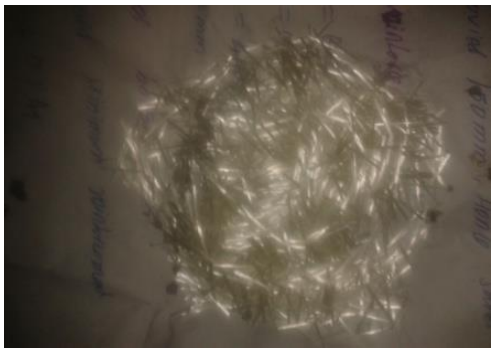

Chart-2: Glass fiber

3 RESULTS

The following table shows that normal value of bitumen without adding any fibers adding of coir and glass fiber.

Table-1. Normal Bitumen test results:

S.No	Penetration (mm)	Softening point(°c)	Flash point(°c)	Fire point(°c)	Ductility (mm)	Stability (kN)
1	33	45	75	102	42	16

Table -2: Modified Bitumen Using Coir Fibers

S.No	% of Materials	Penetration (mm)	Softening point(°c)	Flash point(°c)	Fire point(°c)	Ductility (mm)	Stability (kN)
1	0.5	34	41	70	110	37	16.8
2	1	33	50	85	140	44	17.16
3	1.5	35	55	90	145	45	17.23
4	2	28	60	100	160	32	12.98
5	2.5	34	62	120	190	40	6.42

Table- 3:Modified Bitumen Using Glass Fibers

S.No	% of Materials	Penetration (mm)	Softening point(°c)	Flash point(°c)	Fire point(°c)	Ductility (mm)	Stability (kN)
1	1	32	47	120	180	53	16.2
2	2	34	51	125	190	40	17.4
3	3	33	53	150	200	28.5	17.8
4	4	34	58	140	195	20	18.2
5	5	34	60	150	200	22	17

