IMPROVEMENT IN BITUMINOUS PROPERTIES USING SUITABLE FIBER IN CONVENTIONAL MIX

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Abstract: - In Construction of road Pavement mainly there are two types of pavement, one is flexible pavement and another is rigid pavement. In a developing country like India as an economy purpose we cannot replace Flexible pavement by rigid pavement everywhere so we need to Improve those flexible pavement for reducing its life duration and maintenance cost. As recent trends in Flexible pavement construction we can use modified bitumen with fibers, Chemicals, Waste materials etc. for improving its bituminous properties. In this project we are going to use most suitable fiber for improving bituminous properties (i.e. Marshall Mix design, Viscosity, Ductility, and Specific Gravity). According to literature Forta Fi fiber is most advantageous for improving bituminous properties (i.e. ,Marshall mix , Viscosity , Ductility , Bituminous layer thickness) in different country (i.e. U.S.A ,China ,Germany) So here we will check its feasibility in our country to improve different bituminous property. We will study on 1 %, 2 %, and 3 % of Forta Fi by its weight of Conventional bitumen mix for improving bituminous property.

Index Terms— Bitumen, fibers and Forta Fi

1. INTRODUCTION

The concept of fiber reinforced asphalt is nothing new. In fact, long before the invention of asphalt, builders used straw to help reinforce their mud bricks. After that, horsehair was used in mortar for the same reason: reinforcement. Then, in the 1900s, asbestos fibers were used in concrete and asphalt to help stabilize the mixture. Asbestos fibers were found to increase tensile strength, compressive strength, stability, ability to sustain load after reaching maximum stability, and resistance to weathering. By the 1970s, however, with health and environmental concerns swarming around asbestos, the Substance was replaced with polyester and polypropylene fibers, as well as mineral fibers such as rock wool and slag wool. Then the 1980s brought about the use of synthetic Fibers, a switch made due to high tensile strengths and durability of these new fibers. [1] Forta-Fi Fiber FORTA-Fi is a family of three synthetic fiber blends formulated to reinforce Hot Mix Asphalt (HMA), Warm Mix Asphalt (WMA), and hot/cold Asphalt Patch (PAT). By controlling thermal, reflective and fatigue cracking, as well as rutting, FORTA-FI provides the benefit of immediate cost savings through reduced asphalt thickness or extended asphalt life, or both. The proprietary blends contain Aramid and polyolefin fibers and other materials, known for their strength, durability, and binding properties. [2]

2. OBJECTIVE, SCOPE AND METHODOLOGY

A. Objective:

- To improve bituminous properties like marshal stability value, penetration value etc.
- To improve shoving resistance.
- Improvement in polishing resistance.
- To reduce thickness of pavement using suitable fibers.
- To increase its viscosity with proper method of mixing.
- Comparison between conventional mix and improved bitumen mix.
- To improve its fatigue life.

B. Scope:

- To make flexible pavement strengthen.
- To make ecofriendly pavement.
- To make economically viable.
- To improve life period of flexible pavement.

Adding forta fi fiber in bituminous mix is used to improve various properties of bituminous mix. The varying proportion of forta fi is 1%, 2% and 3% of total bituminous content. Change properties like marshal stability value, penetration value, ductility and viscosity of bitumen.

3. MATERIALS

Bitumen: VG 40

A dark brown to black cementations material in which `the predominating constituents are bitumen's, which occur in nature or are obtained in petroleum processing. Asphalt is one of the two principal constituents of HMA. Asphalt functions as an inexpensive, waterproof, thermoplastic, viscoelastic adhesive. [3]

Fiber:

Forta FI asphalt builds stronger asphalt surfaces, and stronger roads are safer roads. Forta FI asphalt reduces maintenance, thereby reducing future coasts and extending the useful life of pavement. [5]

Advantage:

Increase the durability of life.
It reduced absorption of water, chemicals, etc. [4]

Disadvantages:

High supervision is required.
Sharp labor work is required. [4]

Fine Aggregates: - Particles smaller than 0.125 mm
Course Aggregates: - Aggregate passing 12mm sieve and Retained on 10 mm sieve.
Aggregate passing 10mm sieve and Retained on 4.75mm.
Fine Aggregates: - Particles smaller than 0.125

4. RESULT AND DISCUSSION

A. Aggregate result:
a. Flakiness index
It is used to determine flakiness index of aggregate and to define grade of aggregates. The flakiness index of aggregate is the percentage by weight of particles whose least dimension is less than 0.6 times of their mean dimension.

