USE OF ALSI FLAX FIBER IN WEARING COARSE WITH USING RECYCLE AGGREGATE

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Abstract - *The technology of the asphalt material and their mixtures for paving of roads was first discovered and used to large extent in the European countries and North America. The WC (wearing coarse) mixture is a gap-graded mix that is often characterized by the existence of high coarse aggregate (may be of stone), fiber additives as stabilizers and high bitumen content.*

In the present research work, an attempt has been made for studying the engineering properties to enhance WC(wearing course) prepared with and without fiber (Alsi Flax) and using recycling aggregate (dismantle building) partial replacement of stone aggregate for the coarse aggregate grades. The fibers used for this project is a non-conventional natural fiber, namely flax fiber. This research project was done to check the suitability of Alsi flax fiber as stabilizing agent in the wearing course mixture by conducting tests in laboratory in which stability and flow parameters were analyzed, also the mechanical properties of the mixture was analyzed. And recycling aggregate has been used in partial replacement of the stone aggregate for all the coarse aggregate grades for preparing wearing course mixes and their properties were analyzed as well. Here for the stone matrix asphalt mix the aggregate gradation is taken based on IRC-SP-79 specification and the binder content is varied as 5%, 7%, 8.5%, 10% by weight of aggregates and fiber used is at optimum fiber content i.e. at 0.3% by weight of aggregate. Here stone dust has been used as filler and binder used is 60/70 penetration grade bitumen.

***Key Words*: Recycle aggregate, Alsi flax fiber, Bitumen content** …

1. INTRODUCTION

The adding aggregate with bitumen bounding are conventionally used throughout the world in the construction and maintenance of flexible pavements. The close, well uniform, or dense graded aggregate bound with normal bitumen usually perform well in heavily trafficked roads when designed and finish properly and hence are generally used in paving industry. However it's not always possibility to arrange dense aggregate available at the site. In such a situation bitumen us mix known as wearing course (WC) which is mostly consist of gap-graded aggregate can be experiment.

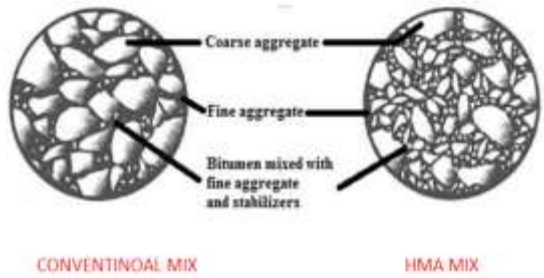

Fig -1: Comparison of the skeleton structure of WC and HMA

1.1 STABILIZERS USED

1FLAX FIBER

The natural fiber used for experimentation process was flax fiber. Flax fiber is obtained from the stem of the flax plant with the botanical name - Linum usitatissimum. This plant in local Hindi language is called as "Alsi ". From the fibre obtained from this plant, textile industry is largely dependent for making Linen, which is used for making clothes and different textile materials.

During the process of extraction of flax Fiber, the seeds are usually obtained and they are used to produce the linseed oil. This is an edible oil and has been a keen interest of research over the years to find its suitability as a natural substitute for petroleum.

The flax fiber available was 300mm long having a diameter of .1mm and less when unsegregated. They are hence cut into smaller pieces for experimenting to a size of around 5-7 mm and is used after being cleansed and is put into the sample at Optimum Fiber Content of 0.3% i.e. 3.6 grams

Fig 2: Alsi plant Flax fiber

1. 2 EXTRAXTION OF FLAX FIBER FROM PLANT

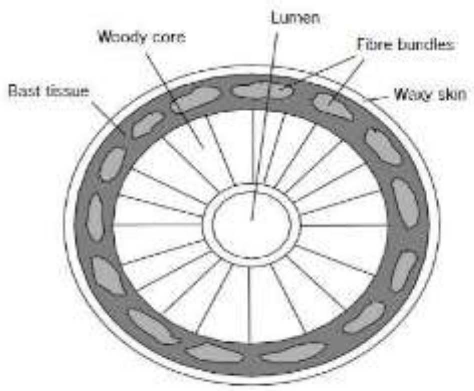

Fig 3: Cross sectional view of the stem

The process executed for extraction of the fiber is

- Ripping- To extract the seed and for removal of the leaves and upper epithelium of the plant.
- Retting- Putting the ripped stems in water to soak the out in a concentrated solution.
- Scotching- Further refining and separation of strands.
- Hackling- preparing the bundles after subsequent refining.

