Study on Marshall Retained Stability of BC Mix Used in Road Construction by Adding Cellulose fiber

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ABSTRACT
The present Study explains the effect of cellulose fibre on Marshall Retained Stability Properties of bituminous concrete. The laboratory test has been conducted on three types of Marshall Specimens. The binder content has been taken 5%, 5.5% and 6% and the fibre content has been taken 0.0%, 0.3% and 0.5% of the total mix, the binder VG-30 grade bitumen are used. The individual properties of material used in the mix design (coarse and fine aggregate, bitumen as binder VG-30, cement as filler and cellulose fibre as stabilizing additive) was find out in the laboratory as per relevant Indian standers code of practice (IS code) and as per MORT&H specification and preparation of mix for Marshall Specimens was as per relevant Indian standers code of practice (IS code) and as per MORT&H specification. The test was conducted on Marshall Specimens to observe the effect of cellulose fibre on the Marshall properties including Marshall Retained Stability. The test result is indicating that the Marshall Stability and Marshall Retained Stability value is higher in fibre content 0.5% in respect 5.45% optimum binder content.

Keywords: *Aggregate Gradation, Bituminous Concrete, Cellulose Fibre, Marshall Properties, Retained Stability.*

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1. INTRODUTION

The Asphalt pavement failure is typically classified as stability (Load) or durability related failure. The moisture damage is significant by loss of strength or durability in an asphalt pavement due to the effects of moisture and may be the asphalt mixtures loss of mechanical properties. Moisture Susceptibility is defined as the weakening and loss of the adhesive bond between the aggregate surface and the binder in HMA mixture due to the presence of moisture, Often called striping, it can also occur in the presence of moisture due to the loss of the cohesive resistance of the binder film that coats the aggregate. Moisture can weaken the binder matrix, subsequently lowering HMA mixture stability and load-carrying capacity. The result of stripping as rutting, shoving, and fatigue cracking. The main causes of stripping are aggregate gradation, aggregate type, binder type and inadequate compaction. Other causes of striping are the presence of a dust and clay coating on the aggregate, inadequate aggregate drying, the presence of weak and friable aggregate, and inadequate pavement drainage. When the aggregate coated with dust or clay, the binder-aggregate bond is reduced and channels are formed where moisture can penetrate. If aggregate are not properly dried before the HMA is mixed, inadequate adhesion occurs between binder and aggregate.

2. OBJECTIVES AND SCOPE

- To study Physical properties of Aggregate, Filler, Binder, Cellulose Fibre.
- To study the Marshall Properties and Retained Stability of Bituminous concrete mix for without Cellulose Fibre.
- To study the effect of Cellulose Fibre on the Marshall Properties and Retained Stability.
- The experimental work has been proposed to improve the properties of pavement using Cellulose Fibre.
- Laboratory study was carried out on Cellulose Fibre asphalt mixture to evaluate engineering properties, using Marshall Properties and Retained Stability.

3. PRESENT INVESTIGATION

Present investigation of the work is to investigate the effects of Cellulose Fibre on the strength and stability characteristics of bituminous Concrete mix which is used for surface course in road construction.

Methodology Adopted for Present Study

- To conducted Standard tests for the properties of Aggregates, Filler, Binder as per IS code and MORT&H Specification.
- To determine the optimum binder content for without fibre bituminous concrete and for with fibre bituminous concrete, by Marshall Stability Method.
- To conducted Standard tests for the properties of Marshall specimens for determination of Marshall properties and Retained Stability as per IS code and MORT&H Specification

Material Characterization

Study involve the use of material Bitumen (VG-30), Aggregate, Filler (Cement), Cellulose Fibre.

Bitumen: - Bitumen is a material which is a byproduct of petroleum refining process. It is highly viscous at temperature above 100^0C and is solid at room temperature. Viscosity grade bitumen VG 30 used as a binder in this research for preparation of mix.

