

Modified Bituminous Mix Prepared Using Natural Fiber

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Abstract: The SMA Technical Working Group of FHWA defined SMA as “A gap graded aggregate hot mix asphalt that maximizes the binder content and coarse aggregate fraction and provides a stable stone-on-stone skeleton that is held together by a rich mixture of binder, filler and stabilizing additives”. The present study is carried out with and without natural fibre. Here, we can use the jute fibre. Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. It is produced from plants in the genus *Corchorus*, family *Malvaceae*. Different experiments were conducted on bitumen with and without using fibre. The results were analyzed with the use of Marshall Stability test. In addition to it cost analysis was also done.

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. SMA was developed in Germany in the 1960s by Zichner of the Straubag-Bau AG central laboratory, to resist the damage caused by studded tires. SMA is a gap graded mixture containing 70-80% coarse aggregate of total aggregate mass, 6-7% of binder, 8-12% of filler, and about 0.3-0.5% of fibre or modifier. Brown and Manglorkar (1993) reported that the traffic loads for SMA are carried by the coarse aggregate particles instead of the fine aggregate asphalt-mortar.

2. Objectives of the study

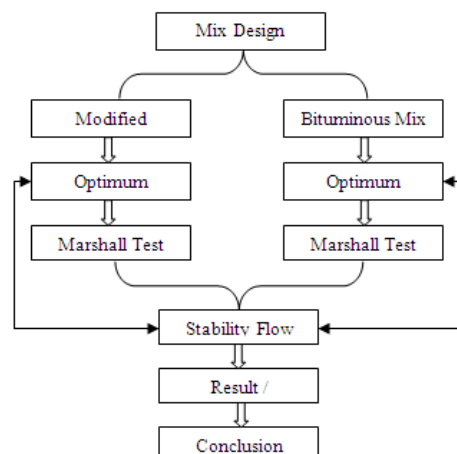
- 1) To carry out the experiments on bitumen and aggregate to assess their qualities.
- 2) Design the bituminous mix with use of natural fiber and without use of natural fiber.
- 3) Conduct the Marshall Stability test for evaluating properties of Bituminous Mix.
- 4) Carry out comparative analysis and Select the best alternative.
- 5) Use of non-conventional natural fibre as Coconut fibre and jute fibre instead of other conventional fibre and to study how they affect the various properties of mix.

3. Methodology of the Study

The Study is divided into five stages stretching over the study period.

- 1) Testing of Bitumen for Bitumen Property Checking.
- 2) Selection of Modifiers & Assessing their Bituminous Property.
- 3) Preparing of Bituminous Modified Mix.
- 4) Assessing the Modified Bituminous Mix.
- 5) Comparative Review of Bituminous Mix

3.1 Chart of Mix Design



3.2 Methodology for Testing

Bituminous Materials are tested in accordance with relevant IS codes & aggregates were tested for suitability in Bituminous concrete show in table 1 and table 2 are as under below.

Table 1. Tests for Bitumen

Types of test	Test method
Ductility Test	IS: 1208-1978
Softening Point Test	IS: 1205-1978
Specific gravity Test	IS: 23869(PART III)
Penetration Test	IS: 1203-1978
Flash and fire point Test	IS: 1209-1978
Viscosity Test	IS: 1206-1978

Table 2. Tests for Aggregate

Types of test	Test method
Grading / Sieve Analysis	IS:2386-1963(PART I)
Specific gravity Test	IS:2386-1963(PART III)
Abrasion value Test	IS:2386-1963(PART III)
Impact value Test	IS:2386-1963(PART IV)

3.3 Marshall Stability Test

Before preparing the specimens for Marshall Test, it is required that following steps.

Material proposed for use the gradation requirements of the project specifications.

The blend combinations meet the gradation requirements of the project specifications.

Therefore use in density and voids analysis the pulse specific gravity of all aggregate used in the blend and the specific gravity of asphalt are determined.

1. Number of Specimen

At least three specimens are prepared for each combination of aggregates and bitumen content.

2. Preparation of aggregate

Aggregate are dried to temperature at 1050°C – 1100C and separation by dry sieving into desired size fractions.

3. Sieve analysis of aggregates

Numbers of trials are done to fix the proportion of different aggregate by sieve analysis. This portion is very important in bitumen mix design.

4. Preparation of mixing and compaction temperature

Bitumen is heated to about 1300C to 1450C so that the water vapour present in it is evaporated. The bitumen is mixed thoroughly with aggregates by manually or mechanically.

5. Preparation of mould and hammer

Specimen mould and compaction hammer are cleaned thoroughly and mould assembly is heated in hot air oven to a temperature of about 1500C. A little grease is applied to the mould before the mix is placed in the mould.

