Enhancement into Bituminous Properties using Forta Fibre in SMA

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Abstract

There are two types of pavement, one is flexible pavement and second one is rigid pavement. If the initial cost is considered, than the rigid pavement is costly, but the maintenance cost of it is low. And country like INDIA, its not possible to provide rigid pavement everywhere, so flexible pavement is the option only. In flexible pavement, it is required to be maintained at some interval of time so the cost of maintenance is should be minimum. At present, the maintenance cost is higher so now the method of maintenance has to be modified for the flexible pavement.To avoid the maintenance cost, the proper quality of work and material is important. So to improve the quality, various material or chemicals are used to improve the quality or to improve the property of the raw material. The study is about to improve the properties of bitumen. In Flexible pavement construction, modified bitumen can be used with fibres, Chemicals, Waste materials etc. for improving its properties. The most suitable fibres are used to improve its properties, i.e. Marshall Mix design, Viscosity ,Ductility ,and Specific Gravity. According to literature, Forta Fi- fibre is most advantageous for improving bituminous properties So here it is checked for its feasibility in our country to improve different bituminous property. 1%, 2 %, and 3 % of Forta Fi by its weight of Conventional bitumen mix is studied.
Keywords: SMA, Pavement, Fibre.

I. INTRODUCTION

A. Problem definition

Because of lower Fatigue strength , it will develop potholes, rutting and stripping in flexible pavement. And Because of low viscosity , the quality of bitumen required to be improved. So to improve it , various types of fibres are used in it.

B. Types of Fibres Used in Bitumen Pavement

- Forta Fi
- Forta Ferro
- Cellulose fibre
- Steel fibre
- Polypropylene fibre
- Aluminum fibre
- Micro steel fibre brass coated
- Glass fibre
- Acrylic fibre
- Aramid fibre
- Carbon fibre
- Nylon fibre
- Polyester fibre
- Polyethylene fibre

– Natural fibres

C. Forta-Fi Fibre

Among all these fibres , FORTA-Fi is a family of three synthetic fibre blends formulated to reinforce Hot Mix Asphalt (HMA), Warm Mix Asphalt (WMA), and hot/cold Asphalt Patch (PAT). By controlling thermal, reflective and exhaustion cracking, as well as rutting, FORTA-FI provides the benefit of immediate cost savings through reduced asphalt depth or extended tarmacadam life, or together. The proprietary blends restrain Aramid and polyolefin fibres and other materials, known for their strength, durability, and binding properties.[25^0]

II. TEST OF AGGREGATE

A. Gradation of aggregate

Table - 1
Gradation of Aggre

[1] *Size of aggregates* [2] *(I.S sieve)* [3]	[4] *Individual weight(W)* [5] *retained between sieves in* [6] *kapchi 10 (kg) sample* [7] [8]	[9] *Individual weight(W) retained between sieves in grit 5 (kg) sample*
[10] *20mm*	[11] *3.35* [12]	[13] *0.004*
[14] *10mm* [15]	[16] *5.964*	[17] *0.268*
[18] *12.5 7.5mm* [19]	[20] *0.550*	[21] *4.21* [22]
[23] *7.5mm*	[24] *0.101* [25] [26]	[27] *0.447*

B. Flakiness Index Test

Table - 2
Flakiness Index Test

size of aggregate	*Individual weight retained between Sieves (kg)*	*Weight of aggregate passing through respective slot of the gauge.(kg)*
20 mm to 16 mm	*W1=2.560*	*W1=0.593*
16 mm to 12.5 mm	*W2=1.440*	*W2=0.420*
12.5mm to 10 mm	*W3=0.560*	*W3=0.183*

Flakiness index = (1.196/4.56)*100 = 26.22

C. Elongation Index Test

Table - 3
Elongation Index Test

Size of aggregate	*Individual weight retained between sieves(kg)*	*Weight of aggregate passing through respective slot of the gauge(kg)*
20 mm to 16 mm	*W1=2.195*	*W1=1.915*
16 mm to 12.5 mm	*W2=1.670*	*W2=1.429*
12.5mm to 10 mm	*W3=0.779*	*W3=0.6.19*

Elongation index = (3.663/4.644)*100 = 85.33

D. Aggregate Impact Value Test

Table - 4
Aggregate Impact Value Test

Sr. No	*Description*	*Sample 1*	*Sample 2*

1	*Weight of Sample,(W1)gm.*	*351*	*345*
2	*Weight of aggregate passing through 2.36mm sieve, (W2)gm.*	*48*	*47*
3	*Aggregate Impact Value in % I.V.=(W2/W1)*100*	*13.67*	*13.62*
4	*Average Aggregate Impact Value in %*	*13.645*	

E. Los Angeles Abrasion Test

Grading of aggregate= b
Weight of charge=390gm to 445gm
No. of spheres used= 11
No. of revolution= 500

Table - 5
Los Angeles Test

Description	*Sample 1*	*Sample 2*
Weight of sample(W1) kg	*5*	*5*
Weight of sample retained on 1.70 mm IS sieve (W2) kg	*4.446*	*4.356*
*Percentage wear (W1- W2)*100/W1)*	*11.3*	*11.4*
Average percentage wear	*11.31*	