TABLE I Flakiness index test result

Size of aggregate	Individual weight retained between sieves	Weight of aggregate passing through respective slot of the gauge
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

b. Elongation index
It is used to determine elongation index of aggregate and to define grade of aggregates. The elongation index of an aggregate is the percentage by weight of particles whose length is greater than 1.8 times of their mean dimension.

TABLE II Elongation index test result

Size of aggregate	Individual weight retained between sieves	Weight of aggregate passing through respective slot of the gauge
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

c. Los Angeles Test
Action between It is used to determine wear and tear on coarse aggregate. It is conducted to find out the percentage wear due to the relative rubbing and pounding between the aggregate.
Grading of aggregate= b
N0. Of spheres used= 11
No. of revolution= 500

TABLE III Los Angeles Test

Description	Sample 1	Sample 2
Weight of sample	5kg	5
Weight of sample retained on 2.36 mm	4.425	4.335
Percentage wear (w1-w2)*100/w1	11.5	13.3
Description	Sample 1	Sample 2
Weight of sample	0.351	0.345
Weight of aggregate passing through 2.36	0.048	0.047
Aggregate impact value in % I.V. = (w2/w1) * 100	13.67	13.62
Average aggregate impact value in %	13.645	

B. Various Tests conducted for Bitumen:
a. Penetration Test
It is used to find out the hardness or softness of bitumen. The consistency of bituminous materials varies depending upon constituent, temperature etc. at temperature 25' C to 100'C.

TABLE IV Penetration test result

	Reading			Average value
	1	2	3	
Without fiber	64.5	64	66.5	65
With Fiber (1%)	66	65	67	66
With Fiber (2%)	65.5	66.5	69	67
With Fiber (3%)	68	69.5	73	73

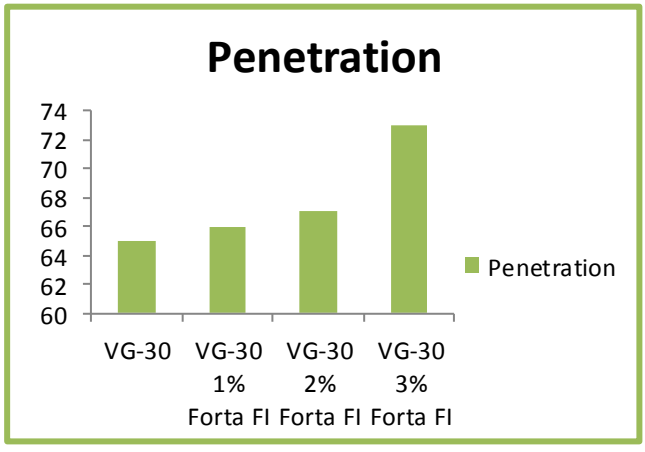

Fig 1 Penetration test result

b. Ductility Test
It is used to measure the ability to stretch of the bitumen. In flexible pavement construction ductile bitumen covers thin films around the aggregates. If bitumen does not possess sufficient ductility, it would crack and thus provide pervious

pavement surface.

TABLE V Ductility Test result

	Reading			Average value
	1	2	3	
Without fiber	82	87	86	87
With Fiber (1%)	80	83	83	82
With Fiber (2%)	76.5	77.5	80	78
With Fiber (3%)	78	80.5	81.5	80

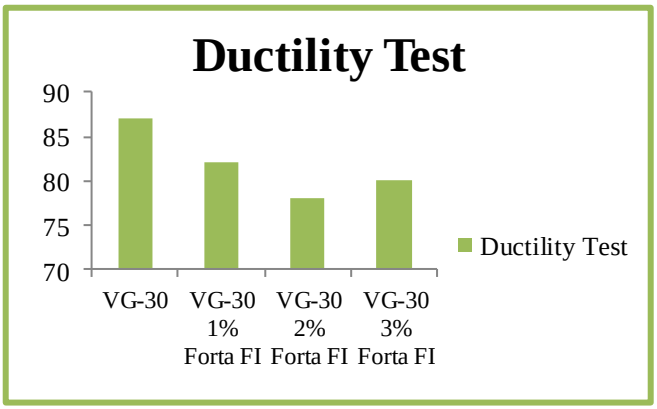

Fig 2 Ductility Test result

c. Softening Point Test

It is used to determine the softening point of bitumen. It is also helps to know the temperature up to which bitumen should be heated for a various road use application.

