Utilization of Fiber as a Strength Modifiers in Stone Matrix Asphalt

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ABTRACT

Construction of highway involves huge outlay of investment. A precise engineering design may save considerable investment as well a reliable performance of the in-service highway can be achieved. Two things are of major considerations in flexible pavement engineering–pavement design and the mix design. The present study is related to the mix design considerations.A good design of bituminous mix is expected to result in a mix which is adequately (i) Strong (ii) Durable (iii) Resistive to fatigue and permanent deformation (iv) Environment friendly (v) economical and so on. A mix designer tries to achieve these requirements through a number of tests on the mix with varied proportions and finalizes with the best one. The objective of the mix design is to produce a bituminous mix by proportioning various components so as to have Sufficient bitumen to ensure a durable pavement, Sufficient strength to resist shear deformation under traffic at higher temperature. Sufficient air voids in the compacted bitumen to allow for additional compaction by traffic, Sufficient workability to permit easy placement without segregation, The SMA samples were prepared using varying bitumen content of 4%, 5.5%, 6%, 6.5%, and 7%. This was done to find out the effect of increasing bitumen content on the stability value. This plot also helps us to find the Optimum binder content for this mix. The plot indicates that the stability value increases initially with increase in bitumen content but then decreases gradually.

Keywords: - SMA, Environment friendly , economical, voids, Optimum binder

1. 1 INTRODUCTION

Construction of highway involves huge outlay of investment. A precise engineering design may save considerable investment as well a reliable performance of the in-service highway can be achieved. Two things are of major considerations in flexible pavement engineering– pavement design and the mix design. The present study is related to the mix design considerations.

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Pavement consists of more than one layer of different material supported by a layer called sub-grade. Generally pavement is two type flexible pavement and rigid pavement. Flexible pavements are so named because the total pavement structure deflects, or flexes, underloading. A flexible pavement structure is typically composed of several layers of material. Each layer receives the loads from the above layer, spreads them out then passes on these loads to the next layer below. Typical flexible pavement structure consisting of:

1. Surface course. This is the top layer and the layer that comes in contact with traffic. It maybe composed of one or several different HMA sub layers. HMA is a mixture of coarse and fine aggregates and asphalt binder
2. Base course. This is the layer directly below the HMA layer and generally consists of aggregate (either

stabilized or un-stabilized).

3. Sub-base course. This is the layer (or layers) under the base layer. A sub-base is not always needed.

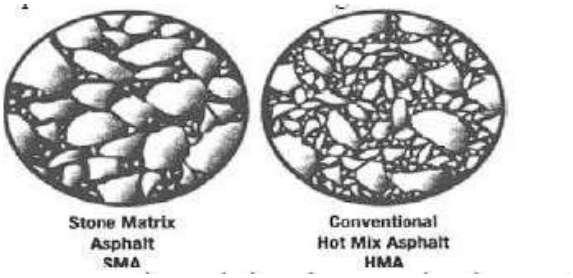

Fig 1 Stone Matrix Asphalt and Conventional Hot Mix

1. 2 LITERATURE SURVEY & BACKGROUND

Anuj Narwal (2023)reviewed the consequences of use of a naturally and locally obtainablefiber known as SISAL fiber is employed as stabilizer in SMA and as an additive in BC. For preparation of the mixesaggregate gradation has been taken as per MORTH specification, binder content has been varied often from 4% to 7%and fiber content varied from 0.33 to maximum 0.5% of total mix. As a section of preliminary study, fly ash has beenfound to result satisfactory Marshall Properties and thus has been used for mixes in resultant works. Using MarshallProcedure Optimum Fiber Content (OFC) for each BC and SMA mixes was found to be 0.3%. Similarly OptimumBinder Content (OBC) for BC and SMA were found to be 5-hitter and 5.2% severally.

Kavalakuntla Kiran Kumar (2020) studied the effects of use of a naturally and locallyavailable fibre called SISAL fibre is used as stabilizerin SMA and as an additive inBC. For preparation ofthe mixes aggregate gradation has been taken as perMORTH specification, binder content has beenvaried regularly from 4% to 7% and fibre contentvaried from 0% to maximum 0.5% of total mix. As apart of preliminary study, fly ash has beenfound toresult satisfactory Marshall Properties and hence hasbeen used for mixes in subsequent works.

P. Bakiya (2018)bituminous concrete mixes are the structural layer used widely in Flexible pavements. The property of bituminous mixes can be enhanced by addition of fibres such as coirfibres. Fibre lengths were kept i.e. 10mm, 15mm and 20mm and used at the rate of 0.3%, 0.5% and 0.7% by weight of mix. The mechanical properties such as indirect tensile strength test (ITS), short and long term ageing test and stiffness modulus test were investigated. It is concluded that the incorporation of coir fibre in the mix enhance the properties of bituminous concrete.

1.3 OBJECTIVES OF THE WORK

In this investigation we are concentrating about the amount of fiber that is added to the bituminous mix design and which will give the optimum fiber content and as a outcome expecting an increase in strength. Dense bituminous concrete Mix is used in our investigation. Fiber content varies between (0.5% - 2.5%). In the present study 60/70 penetration grade bitumen is used as binder.