Table -3.1
Physical Properties of Bitumen used in Present Study

Sr. No.	Description of Test	Test Method	Specification as per IS: 73 (2007)	Test Result Observed
1	Penetration Value of bitumen	IS: 1203	50-70mm	55.3
2	Ductility	IS: 1208	Min.40 Cm	91.3
3	Specific Gravity	IS: 1202	Min.0.99	1.03
4	Softening Point	IS: 1205	$>47^0$C	51.6
5	Viscosity at 135^0C	IS: 1206	Minimum 350 CST	550 CST

Aggregates: - Aggregate chosen which have good and sufficient Strength, Hardnees, Toughness, Crushed Aggregate produced higher Stability.

Table -3.2
Physical Properties of aggregates used in Present Study

S. No.	Description Of Test	Test Method	Specification as per MORT&H Table-500-18	Test Result Observed
1	Aggregate Impact value (%)	IS-2386 (P IV)	Max 24%	14.19
2	Aggregate Crushing value (%)	IS-2386 (P IV)	Max 10-25	18.83
3	Los Angles Abrasion Value (%)	IS 2386 (P IV)	Max 30%	20.00
4	Flakiness and elongation Index (%)	IS-2386 (PI)	Max. 30%	25.50
5	Water absorption	IS-2386 (P-III)	Max 2%	0.632
6	Grain size Analysis	IS-2386 (P-I)	Max 5% passing 0.075 sieve	4.17
7	Stripping	IS-6241-1971	Minimum retained coating 95%	98

Specific Gravity and Water Absorption used in Present Study

S.No.	Aggregate Type	Mix Proportion	Bulk Specific Gravity	Apparent Specific Gravity	Effective Specific Gravity	Water Absorption
1	13mm	46%	2.882	2.915	2.898	0.449
2	6mm	34%	2.755	2.825	2.790	0.920
3	Stone Dust	18%	2.653	2.723	2.688	0.968
4	Cement	2%	3.15	-	-	-

Mineral Filler: - Mineral filler shall consist of finely divided mineral matter such as stone dust and / or hydrated lime, cement. The filler shall be free from organic impurities and have a plasticity index not greater than 4. The plasticity index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel 2 percent by weight of total aggregate shall be Portland cement

or hydrated lime and the percentage of fine aggregate reduced accordingly. In this research Portland cement used as filler.

Cellulose Fibre:-Cellulose Fibre is used as a stabilizer additive. The doses rate as cellulose Fibre is 0.3% to 0.5% by the weight (on Loose Fibre basis) of the total mix.
In the present analysis it is proposed to use cellulose fiber in the bituminous mix. The cellulose fibres are supply from manufacture only for research work. The properties are provided by the manufacture are listed below.

Physical and chemical properties of cellulose fibre

S.No.	Description	Properties
1	Cellulose Content	Approx. 80%
2	Oxide Ash (850 ^{o}C, 4 h)	Approx. 15%
3	pH-value (5 g / 100 ml)	7.5 ±1
4	Average Fibre length	1,400 µm
5	Average Fibre Thickness	45 µm
6	Bulk Density	25 g/l – 45 g/l

