A Natural Fibers Laboratory Study for Bituminous Mixtures

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***Abstract* - A bituminous mixture is usually a mixture of coarse, fine, filler, and binder. A Hot Mix Asphalt is a bituminous mixture that mixes, places and compacts all the components at high temperatures. HMA may be Dense Graded Mixes (DGM) called Bituminous Concrete (BC) or Stone Matrix Asphalt (SMA) graded gap. SMA requires stabilizing additives made of cellulose fibers, mineral fibers or polymers in order to prevent the mix from draining.**

In this study, an attempt was made to investigate the effects of using a naturally and locally available fiber called SISAL fiber as a stabilizer in SMA and an additive in BC. For the preparation of the mixed aggregate gradation according to the MORTH specification, the binder content was varied regularly from 4% to 7% and the fiber content varied from 0% to a maximum of 0.6% of the total mixture. In the preliminary study, fly ash was found to have satisfactory Marshall properties and was therefore used in subsequent works for mixing. The Marshall Procedure Optimum Fiber Content (OFC) was found to be 0.3 percent for both BC and SMA mixes. Similarly, the Optimum Binder Content (OBC) was found to be 5.1% and 5.3% respectively for BC and SMA. The BC and SMA mixes prepared at OBC and OFC are then subjected to various performance tests such as Drain Down Test, Static Indirect Tensile Strength Test and Static Creep Test to evaluate the effects of the addition of fibers on mixing performance. It is concluded that the addition of sisal fiber improves mixing properties such as stability in MarshallStability, drainage features and indirect traction strength for both BC and SMA mixes. Ii it is observed that SMA is better than BC with regard to indirect tensile strength and creep.

Keywords— Bitumen Concrete(BC),Optimum Fiber content(OFC),Optimum Binder Content (OBC),Stone Matrix Asphalt (SMA), Dense Graded Medium (DGM)

I. INTRODUCTION

Highway construction involves enormous financing costs. An exact engineering design can save substantial funding and the reliable execution of the in-service road can be achieved. Two important things are analyzed in the adaptable pavement engineering plan and the blend plan. The display consideration is related to the design of the mixture.

A large bituminous blend plan is expected to lead to a blend that is (I) solid (ii) strong (iii) resistant to weariness and lasting distortion (iv) environmentally friendly (v) prudent and so on. A blend creator tries to fulfill these requirements through a number of tests on the blend with different proportions and finishes with the best.The present research work tries to distinguish a few of the issues included in this craftsmanship of bituminous blend design and the heading of current research. In the mid-1900s, the bituminous clearing strategy was to begin with in rural streets–in order to deal with the rapid expulsion of fine particles from the Water Bound Macadam, caused by the rapid development of cars. Heavy oils were used as a tidy palliative at the beginning. A pat test called eye estimation handle was used to estimate the imperative amount of the overwhelming oil in the mixture. In this preparation, the mixture was pressed like a pancake and pressed against a brown paper. The suitability of the amount was decreed depending on the degree of color it was produced on the paper. In this examination, a comparative consideration was made between Bituminous Concrete (BC) and Stone Framework Black-top (SMA) mixtures with changing cover substance (4%-7%) and fiber content (0.3%-0.6%). Bitumen is used as a binder in the display study 50/60 infiltration review and sisal fiber is used as a stabilizing additive.

II. LITERATURE REVIEW

MUNIANDY and HUAT(2006) used cellulose oil palm fiber(COPF) and found fiber- modified binder showed rheological properties when cellulose filaments were pre-mixed in PG64- 22 with fiber extents of 0.2%, 0.4%, 0.8% and 1.0% by weight of total. It has been shown that the PG64- 22 folio can be adjusted and increased to PG70- 22 .The Cellulose Oil Palm Fiber (COPF) has been found to move the weakness of the SMA deign blend forward. The fatigue life at a fiber substance of about 0.6 percent expanded to the extreme, while the flexible push and steadiness also appeared to be a comparable slant in execution. The starting strains of the mixture were mostly reduced by 0.6 percent fiber Moreover, the flexible push and stiffness appeared to be a comparable slant in execution. The starting strains of the mixture were mostly reduced by 0.6 percent fiber.