1.3 RECYCLE AGGREGATE

The recycling of aggregate pavement rehabilitation alternatives are mainly overlaying, recycling and reconstruction. In the recycling process the material from deteriorated pavement, known as reclaimed asphalt pavement (RAP), is partially or fully reused in fresh construction.

Some of the advantages associated with pavement recycling are as following:

i. less user delay
ii. conservation of energy
iii. preservation of environment
iv. reduced cost of construction
v. conservation of aggregate and binder
vi. preservation of existing pavement
vii. Geometrics etc.

It is also reported that recycled mix has higher resistance to shearing and scuffing, which in turn increase the rutting resistance. Chances of reflective cracking are found to be less with recycled mix.

2. Material & Methodology

2.1|MATERIALS USED

1. Recycle aggregate (dismantle building or demolition waste)
2. Mineral filler (Stone dust)
3. Binder (Bitumen of penetration grade 60/70)
4. Stabilizers (Natural stabilizer –Flax waste).

2.2 RECYCLE AGGREGATE

The mineral aggregates constitute of coarse and fine aggregates. The coarse aggregate obtained from recycled aggregate retained on a 2.36 mm sieve. It should be clean, cubic shaped and rough texture to resist rutting and movements and hardness which can resist fracturing under heavy traffic loads.

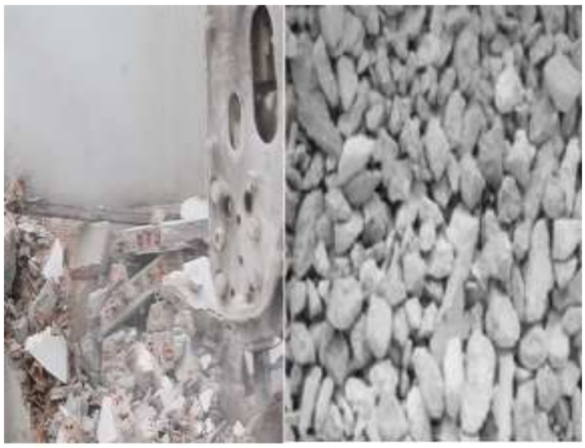

Fig 4: Recycle aggregate

The fine aggregate shall consist 100% of fine crushed sand passing the 2.36 mm sieve and retained on .075mm sieve. Preferably it should be clean, hard, durable, cubical in shape and free from soft pieces.

The aggregates test are conducted the testing from Impact value, crushing value and Los Angeles abrasion value the stone aggregates.

Test description	Coarse aggregates	Fine aggregates	Standard value
Flakiness index (%)	17	-	< 20
Elongation index (%)	12	-	<15
Specific gravity	2.76	2.64	2.6-2.9
Los Angeles abrasion value(%)	25.4	-	< 30
Impact value (%)	19.4	-	< 18
Aggregate Crushing value (%)	18	-	<30
Angularity number	10	-	0-11
Water absorption	0.9	-	1.3

Table 1: Physical property of stone aggregates.

The filler used in our experiment is stone dust which has passed through 0.075 mm sieves and these are used as the filler material with a specific gravity of 2.7 g/cm^3

- Mineral fillers have significant impact over the properties of wearing coarse mixes.
- Mineral fillers have significant impact over the properties of SMA mixes.
- Mineral fillers tend to increase the stiffness of the asphalt and mortar matrix.
- Mineral fillers also affect the workability, aging characteristics and moisture resistance of SMA mixtures.
- Mineral fillers help to reduce the drain-down in the mix during construction which improves the durability of the mix by properly maintaining the amount of asphalt used in the mix.
- It also helps in maintaining adequate amount of void in the mix

2.3 BINDER

Bitumen along with different additives fibers acts as a stabilizer for the WC mix. The bitumen for fiber-stabilized WC shall be Viscous grade VG-30 complying with Indian Standard Specification for paving bitumen IS: 73 Bitumen acts as a binding agent to the aggregates, fines and stabilizers in WC mixtures. WC mixes are rich in mortar binder which provides durability to the mix.