6. Preparation of Specimen

The amount of each size of fraction required to produce a mixed aggregate of 1200 Kg. as per gradation is weighted. The required height of specimen is 63.5±1 mm. aggregate and bitumen is heated separately to the require temperatures. Then bitumen is poured in aggregate as per requirement. Then mixture is mixed till a uniform coating of bitumen is obtained on aggregate. This is obtained at about 1500C.

Compaction of the Specimen

Mould is assembled and a little grease is applied to it. Mix is transferred into 3 layers and each layer being tamped with spatula by 25 times. Then 75

blows are applied through manually electrically operated compactor. Then same numbers of blows are applied on the other side of mould. Then the specimen is allowed to cool, once the specimen comes to room temperature de-mould is carried out.

8. Application of water bath

Before testing mould on Marshall Apparatus, the moulds are followed to keep in the water bath for 30 minutes at 600C. Mould should be tested within 3 to 4 minutes after taken out from water bath.

9. Finalizing the Sample

We made a final sample of the bituminous mix with and without fibre.

4. Result and Discussion

4.1 Optimum Fibre Content

First we find the Optimum fibre content at the 5.5 % of bituminous mix design of Marshall Stability test Result. We take the 0.2 %, 0.3 %, 0.4 % fibre and check the Stability, Density and Flow. In table 4 we show that we get maximum stability and density at the 0.3 % adding of Jute fibre. Hence we take 0.3 % fibre and conducting the test at 5.0 %, 5.5 %, 6.0 % and 6.5 % bituminous mix design without fibre, with jute fibre. It is mentioned earlier that one type of binders, namely 60/70 penetration grade bitumen binder have been used in the SMA mixes with and without coconut fibre, and jute fibre in this investigation. The details result for bitumen test, aggregate test , optimum fibre content and Marshall Stability test are given as below.

Property	Test Value
Penetration	83 mm
Ductility	>100 mm
Softening point	48.5
Flash Point	278
Specific Gravity	1.003
Ash content	0.5 - 0.8%
Pectin	0.2 - 0.5%

Table 3. Results for Bitumen

Property	Test Value
Specific Gravity	2.65
Abrasion value	14.98
Impact value	14.71
Water absorption	0.5
Flakiness & Elongation	26.79

Table 4. Results for Aggregate

Table 5. Results for Aggregate

Sr no.	Bituminous %	Fibre %	Without fibre			With Jute fibre		
			Stability	Density	flow	Stability	Density	flow
1	5.5	0.2	1012	2.32	2.8	1182	2.34	2.7
2	5.5	0.3	1100	2.35	2.7	1307	2.36	2.6
3	5.5	0.4	1040	2.33	2.9	1220	2.35	2.5



Figure - performing the experiment

4.2 Marshall Stability Test result

Tests were performed on different bitumen content like 5%, 5.5%, 6% and 6.5%. Tests results shown in following tables.

Table 6. Results of Marshall Stability Test without fiber

Sr. No.	Bitumen % By Wt. of Mix (%)	Wt. of Specimen gms.			Vol. of Specimen	Bulk Density (Gmb)	Max. Th. Sp.Gr.	Air Void %	VMA %	VFB %	Stability (Kg.)	Flow value
		Wt. in Air	Wt. in Water	Wt. of S.S.D								
1	5	1211	701	1218	517	2.342	2.537	8.04	17.91	55.1	1117	2.5
		1234	709	1240	531	2.324					1028	2.8
		1211	700	1219	519	2.333					1077	2.6
						2.333					1074	2.6
2	5.5	1220	707	1227	520	2.346	2.517	6.83	17.93	61.9	1257	2.9
		1214	704	1221	517	2.348					1211	3.2
		1229	712	1237	525	2.341					1189	3.1
						2.345					1219	3.1
3	6	1211	708	1218	510	2.375	2.498	4.8	17.21	72.1	1315	3.5
		1227	719	1235	516	2.378					1334	3.4
		1221	716	1229	513	2.380					1361	3.8
						2.378					1337	3.6
4	6.5	1215	708	1222	514	2.364	2.477	4.72	18.27	74.1	1260	4.4
		1224	714	1232	518	2.363					1224	4.8
		1210	705	1219	514	2.354					1236	4.4
						2.360					1240	4.5

Table 7. Result of Marshall Stability Test with fiber:

Sr. No.	Bitumen % By Wt. of Mix (%)	Wt. of Specimen gms.			Vol. of Specimen	Bulk Density (Gmb)	Max. Th. Sp.Gr.	Air Void %	VMA %	VFB %	Stability (Kg.)	Flow value
		Wt. in Air	Wt. in Water	Wt. of S.S.D								
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						2.378					1337	3.6
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		1224	714	1232	518	2.363					1224	4.8
		1210	705	1219	514	2.354					1236	4.4
						2.360					1240	4.5

5. Cost Estimation

The cost estimation for the under mentioned project road link (1km) have been calculated based on the detailed quantities worked out for various items of work to be executed