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CONTRIBUTION OF POLYPROPYLENE FIBERS IN MODIFICATION OF VG 30 BITUMINOUS MIX

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ABSTRACT

Road transportation sector plays a pivotal role in accessing the growth of any country. In developing nations like India, where the traffic development and axle loading is developing at logarithmic scale, weakening of roadways is quick before their future on account of adaptable flexible pavement. The researchers and designers are continually attempting to enhance the execution of bituminous mixtures. In this concentrate, at first bituminous mixtures samples were readied at the ideal bitumen content. To the acquired bitumen content polypropylene fibers in extent of 4%, 5% and 6% are added to assess the volumetric properties of Marshall Mix design. It was observed for fiber-reinforced specimens that the Marshall Stability values increased and flow values reduced in a recognizable way. The change of the properties of bituminous mixture shows the constructive outcome of polypropylene fibers. In this manner, it is presumed that the utilization of polypropylene fibers changes the attributes of bituminous mixtures in an exceptionally helpful manner.

KEYWORDS: Marshall Stability, Voids in Mineral Aggregates, Polypropylene fibre, Percentage air voids.

INTRODUCTION

A decent roadway framework is a fundamental segment of a strong and stable economy for a developing nation like India. Bituminous Concrete (BC), a blend of bitumen and aggregate is a broadly utilized material for asphalt development. As the present day interstate transportation has fast, high traffic activity, substantial load and channelized traffic movement, bituminous asphalts roads are subjected to different sorts of distresses. Utilization of changed bitumen with added substances like polypropylene fibers are picking up fame as method for controlling asphalt distresses. Improvement of polypropylene fibers as modifiers has prompted propelled characteristics known for its great procedure ability, low cost, vital binding property, low density and control of properties of materials at submicron level.

In this paper, VG 30 bituminous mix design with utilization of 12mm length polypropylene fiber with 4%, 5% and 6% by weight of bituminous binders and without it is concentrated on to decide the result of it as volumetric properties at the best bitumen content.

MATERIALS AND METHODS

MATERIALS:

For the laboratory study, crushed Quartzite aggregate of sizes 20 mm, 10 mm and stone dust were used and tested as per IS Standards for sufficient strength, hardness, toughness were chosen, keeping in view the availability and economic consideration. The results of tests performed on aggregates for the study are shown in Table 1 as per codal provision and limits as per the specifications of Ministry of Road Transport and Highways **Table: 500-8 for Bituminous Concrete.** The MoRTH specification also states that either of one tests is needed i.e. Aggregate Impact Value test or Los Angeles Abrasion test, therefore in the present research only Aggregate Impact Value test has been done. Bitumen is a thermoplastic material and its firmness is subject to temperature. Higher is the evaluation of bitumen, the stiffer the bitumen. For the study VG-30 evaluation bitumen is acquired from IOCL, Vadodara and was used and tested as per Indian Standards which is shown in Table 2. Aggregate grading has been done as per the requirements of the Ministry of Road Transport and Highways (MoRTH, 2004) specifications and a middle value is selected for preparing mix design for BC grade-I which is shown in Fig-1

Table 1: Physical Requirements for Coarse Aggregate for Bituminous Concrete (As Per MoRTH Table: 500-8)

Sr. No.	Properties	Test Conducted	Specification	Test Result
1	Cleanliness (dust)	Grain size analysis	Max 5 % passing 0.075 IS Sieve	For 19 mm= 0.52% For 10 mm= 0.77%
2	Particle shape	Flakiness & Elongation Indices (Combined)	35% Max	34.45
3	Strength	Aggregate Impact Value(AIV)	Max. 30%	13.93%
4	Water Absorption	Water Absorption	2 % Max	1.080
5	Stripping	Coating and Stripping Bitumen Aggregates	Min. Retained Coating 95%	96.00
6	Durability	Sodium sulphate	Max 12 %	0.62%
		Magnesium Sulphate	Max 18 %	0.75%

Table 2: Physical Requirements for VG 30 grade bitumen for Bituminous Concrete

Serial No.	Test	Test Readings	VG 30 (IS: 73- 2013)	Test Method
1	Ductility test	44 cm	min 40	IS: 1208 – 1978
2	Penetration Test	55 mm	min 45	IS: 1203- 1978
3	Softening Point	50 °C	min 47 °C	IS: 1205- 1978
4	Specific Gravity	1.05	0.97-1.20	IS: 1202- 1978
5	Absolute Viscosity at 60 (C°)	2420	2 400-3 600	IS: 1206 (part 2)