Bitumen acts as a binder for the aggregates, fines and stabilizers inside the WC mixes that are rich in mortar binder that which provides desired durability to the mix. The various characteristics of bitumen that affects the bituminous mix behavior are susceptibility to temperature, visco-elasticity and aging.

Test description	Results	Standard values
Penetration at25ºC (1/10 mm)	65	50 to 89
Softening point ºC	65.2	>48 ºC
Ductility, cm	90	>50
Specific gravity	1.025	-

Table2: Properties of binder

2.4SELECTION OF STABILIZER

HMA is a used to fill the gap – graded mix which is present in the form of moister in the mix. So stabilizing additives are used in the mix in order to prevent mortar drain-down and to provide a better binding between the constituents recycle waste. Initially HMA was developed using artificially produced asbestos fibers. For all that it was perfect from technical point of view its use was gradually restricted for health reasons. Fibers commonly used now-a-days are materials like polypropylene, minerals, polyesters and cellulose. The important stabilizing additives used in the HMA mixes can be classified into three different groups;

- Fiber (cellulose Fiber, Different Chemical Fibers and Mineral Fiber)
- Polymer
- Powder and flour like materials

As per MoRTH specification usually 0.3%-0.5% fiber is used in HMA mixtures. In this research study, we used 0.3% fiber by weight of aggregate. The flax fibers (Alsi) were cleaned and cut in to small pieces of 15-20 mm in length to ensure proper mixing with the aggregates and binder during the process of mixing.

PROPERTY	VALUE
Density(gm/ cm^3	1.5
Elongation (%)	2.0-2.5
Tensile Strength(Mpa)	500-900
Young Modulus(Mpa)	9.4-2.0
Pectin(%)	10
Moisture Content (%)	10-22.3
Ph	5.7-6.2

Table3: Properties of flax fiber.

3 MIX DESIGN

The main objective of the bituminous mix is to get the mix to have;Acceptable bitumen to ensure the durability of the pavement,

- Acceptable strength that will be used to resist the shear deformation under the traffic at higher temperature.
- Acceptable air void in the compacted bitumen so as to allow further additional compaction by the imposed load caused due to heavy traffic.
- Acceptable workability of the mix to permit easy placement and transportation without segregation.
- Acceptable flexibility is needed to avoid premature cracking of the pavement caused due to repeated bending by traffic; and
- Acceptable flexibility at lower temperatures to promote better frost and thaw resistance and avoid shrinkage cracks.

3.1 PREPARATION OF MIXES

Sampling of coarse and fine aggregates is carried out for 13mm Wearing coarse mixture composition as specified by IRC:SP-79.

Three samples each of 5%,7%,8.5% and10% bitumen were prepared respectively for bituminous course and Marshall test was carried out to calculate their Stability, flow, VA and VMA respectively.

The various samples prepared were-,

1. Samples with recycle aggregate as coarse and fine aggregate without fiber.

2. Samples with recycle aggregate and bitumen without fiber.

3. Samples with recycle waste as coarse and fine aggregate with fiber (Flax Alsi).

3.2 FINISHING THE MARSHALL SPECIEMEN

After casting of the samples is done, we remove the sample from its mould with the sample extractor. After it is removed from the mould, its weight, radii, height are measured and then is coated with wax. After the coat of wax is provided the weight of the sample in air and water is taken for computing the volume of sample. Before conducting the Marshall test, each of the samples were kept in hot water bath for 30 min. at 60 degree temperature. Filler used was stone-dust.