KUMAR et.al.(2007) Considered on 2 fiber types. Try to use a SMA fiber by taking jute fiber covered with moo thickness folio and compare the result with an imported cellulose fiber(a cellulose fiber imported from Germany) using 60/70 bitumen review. and the optimum fiber rate as 0.3 percent of the blend was found. Jute fiber appears to be proportionate to imported patented strands as demonstrated by the Marshall Soundness Test, long-term distortion test and fatigue life test. The maturity list of the jute fiber mixture appeared to be much better than the patented fiber.

YONJIE XUE et.al. (2008) the fly-fiery civil squander incinerator (MSWI) used remains a partial substitution of the fine total or mineral filler in the black-top blends of the stone network. They carried out a comparative reflection on the execution of the plan mixes using the Super pave and Marshall Mix procedures.

C.SBINDU ,BENNA ,K.S.et.al. (2010) used destroyed squander plastic as a stabilizer specialist in the black-top blend of stone matrix and compare its property with SMA without a stabilizer. Marshall Test, compressive quality test, flexible quality test, tri pivotal test, varying bitumen percentage (6-8 percent) and distinctive plastic percentage (6-12 percent) per wt were performed. Mix. Of mix.

JONY HASSAN et.al.(2010**)** Considered impact on the Marshall property of SMA by using squander glass control as a mineral filler compared to SMA where lime stone, standard Portland cement was taken as a filler with a shifting substance (4-7 percent). Ideal glass control substance 7 percent was discovered. By using glass control as a filler in SMA, its steadiness inclined to 13%, stream estimates decrease to 39%, thickness moreover diminishes as compare to SMA contains lime stone and cement filler.

Dr. MOHAMED ILYAS ANJUM et.al. (2014) flexible paving with bituminous surface is used. Symptoms of distress, such as cracking, rutting, etc., are increasingly caused earlier by high traffic intensity, vehicle loading and significant variations in the pavement 's daily and seasonal temperature. This paper reports an investigation of bituminous concrete mixes of grade 1 produced in midpoint gradation using Fly Ash as a modifier. The conventional Marshall Stability Test was performed on the ASTM D 1559 specimens

LOKESH GUPTA et.al (2016) A good bituminous mix design is expected to produce a mix which is supposed to be sufficiently robust, long-lasting and resistive. Binder is a top in the bituminous mix. Marshall's Bituminous mix properties vary from binder to binder. In this work, the Marshall properties of dense bituminous macadam prepared using VG-30 and CRMB-55 as binder materials have been evaluated. DBM mixture is prepared using 2 percent lime as filler and VG-30, CRMB-55 as binders.

DIPANKAR SARKAR, MANISH PAL et.al. (2016) The effect of brick-stone mixing on various mechanical properties of bituminous concrete, such as the stability of Marshall, flow, Marshall Quotient (flow rate stability), indirect tensile strength, stripping, rutting and fatigue life of bituminous concrete overlays, was evaluated. Overburnt brick aggregates (OBBA) and stone aggregates (SA) were mixed in different ratios in this study.

III. TYPES OF BITUMINIOUS DESIGNS

A. DENSE BITUMEN MACADAM (DBM)

A binder course for roads with more heavy commercial vehicles and a close premix material with 5-10 percent void content.

B. BITUMINIOUS CONCRETE (BC)

Bituminous concrete consists of a mixture of totals graded persistently from the most extreme estimate, usually less than 25 mm, by a fine filler of less than 0.075 mm. Adequate bitumen is included in the mixture so that the compacted mixture is viable and impervious and has valuable dissipative and flexible properties. The bituminous blend plan points to the extent of bitumen, filler, fine totals and ground totals to create a workable, solid, robust and conservative mixture.