The main objectives of the present study are as follows:

1. To find the suitability of fibers as a stabilizer for use in Stone Matrix Asphalt
2. To compare the Marshall properties of SMA samples with varying binderConcentrations and to obtain optimum binder content with the help of Marshall Test data.

Result –

MARSHALL TEST RESULTSOFMIXWITHOUT AND WITH BANANA FIBER

Variation of Marshall Properties of bituminous concrete (BC) with varying percentage ofbitumen without and with banana fiber is explained below.

The results of the Marshall Test i.e. Marshall Stability and flow values and void parametersfor the bituminous mixes without and with banana fiber are given in Table 6.1.

Table 6.1 Parameters of reference mix without and with banana fiber

	Bitumen content %	Stability, KN	Flow, mm	VV%	VFB %
Without Banana fiber	4	7.57	2.2	4.97	65.31
	5.5	8.16	2.5	2.32	83.73
	6	6.9	3.7	2.09	86.13
	6.5	5.76	4.5	1.19	92.74
	7	4.77	5.4	1.02	94.11
With Banana fiber	4	8.14	2.68	5.04	68.42
	5.5	9.49	3.01	3.21	82.46
	6	7.27	4.19	2.24	89.68
	6.5	6.45	4.67	2.13	94.25
	7	5.49	5.75	1.14	95.36

6.1.1.1 MARSHALL STABILITY

It is observed that stability value increases with increase binder content up to certain binder content; then stability value decreases. This is due to with increase in bitumen content, the bond between the aggregate and the bitumen increases but with further increase, the strength between them decreases as the contact point between the aggregates become immobilize. Dueto which mix become weak against plastic deformation. Simultaneously the stability Values also decreases. Variation of Marshall Stability value with different binder content is given fig

6.1.From Table 6.1, it is evident that the presence of fibre in the SMA mixtures effectively improves the stability values, which will result in an improvement of mixture toughness. Thisresult indicates that the mixture using fibre would result in higher performance than using the control mixture.

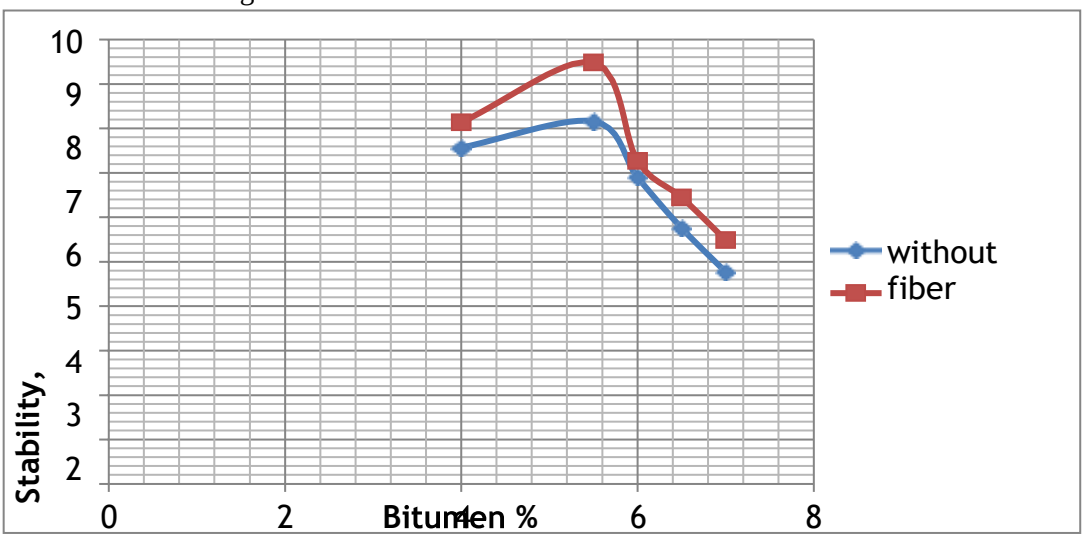

Figure 1 Variation of stability for different bitumen % without and with banana fiber

1.5 CONCLUSION

The SMA samples were prepared using varying bitumen content of 4%, 5.5%, 6%, 6.5%, and 7%. This was done to find out the effect of increasing bitumen content on the stability value. This plot also helps us to find the Optimum binder content for this mix. The plot indicates that the stability value increases initially with increase in bitumen content but then decreases gradually. This can be attributed to the fact that with initial increase in bitumen content, the aggregate bitumen bond gradually gets stronger, but with further increase in the bitumen content, the applied load is transmitted as hydrostatic pressure, keeping the fraction across the contact points of aggregates immobilized. This makes the mix weak against plastic deformation and thestability falls. The same principle applies to mix with fibers, but this mix showshigher stability value at the same binder content than the mix without fibers. This can be attributed to the fact that , the fibers in the mixes act as stabilizers which not only fills up the voids in the sample but also reduces the drain down significantly, thus

holding up the binder in the mix. The addition of fibers also provides homogeneity to the mix.

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