Hammer Marshall Mould Marshall testing machine

Fig 5: Preparation of material for testing

Fig6: Mixing of wearing coarse Sample before and after wax coating

3.3 VARIOUS TESTS PERFORMED

3.3.1 MARSHALL TEST

After preparation of the sample and its initial treatments we remove the samples from the hot-water-bath and take them for testing. It is then placed in the Marshall stability testing machine and loaded at a constant rate of deformation of 5 mm per minute until failure.

Fig 7: Marshall test being conducted with the Marshall apparatus.

3.3.2 DRAIN DOWN TEST:

Drain-down results shows that upon addition of slag as coarse aggregate drain-down also reduces phenomenally and is absent sometimes at a bitumen content below 7%.

Fig 8:No drain down in case of sample with fiber

4. RESULT AND DISCUSSION

4.1 GENERAL DISCUSSION

So for this analysis section we are going to compare all the results obtained from different tests conducted on the sample. Results will be compared in between,

1. Recycle as both coarse and fine aggregates for the cases of without fiber, with fiber.
2. Recycle aggregate in partial replacement for the coarse aggregates with stone as fine aggregate for the cases of with and without Flax fiber.

So for the analysis of results, we need to deal with some basic abbreviations.
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4.1.2 MARSHALL STABILITY

Stability of a mix is obtained after deciding the load taken by the sample and after that multiplying by a suitable factor called as the correlation ration which is obtained by comparing the thickness/ height of the sample or the volume of the sample. On increasing bitumen content the stability value, increases upto some point theoretically and then. Because the fibers in the mix act as stabilizer that not only fills the voids up in the sample, but also reduces the drain down quite significantly, and hence holding up the binder in the mix for good results. This method of addition of fibers also provides homogeneity to the mix.

4.2 COMPARISON OF RESULTS OF RECYCLE AGGREGATE AS BOTH FINE AND COARSE AGGREGATE, WITH AND WITHOUT FLAX FIBER AND WITH RECYCLE AGGREGATE.

COMPARISON OF RESULTS

	BITUMEN CONTENT	RECYCLE AGGREGATE NO FIBER	RECYCLE AGGREGATE & FIBER
STABILITY	5	6	6.2
	7	7.59	8.46
	8.5	8.1	8.19
	10	6.01	6.98

Table 3 Avg. Stability value comparison

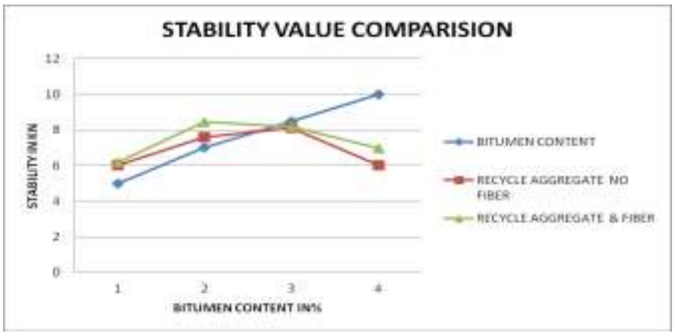

Fig 9: Avg. stability value comparison for stone aggregate

Table 4 Avg. Flow value comparison

	BITUMEN CONTET	RECYCLE AGGREGATE NO FIBER	RECYCLE AGGREGATE & FIBER
FLOW	5	2.89	2.56
	7	4.4	5.06
	8.5	4.9	5.72
	10	5.4	5.7