C. ADEQUATE BITUMEN DESIGN

- Adequate quality to withstand shear distortion under higher temperature activity.
- Discuss adequately the voids in the compacted bitumen to allow extra compaction by activity.
- Adequate functionality for easy arrangement without segregation.
- Adequate resistance to maintain a strategic distance from untimely splitting due to rehashed twisting by traffic.
- Adequate resistance at moo temperature to anticipate shrinkage cracks

D. REQUIRMENT FOR BITUMINIOUS MIXES

- Stability
- Durability
- Flexibility
- Skid Resistance
- Workability

E. CONSITUENTS OF THE MIX

- Coarse Totals
- Fine Totals
- Filler
- Binder

IV. RESULT OF MATERIAL USED

A. Physical Properties of Sisal Fiber

Density (gm/cm) – 1.6
Elongation (%) - 1.9-2.4
Tensile Strength (MPa) – 513-630
Young Modulus (MPa) – 9.2-9.4

B. Chemical Properties of Sisal Fiber

Cellulose(%) – 68-76
Hemi-Cellulose(%) – 12-14
Lignin(%) – 10-13
Pectin(%) – 9
Moisture Content(%) – 10-24
pH – 5.8-6.3

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C. Gradation of Aggregate For Bitumen Concrete (BC)

Sieve Size (mm)	Percentage Passing(%)
26.5	100
19	96
9.5	72
4.75	55
2.36	40
0.30	15
0.075	6

D. Gradation of Aggregate For Stone Matrix Asphalt (SMA)

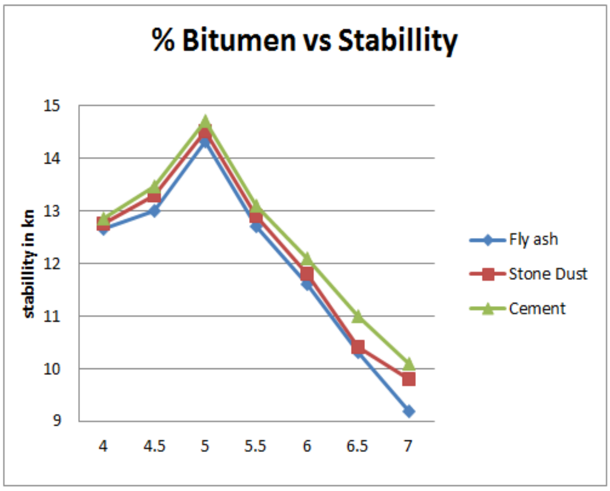
Seive Size (mm)	Percentage Passing(%)
16	100
13.2	95
9.5	64
4.75	36
2.36	28
1.18	22
0.6	19
0.3	15
0.15	11
0.075	9

E. Physical Properties of Coarse Aggregate

Property	Test method	Test result
Aggregate impact value (%)	IS:2386 (P IV)	14.5
Aggregate crushing value (%)	IS:2386 (P IV)	13.06
Los angles abrasion value (%)	IS:2386 (P IV)	19
Flakiness index (%)	IS:2386 (P I)	18.87
Elongation index (%)	IS:2386 (P I)	21.3
Water absorption (%)	IS:2386 (P III)	0.2

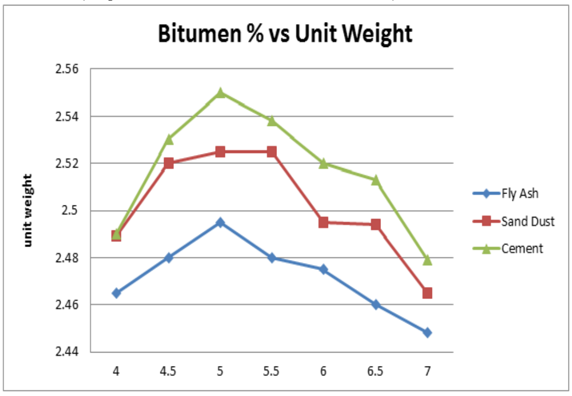
V. RESULTS OF MARSHALL STABILITY, UNIT WEIGHT AND DEFORMATION

I. Marshall Stability With Their Different Corresponding Binder Content (Fly Ash, Stone Dust, Cement) With Bitumen



BC with filler type	Max. stability (KN)	Corresponding Binder Content (%)
Cement	14.70	5
Stone Dust	14.50	5
Fly Ash	14.32	5

II. Difference of Unit Weight of Bitumen With Different Binder (Fly Ash, Stone Dust, Cement) Content



BC with filler type	Max. Unit weight	Corresponding Binder Content
Fly Ash	2.49	5
Stone Dust	2.52	5
Cement	2.55	5