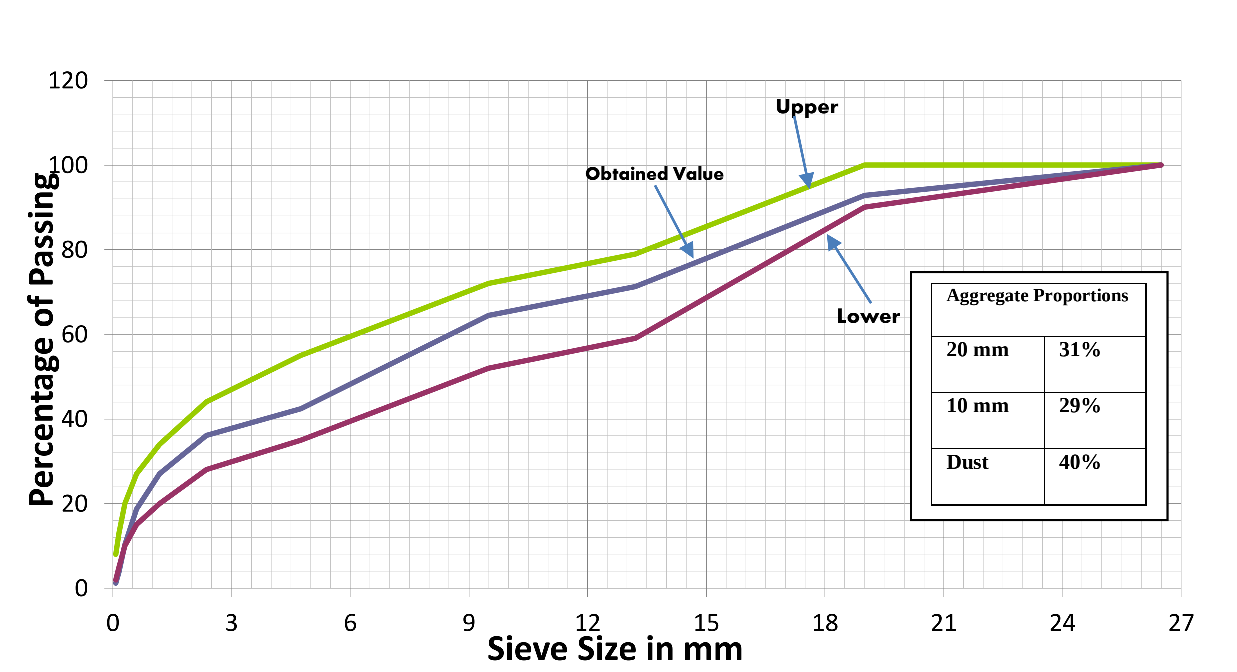


Figure 1: Aggregate gradation of bituminous concrete mix grade 1

OUTLINE OF BITUMINOUS CONCRETE (GRADING 1) MIX:

Marshall Method as per Asphalt Institute Manual (MS 2, 1997) of mix design was done for this study. The Marshall Test specimens were arranged by including 4.5, 5.0, 5.5, 6.0, 6.5 every percent of bitumen by weight of aggregates. Compaction is carried out by giving 75 blows each one side according to MS-2 of the specimen. Satisfying the standard criteria's the specimens are arranged and tried according to the procurements of codal practice to focus. The ideal bitumen substance is worked out as 5.50% by weight of aggregate. The properties of the Marshall design and limits for bituminous concrete grade 1 as per MoRTH specifications are given in Table 3.