Gradation and Proportion of Aggregates

AVERAGE PERCENTAGE OF GRADATION					BY BLENDING				Total	Specified Limit as per MORT&H		
IS Sieve Size in mm.	13 mm.	6 mm.	Crusher Dust	Filler	13 mm.	6 mm.	Crusher Dust	Filler		Lower Limit	Mid Limit	Upper Limit
					46%	34%	18%	2%	100%			
19	100.00	100.00	100.00	100.00	46.00	34.00	18.00	2.00	**100.00**	100	**100**	100
13.2	91.25	100.00	100.00	100.00	41.98	34.00	18.00	2.00	**95.98**	79	**89.5**	100
9.5	54.03	100.00	100.00	100.00	24.86	34.00	18.00	2.00	**78.86**	70	**79**	88
4.75	9.56	92.27	100.00	100.00	4.40	31.37	18.00	2.00	**55.77**	53	**62**	71
2.36	3.11	62.18	100.00	100.00	1.43	21.14	18.00	2.00	**42.57**	42	**50**	58
1.18	0.00	47.99	97.96	100.00	0.00	16.32	17.63	2.00	**35.95**	34	**41**	48
0.600	0.00	30.47	90.04	100.00	0.00	10.36	16.21	2.00	**28.57**	26	**32**	38
0.300	0.00	19.87	65.14	100.00	0.00	6.76	11.73	2.00	**20.48**	18	**23**	28
0.150	0.00	15.92	35.60	99.02	0.00	5.41	6.41	1.98	**13.80**	12	**16**	20
0.075	0.00	7.73	9.16	94.54	0.00	2.63	1.65	1.89	**6.17**	4	**7**	10

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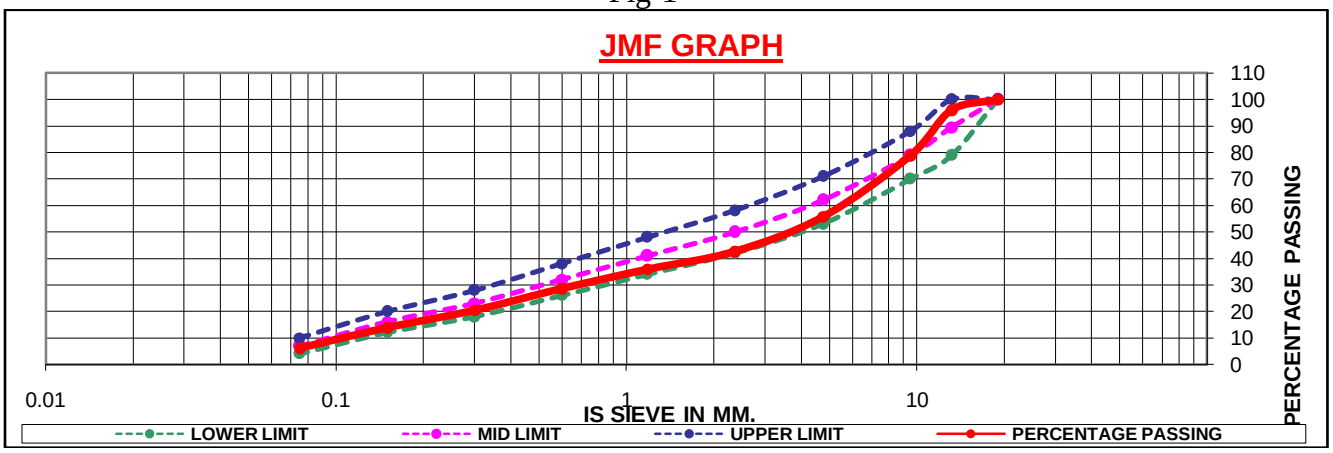
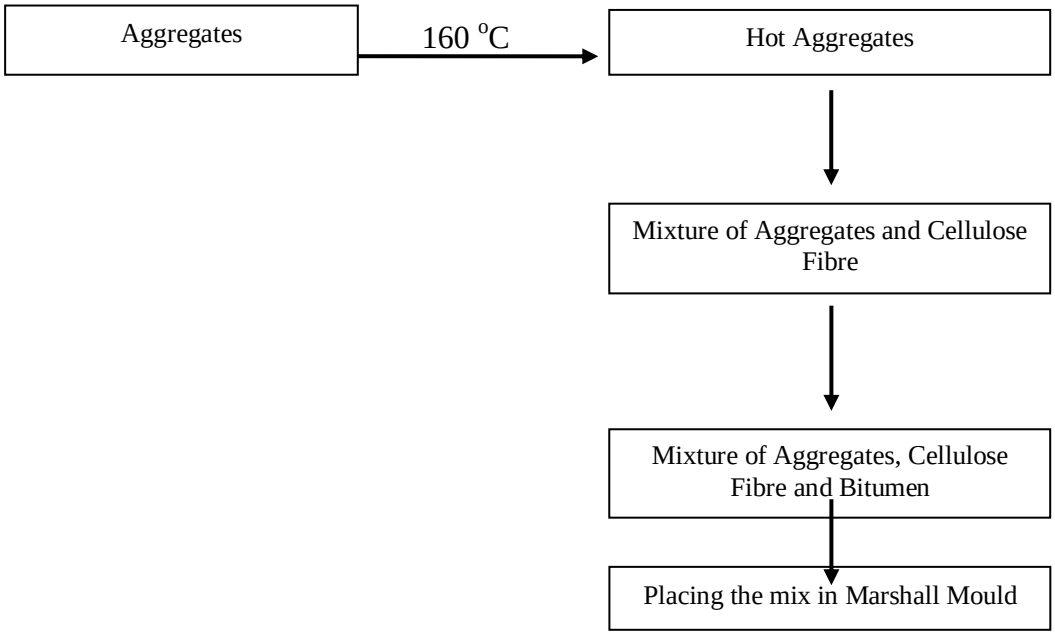
Fig-1