TABLE VI Softening Point Test

	reading			Average value
	1	2	3	
Without fiber	55	57	56	56
With Fiber (1%)	52	51	56	53
With Fiber (2%)	52.5	50.5	50	51
With Fiber (%)	49	50	51	50

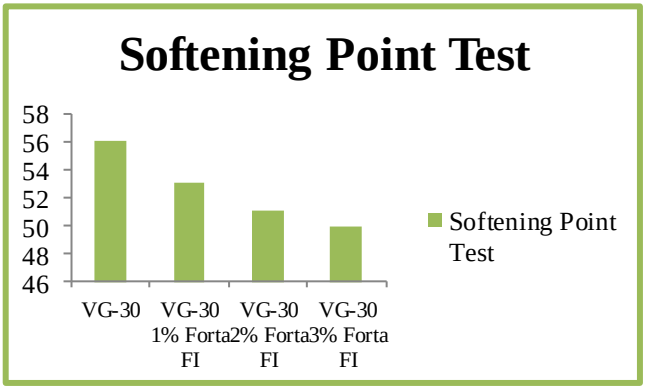

Fig 3 Softening Point Test

d. Viscosity Test

It is used to determine viscosity of bitumen. The degree of fluidity influence the ability of bituminous material to spread penetrate and coating the aggregate. It affects the strength characteristics of paving mixes.

TABLE VII Viscosity Test result

	Reading			Average value
	1	2	3	
Without fiber	2478	2487	2490	2485
With Fiber (1%)	2474	2467	2463	2468
With Fiber (2%)	2440	2447	2445	2444
With Fiber (3%)	2424	2420	2419	2421

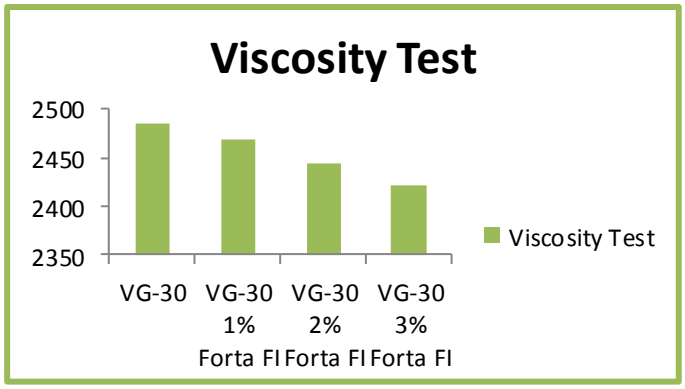

Fig 4 Viscosity Test result

e. Marshall Stability Test:

It is used to determine the density void analysis for the given bituminous mixture and strength and flexibility of the same mixture. It is used to designing and evaluating bituminous paving mixing. The major features of the marshal method of designing mixes are to determine the strength and flexibility. Strength is measured in terms of "marshal stability" of bituminous mix and flexibility is measured in terms of "flow value" of bituminous mix