Table3: Summary of VG 30 grade Bituminous Concrete Marshall Mix Design for Grade 1

% Bit by wt. of mix sample	Bulk Sp. Gr Of Volume Gm/CC (GMB)	%Air voids (VA)	% voids in mineral Agg. (VMA)	% Voids filled with bitumen (VFB) K=J-I/J*100	Stability (KN)	Flow mm
4.50	2.35	7.94	20.85	61.91	20.04	5.00
5.00	2.41	4.96	19.32	74.34	23.10	5.60
5.50	2.53	4.01	16.16	72.62	32.37	3.83

6.00	2.49	5.53	17.59	68.54	27.66	4.70
6.50	2.42	7.93	20.12	60.55	23.27	4.20
Limits (MoRTH Table 500:11)	--	3 to 5 %	Min 14 %	65 to 75 %	Min 12 KN	2.5 to 4

Reinforcement of VG 30 Bituminous Mix Grade 1 Using Polyester Fiber:
The raw material of polypropylene is gotten from monomeric C3H6 which is simply hydrocarbon. The specific gravity is 0.91, external appearance of fibers is white, C , diameter of fibers is 30 – 35 microns, tensile strength is 0.67 KN/mm^2, young modulus is 4.0 KN/mm^2, absorbency is <0.1 % and fiber cut length is 12mm. Its method of polymerization, its high atomic weight and the way it is handled into fibers concrete to give polypropylene filaments extremely valuable properties as clarified underneath:

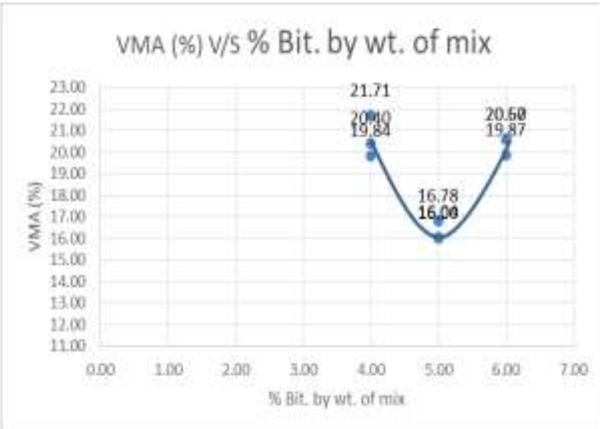
There is a sterically customary nuclear course of action in the polymer atom and high crystalline. Chemical inertness makes the filaments impervious to most chemicals. The water interest is nil for polypropylene filaments and the introduction leaves the film feeble in the horizontal direction which encourages fibrillations. The bituminous concrete network can in this way enter in the cross section structure between the individual fibrils and make a mechanical bond in the middle of lattice.

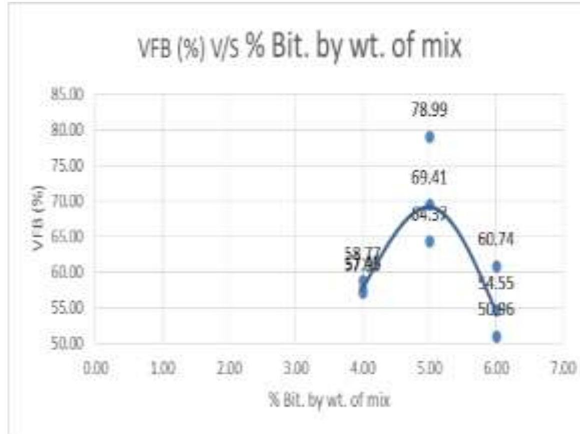
RESULTS AND DISCUSSION

As the polyester fibers was not uniformly dispersing in the binder as the melting point is greater then 250°C for polyester fibers respectively. The mixing temperature of asphalt is around 150 °C - 160 °C so the fibers were not blended with the binder but are added to the mix. An automatic mixer was used to mix the fibers for five minutes known as dry mixing.
The volumetric analysis of various parameters in asphalt mix design at varying asphalt content and doses of fibers were performed to arrive at Polyester fiber to binder ratio as the same was adopted for finding out Optimum Binder Content (OBC). Marshall Samples were made using polyesters fibers and also calculated for various tests for volumetric analysis.