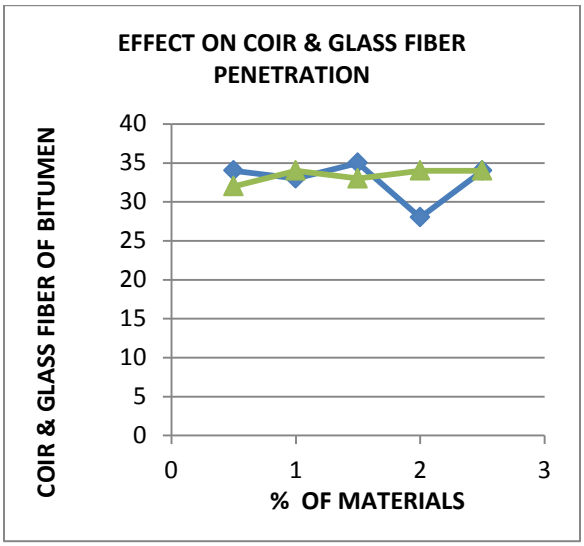

Chart -3: Penetration Test

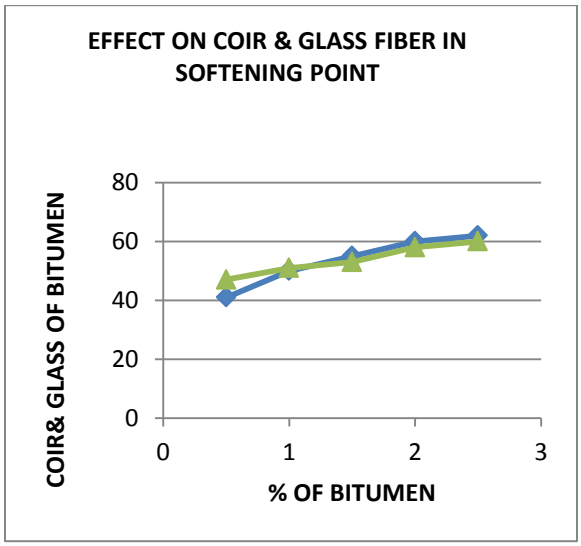

Chart- 4 : Softening Point Test

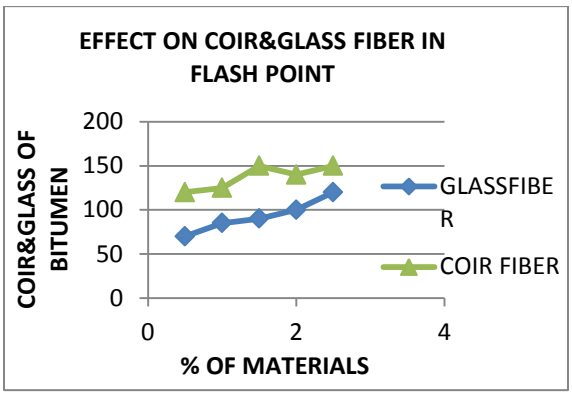

Chart -5: Flash Point Test

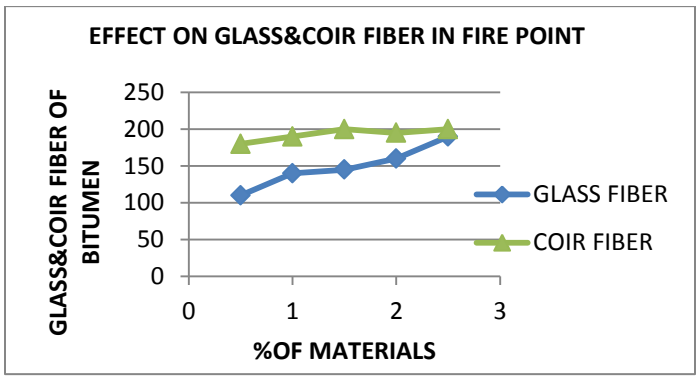

Chart -6: Fire Point Test

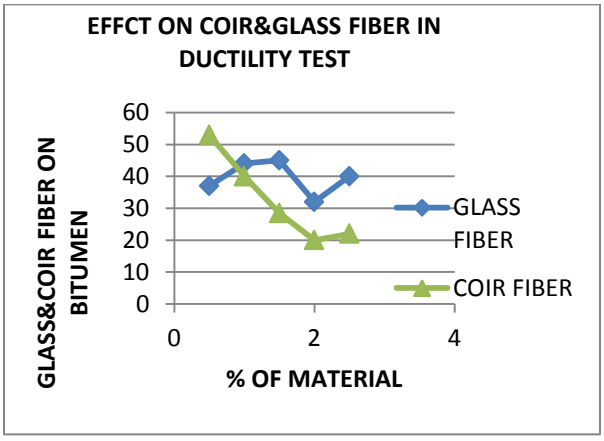

Chart -7: Ductility Test

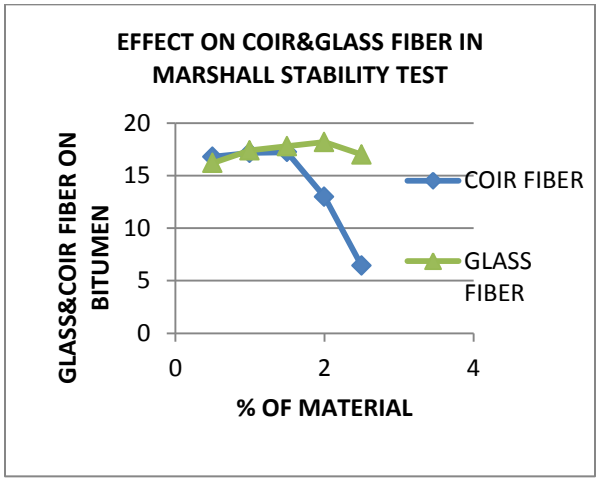

Chart- 8: Marshall Stability Test

4. CONCLUSION

In this study fibers of different sizes were used in polymer modified bitumen to compare the strength of variations in bitumen. The following observations were derived with various results obtained from various tests:

- Modified bitumen shows increase in stability and viscosity when compared to the normal bitumen.
- Modified bitumen ductility value is also similar to the normal bitumen.
- Softening value shows slight decrease in the modified bitumen when compared to the normal bitumen.
- Penetration result generally decreases when polymers are added.
- This can be used to avoid rutting and pot hole failure that occur frequently in roads constructed across water logged areas.

The study indicated physical hardness of the binder after adding coir fibers of different size reduces binder penetration and increases softening points. This indicates that aging depends on time and binder source.

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