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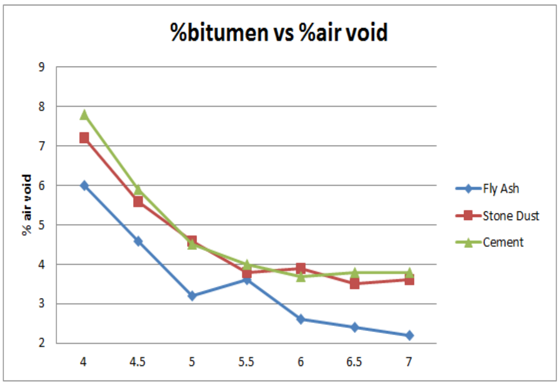
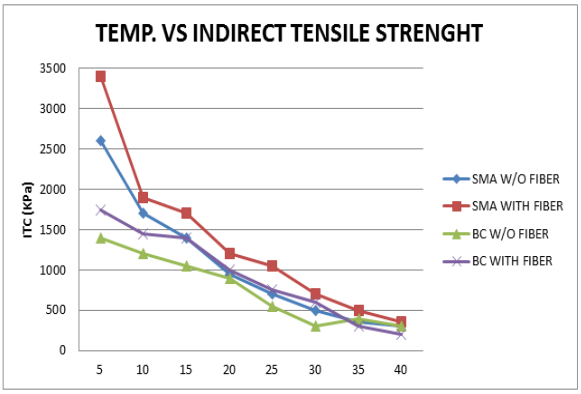
III. *Difference of Air Voids In Bitumen With Different Binder (Fly Ash, Stone Dust, Cement) Content*



BC with filler type	Air Void (%)	Corresponding Binder Content
Fly Ash	3.2	5
Stone Dust	4.6	5
Cement	4.5	5

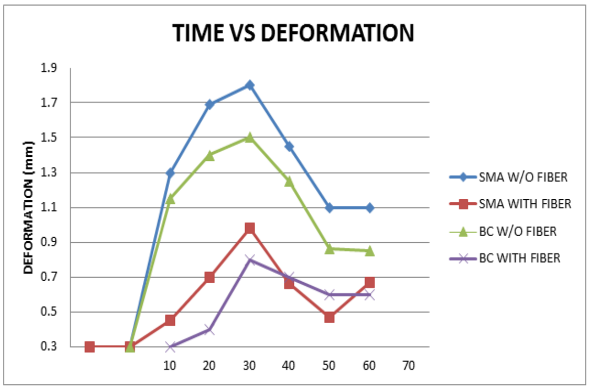
IV. *EFFECT OF TEMPRATURE ON INDIRECT TENSILE STRENGTH*

Here the graph is representing the effect of the temperature on indirect tensile strength with bitumen concrete (BC) with and witout fiber and also stone matrix asphalt(SMA) with and without fiber



V. *STATIC CREEP TEST*

In this graph the deformation of the bitumen concrete (BC) and stone matrix asphalt (SMA) with and without fiber is shown



VI. CONCLUSION

1. Optimum Binder Content(OBC) is 5.1% and Optimum Fiber Content (OFC) is 0.4%
2. It is found that for SMA without fiber the binder requirement is 5.6%, this value is reduced to 5.2 % by the expansion of sisal fiber 0.4% to SMA and advanced fiber addition increase to 6 leading to the greatest drain down
3. Stability decreases by an overall expansion of 0.4% fiber to SMA stability value increase and further additions
4. By expansion of 0.4% fiber to SMA stream value decreases and encourage expansion of fiber flow value increases
5. The fundamental benefit of using fiber is that the mix decreases void.

There are two types of mix i.e. SMA and BC are prepared for use as a cover for bitumen 50/60. In addition, a sisal fiber that is actually available is used at different concentrations (0 to 0,6 percent). A Marshall blend design method is used to determine OBC and OFC. The fiber properties of Blend 's are generally improved by 0.4%. Drain down test, indirect tensile strength and static creep test conclude that SMA has exceptionally good sisal fiber results and can be used in flexible paving.

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