a. Without fiber

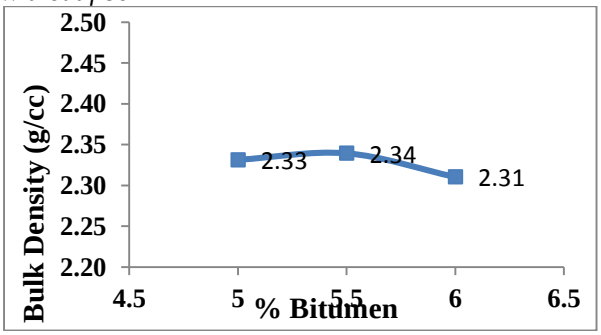

Fig 5 bulk density

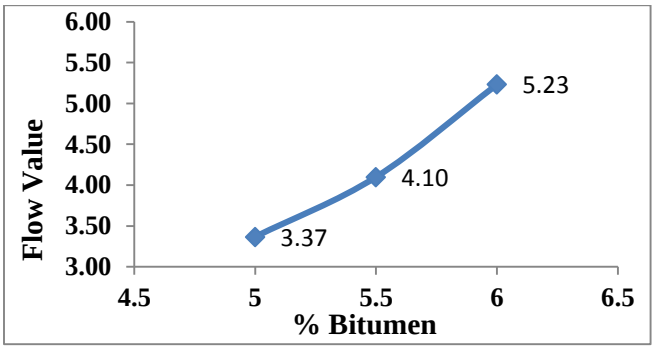

Fig 6 Flow value

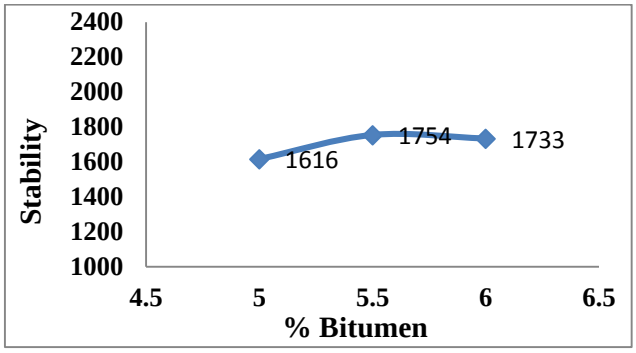

Fig 7 Stability

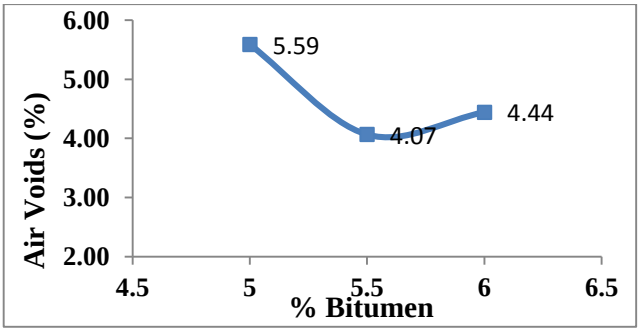

Fig 8 Air voids

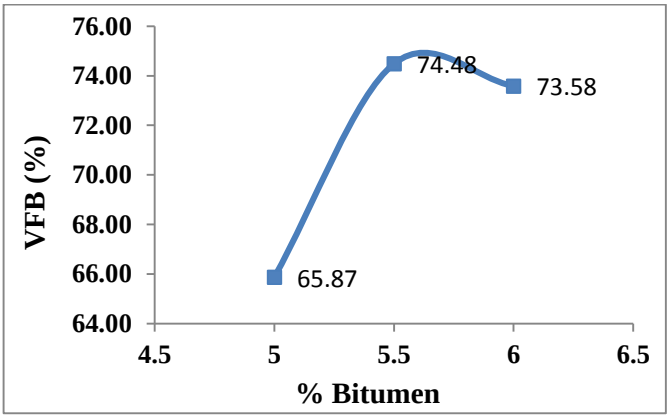

Fig 9 VFB

b. With fiber 1%

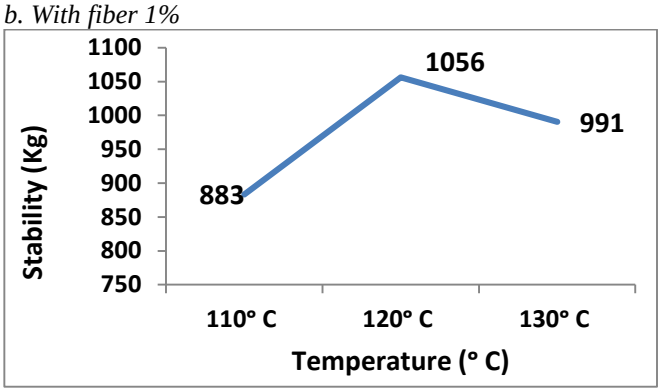

Fig 10 Stability

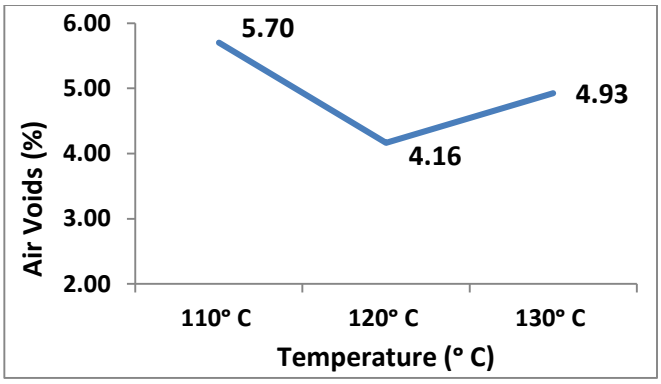

Fig 11 air voids

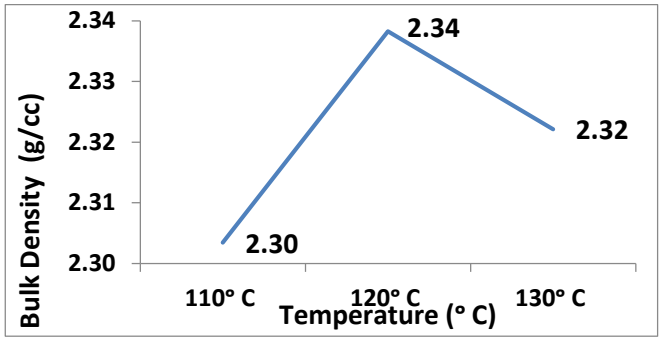

Fig 12 bulk density

c. With fiber 2%

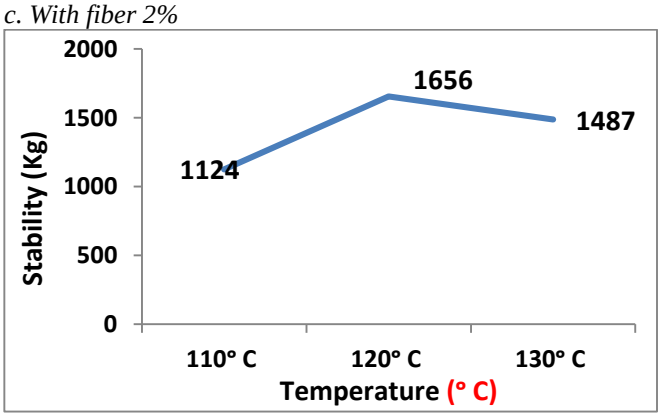

Fig 13 stability

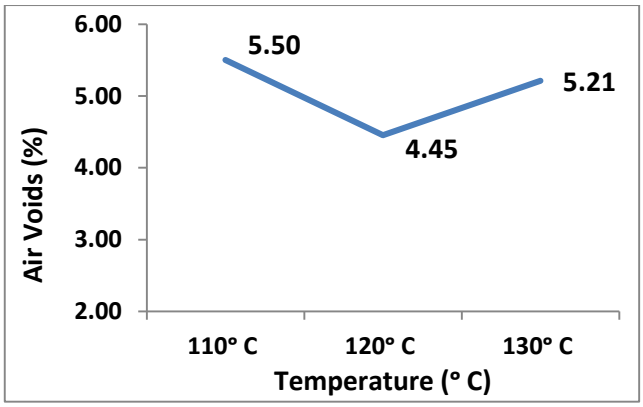

Fig 14 air voids

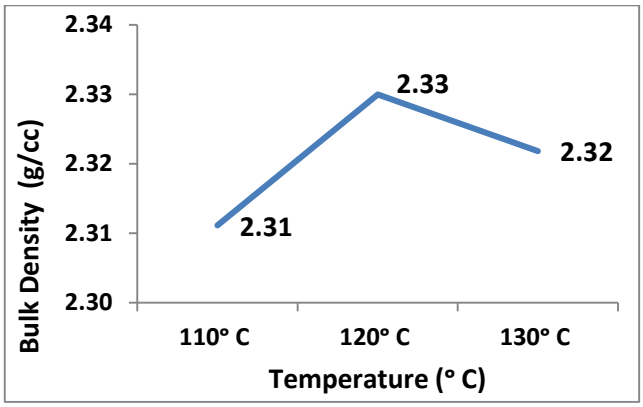