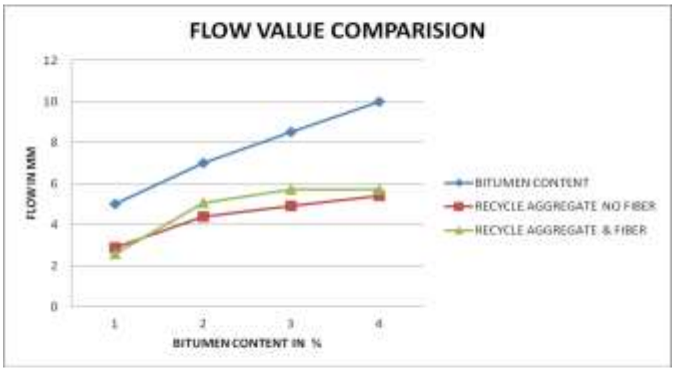

Fig 10: Avg. Flow value comparison for recycle aggregate

Table 5: Comparison of data avg. VA

	BITUMEN CONTENT	RECYCLE AGGREGATE NO FIBER	RECYCLE AGGREGATE & FIBER
VA COMPARITION	5	8.4	11.99
	7	6.46	9.64
	8.5	6.36	8.8
	10	5.21	6.7

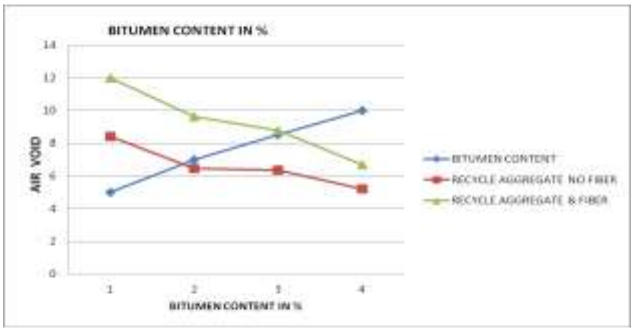

Fig 11: Comparison of data avg. VA

	BITUMEN CONTENT	RECYCLE AGGREGATE NO FIBER	RECYCLE AGGREGATE & FIBER
VMA COMPERITION	5	19.4	20.33
	7	16.21	18.89
	8.5	20	21.82
	10	14.1	22.96

Table 6: Comparison of data avg. VMA

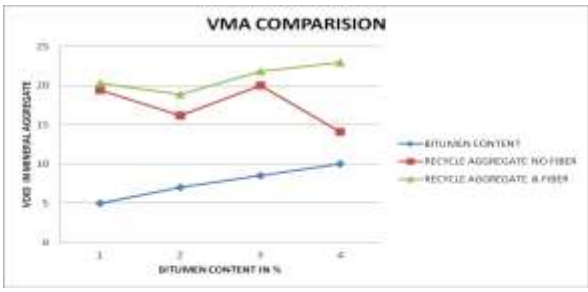

Fig 12: Comparison of data avg. VMA

5 CONCLUSION

The WC samples were prepared using varying bitumen content of 5%, 7%, 8.5% and 10%. This was done to find out the effect of increasing bitumen content on the stability value. The plot obtained also helps us to find the Optimum binder content for this mix. The plot shows that the stability value increases initially with increase in bitumen content but then decreases gradually. The same principle applies to mix with fibers, but this mix shows higher stability value at the same binder content than the mix without fibers.From experiments it was obtained that At optimum binder content of 5% for the stone aggregate being used in coarse as well as fine grades there is an **increase of 18.02% stability values** when flax fiber is used as the stabilizing agent.

At an optimum binder content of 7% for recycle aggregate being used in partial replacement for the coarse grades and stone being used as fine aggregates there is an **increase of 17.06% stability values** upon addition of stabilizing agent i.e. flax fiber.

5.1 CONCLUDING REMARKS

Maximum stability obtained in this case after addition of fiber is 9.82 kN. When compared to other fibers obtained and prepared naturally it is has a higher value. So because of this reason flax fiber(Alsi) can be used for general heavy traffic load taking requirements and it would also be very much suitable for severe traffic conditions also.

From the experiments conducted it is evident the stability and flow values have improved significantly to a higher value which makes this fiber liable to be used for paving roads.

It is also found that the drain down property of the sample improve as after addition of the flax fiber we don't find any drain-down.

When recycle aggregate is used as coarse aggregate.

There is an increase of 1.3% stability values when no fibers are added to the mix as compared with the samples that use only stone as aggregates.

There is an increase of 4.75% of stability after addition of flax fiber as compared to the samples that use only stone as aggregates.

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