Laboratory Tests

- Tests on Aggregates: - Standard tests on Aggregates like Aggregate Impact Value, Aggregate Crushing Value, Los Angles Abrasion, Flakiness and Elongation Index, Water Absorption, Grain Size Analysis, Specific Gravity, Stripping Value were conducted by using appropriate apparatus.
- Tests on Bitumen:-Standard tests on Bitumen like penetration Value, Ductility, softening point, Viscosity were conducted by using appropriate apparatus.
- Tests on Mix:-Tests on bituminous concrete mix for various properties like Stability, Flow Value, Bulk Specific Gravity and Optimum Binder content were conducted by using Marshall Stability Apparatus.
- Method Adopted for adding Cellulose fibre to the mix:-The dry blending method were adopted, in dry process cellulose fibre (on loose bases) is added to hot aggregates and mixed thoroughly. Then bitumen is added to the mix and mix to get uniform mix, this is placed in Marshall Mould.



4. PARAMETERS USED FOR CALCULATION:

Maximum Spesific Gravity

S.No.	Binder Content %	Fibre Content %	Maximum Specific Gravity(GMM)
1	5.46	0.0	2.570
2	5.43	0.3	2.571
3	5.45	0.5	2.570

PROPERTIES ANALYSIS:-

MARSHALL TEST AT 60^0C FOR 30 MINUTS

Marshall Properties	Without fibre	With 0.3% of cellulose fibre	With 0.5% of cellulose fibre
Bitumen Content (%)	5.46	5.43	5.45
GMB (gm/cc)	2.444	2.449	2.453
GMM(gm/cc)	2.570	2.571	2.570
Stability (N)	1213	1234	1296
Flow (mm)	3.00	3.10	3.07
Air Voids (%)	4.90	4.75	4.55
VMA (%)	17.48	17.29	17.17
VFB (%)	71.95	72.53	73.49