III. BITUMEN TEST RESULT ANALYSIS

A. Penetration Test

Table - 6
Penetration Test

	Reading			*Avg. value*
	1	*2*	*3*	
Without fibre	*62.32*	*64*	*66.5*	*65*
Wth fibre(1%)	*65*	*65*	*67*	*66*
With fibre(2%)	*65.5*	*66.5*	*69*	*67*
With fibre(3%)	*68*	*69.5*	*73*	*73*

B. Ductility Test for Bitumen

Table - 7
Ductility Test

	Reading			*Avg. value*
	1	*2*	*3*	
Without fibre	*78*	*80.5*	*81.5*	*80*
Wth fibre(1%)	*76.5*	*77.5*	*80*	*78*
With fibre(2%)	*80*	*83*	*83*	*82*
With fibre(3%)	*82*	*87*	*92*	*87*

Fig.1: Ductility Mould

C. Softening Point Test For Bitumen

Table - 8
Softening Point Test

	Reading			*Avg. value*
	1	*2*	*3*	
Without fibre	*47*	*50*	*53*	*50*
Wth fibre(1%)	*52.5*	*50.5*	*50*	*51*
With fibre(2%)	*52*	*51*	*56*	*53*
With fibre(3%)	*55*	*57*	*56*	*56*

D. Viscosity Test

Table - 9
Viscosity Test Result .

	Reading			*Avg. value*
	1	*2*	*3*	
Without fibre	*2424*	*2420*	*2419*	*2421*
Wth fibre(1%)	*2440*	*2447*	*2445*	*2444*
With fibre(2%)	*2474*	*2467*	*2463*	*2468*
With fibre(3%)	*2478*	*2487*	*2490*	*2485*

E. Flash Point Test for bitumen

Table - 10
Flash Point Test For Bitumen

	Flash point reading °C			*Avg. Value in °C*
	1	*2*	*3*	
Without fibre	*242*	*240*	*232*	*238*
Wth fibre(1%)	*240*	*245*	*240*	*242*
With fibre(2%)	*225*	*247*	*242*	*244*
With fibre(3%)	*241*	*250*	*247*	*246*

F. Marshall Stability Test

Table - 11
Marshall Stability Test

sr. no.	*Sample*	*Wt. In air*	*Wt. In water*	*volume*	*Density*	*Gt*	*Vv*	*Vb*	*VMA*	*VFB*	*Stability*	*Flow value*
1	*5.0A*	*1278*	*712*	*545*	*2.31*	*2.47*	*5.94*	*10.65*	*16.63*	*64.42*	*1612*	*3.4*
2	*5.0B*	*1275*	*713*	*542*	*2.32*	*2.47*	*5.42*	*10.69*	*16.24*	*66.58*	*1610*	*3.1*
3	*5.0C*	*1276*	*714*	*542*	*2.33*	*2.47*	*5.42*	*10.70*	*16.24*	*66.60*	*1625*	*3.5*
4	*5.5A*	*1278*	*715*	*543*	*2.34*	*2.45*	*4.52*	*11.72*	*16.34*	*72.35*	*1752*	*4.1*

5	*5.5B*	*1274*	*716*	*538*	*2.35*	*2.44*	*3.63*	*11.79*	*15.34*	*76.61*	*1745*	*4.1*
6	*5.5C*	*1271*	*711*	*540*	*2.32*	*2.43*	*4.05*	*11.71*	*15.45*	*74.47*	*1764*	*4.2*
7	*6.0A*	*1274*	*706*	*548*	*2.30*	*2.41*	*4.33*	*12.58*	*17.56*	*74.56*	*1726*	*5.3*
8	*6.0B*	*1280*	*710*	*550*	*2.30*	*2.42*	*4.67*	*12.86*	*17.34*	*73.09*	*1732*	*5.1*
9	*6.0C*	*1279*	*711*	*548*	*2.31*	*2.42*	*4.33*	*12.63*	*17.23*	*74.63*	*1742*	*5.2*

IV. CONCLUSION

Replacement of forta fi in bituminous mix, it gives desirable properties changes. In embryonic country like India mixing forta fi with asphalt mix is one solution for more durable, cheaper and eco friendly road.

Mixing forta fi in various proportion like 1%, 2% and 3% in bituminous mix , the penetration value is increasing up to 1% of plain bituminous mix to 5% in case of binding containing of forta fi. But in case of adding 3% fibre in bituminous mix, penetration value is exceed, so 3% fibre of binding containing is not suitable for bituminous mix. The viscosity value of bituminous mix increases in wide range up to 17% of plain bituminous mix to 64% in case of binding containing 1%,2% and 3% of forta fi.

The softening point value increases up to 3% to 6% of normal bituminous mix. The ductility test value increases up to1% of normal bituminous mix to 6% in case of binding containing 1%, 2% and 3% of forta fi. Flash point value increases up to 7% of normal bituminous mix. Ductility value increases up to 1% to 7% in case of containing binder material forta fi 1%, 2% and 3% of bituminous mix. Bulk density, stability and flow rate of bituminous mix increases in case of increasing percentage of bitumen content. Marshall Stability Value and Marshall Flow Value is also increase, when fibre content increases with bitumen
Air voids in bituminous mix are decrease so cracks in bitumen pavement can decrease.

Forta fi is stronger than steel and thinner than hair so it can resist any type of weathering condition and high heat on pavement. so pavement can be more durable and serviceability of pavement can increases. The distribution of bituminous particles is even so it can achieve more strength in less bituminous content. It require a smaller amount bituminous content to achieve sufficient strength with forta fi so the thickness of pavement will decrease and also turn out to be eco- friendly.

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