Fig 15 bulk density

d. With fiber 3%

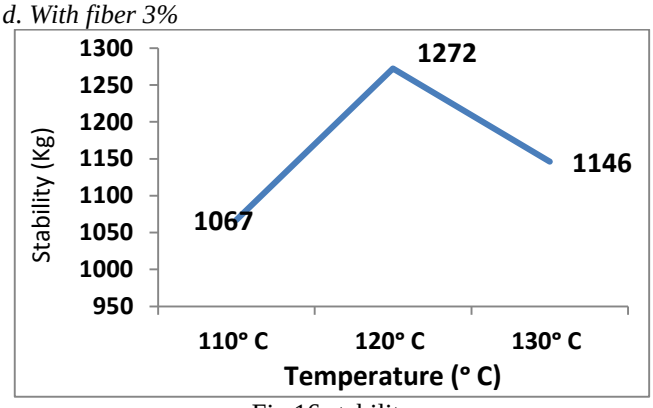

Fig 16 stability

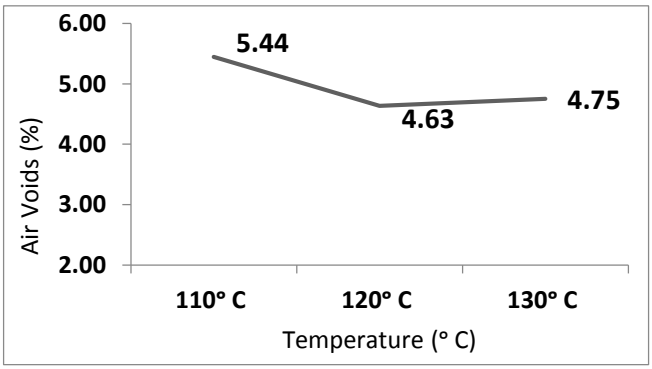

Fig 17 air voids

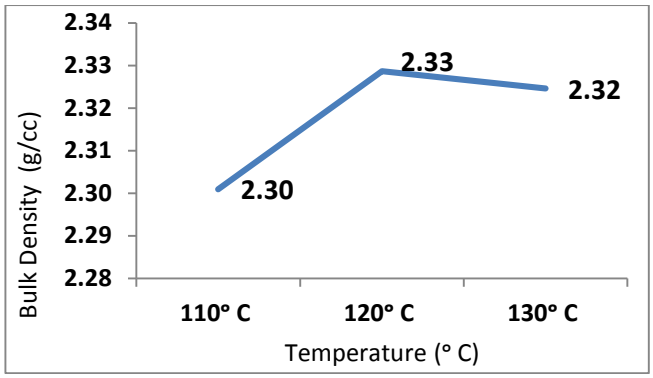

Fig 18 bulk density

TABLE VIII

Temp	Stability	Air voids	Bulk Density	Flow value	Dose (%)
110	883	5.70	2.30	3.6	1.0
120	1056	4.16	2.33	4.7	
130	991	4.93	2.32	4.7	
110	1124	5.50	2.31	4.1	2.0
120	1656	4.45	2.34	3.6	
130	1487	5.21	2.32	3.9	
110	1067	5.44	2.30	3.8	3.0
120	1272	4.63	2.33	4.8	
130	1146	4.75	2.32	3.6	

5. CONCLUSION

The penetration value is increasing up to 1% of bituminous mix to 4% in case of binding containing 1%, 2% and 3% of forta fi. In case of adding 3% fiber in bituminous mix, penetration value is exceed, so 3% fiber of binding containing is not suitable for bituminous mix. The viscosity value of bituminous mix decreases 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 decreases up to 3% to 6% of normal bituminous mix. The ductility test value decreases up to 3% of normal bituminous mix to 7% in case of binding containing 1%, 2% and 3% of forta fi. Marshal stability point value and marshal flow value increases gradually in case of 1%, 2% and 3% fiber of binding containing. Softening point of bituminous mix decreases 3% from normal bituminous mix.

6. ACKNOWLEDGMENT

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