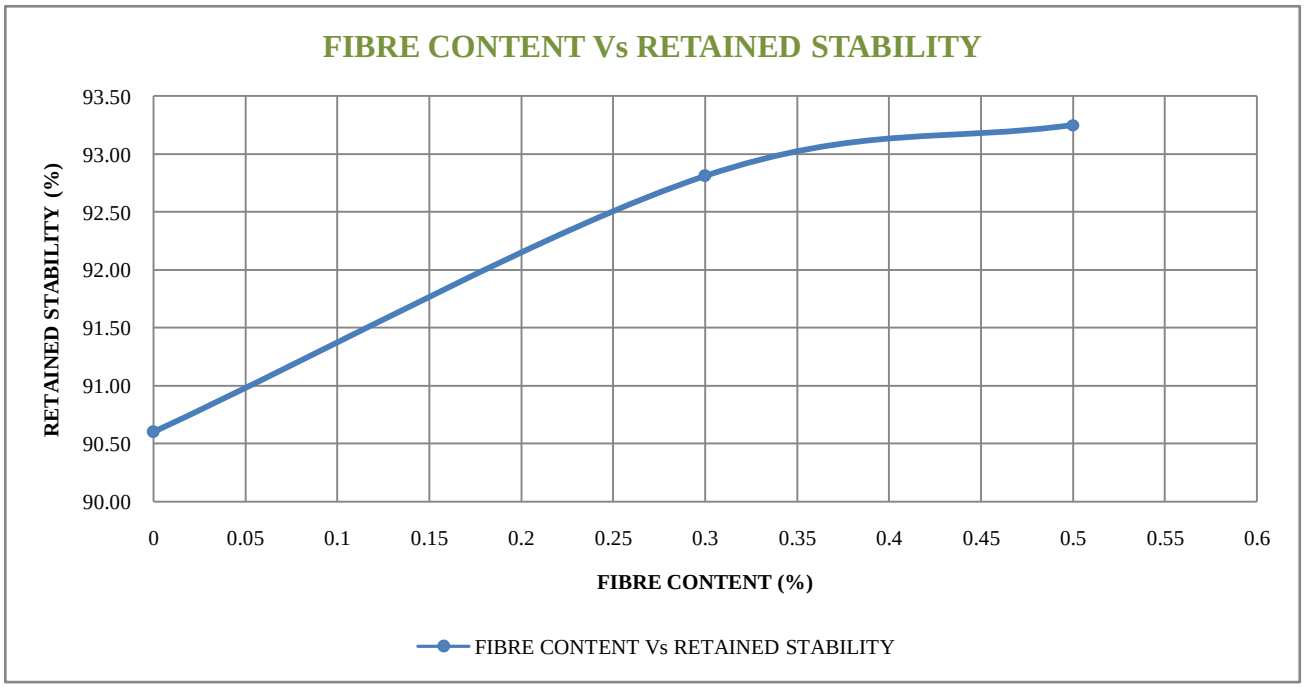
MARSHALL TEST DATA AT 60 ^{0}C FOR 24 HOURS

Marshall Properties	Without fibre	With 0.3% of cellulose fibre	With 0.5% of cellulose fibre
Bitumen Content (%)	5.46	5.43	5.45
GMB (gm/cc)	2.444	2.450	2.454
GMM(gm/cc)	2.570	2.570	2.570
Stability (N)	1099	1145	1208
Flow (mm)	3.23	3.30	3.20
Air Voids (%)	4.89	4.71	4.52
VMA (%)	17.50	17.32	17.19
VFB (%)	72.07	72.79	73.67

RETAINED STABILITY FOR BITUMIOUS CONCRETE

S. NO.	OPTIMUM BITUMEN CONTENT (%)	FIBRE CONTENT (%)	STABILITY		RETAINED STABILITY (%)
			AT 60^{O}C 30 MINUTS	AT 60^{O}C 24 HOURS	
1	5.46	0.0	1213	1099	90.60
2	5.43	0.3	1234	1145	92.81
3	5.45	0.5	1296	1208	93.25

Fig-2



5. CONCLUSION

In the present study, the important was to add the cellulose fibre to bituminous concrete (BC) Mix And To Evaluate the various mix properties like Marshall Stability, Flow Vakue,Bulk density, Void in the mix and VFB. Also the effect of soaking condition of the mix was investigates. There are decreases in Stability value in water sensivity test result, unsoaked specimens show high stability value but soaked specimens showed a decreasing stability value.

Hence there is an increase in retained stability with addition of 0.5% cellulose fibre and found higher stability compared to without fibre bituminous concrete.

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