Table3: Summary of VG 30 grade Bituminous Concrete Marshall Mix Design with Polypropylene fibers for Grade 1

Marshal Mix Design Test Values						
Bitumen / fiber content by wt of total mix (%)	Stability KN	Unit weight in gm/cc	Flow in mm	Air Voids in %	VMA in %	VFB in %
5.5 %	32.37	467.00	3.83	4.01	15.80	74.64
4 % fibre	35.42	488.67	5.5	7.66	19.73	61.14
5 % fibre	55.35	468.33	3.67	4.71	16.27	70.92



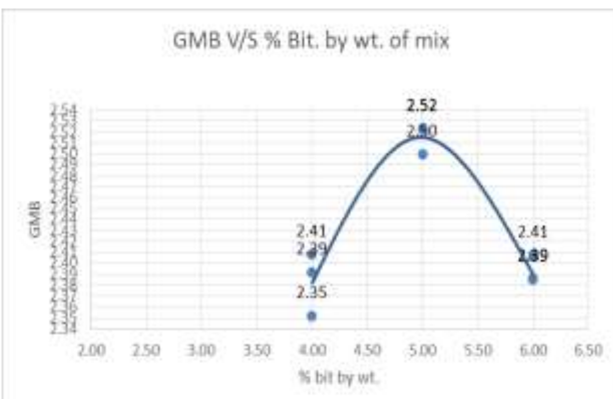


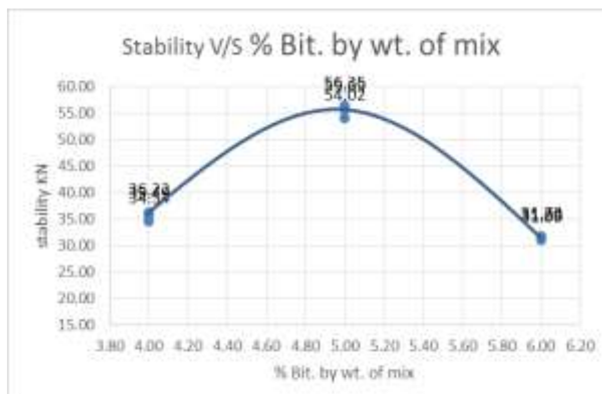
6 % fibre	35.39	486.67	4.86	8.40	19.75	57.42
Limits	Min 12 KN	-	2.5 to 4	3 to 5 %	Min 14%	65 to 75 %

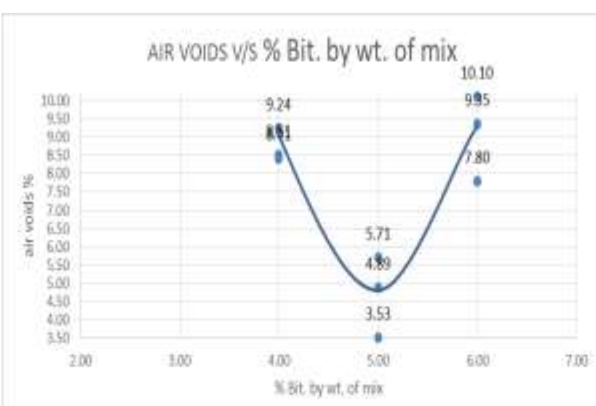
IRC : SP: 053, Page No. 9

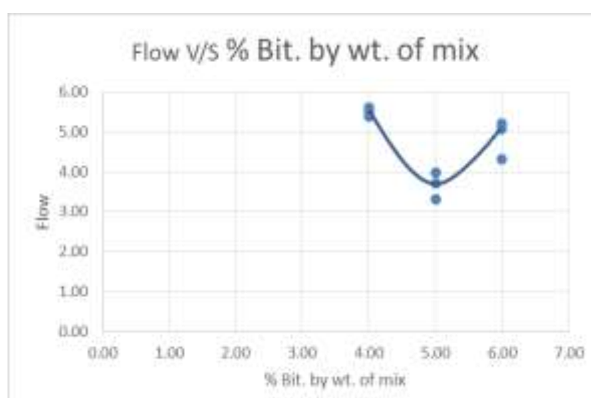
CONCLUSION

Scientists and engineers are constantly trying to improve the performance of asphalt mixtures by using various methods including asphalt binder modification. In this study, therefore, polypropylene fibres were selected as fibre modifier to lead to the following conclusions:









Addition of PP fibres showed an increase in Marshall Stability as well as increase in percent of air void is noted while decreases in flow property is seen considerably. As a result, the data show that PP modified asphalt-concrete samples can be considered as high performance asphalt-concrete mixtures. Increasing the percent of air void, in modified treatments, they are useful for hot regions where bleeding and flushing are critical distresses.

Finally, the study concluded that 5.0% of polypropylene of 12 mm length is better than other percentages used in the experiment, because the air void increased to 17.45% at this percentage.

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