iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** IV **Month of publication:** April 2017

DOI:

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Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Refitting Cellulose Fibers for Enhancing Value of Dense Bituminous Mixes Design

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Abstract: ***Ascend in infrastructure improvement in developing economies has brought about moving interest for bitumen over the most recent couple of years. Highway broadening and reconstructing existing resources are some key territories where item need is required to increment always. This requires the request of bituminous blend which can maintain steadily changing vehicle loads in the changing environmental condition. In this paper an endeavor is made to decide the impact of cellulose fibers in thick bituminous blend grade 2 outlines. The result of Marshall Mix configuration satisfies the perfect state of the codal arrangement too which can be useful to asphalt designers and highway contractors.***
Keywords: Marshall Stability, Voids in Mineral Aggregates, Cellulose fiber, Percentage air voids, VG 30 Bitumen

I. INTRODUCTION

Upgraded use on the foundation advancement and road organize development is driving the interest for bitumen, a semi-strong hydrocarbon item created from substantial unrefined petroleum amid the refining procedure and broadly utilized as a part of road development, in India. With road framework of 3.3 million km, India has the second biggest road organize on the planet, second to USA. Bitumen turns into a vital parameter in arranging and execution of road development extends in India. Elements, for example, a move popular towards esteem included bitumen items are there. An exact bituminous mix configuration may spare extensive speculation fetched and in addition support cost to enhance execution of roadway asphalt. By and by, the augmentation in movement power because of fast development of creating nation and the significant variety in day by day mean temperature set us in a place to consider some discretionary courses for the change of the properties of bituminous mix by applying some important conduct alterations which might satisfy both the quality and efficient viewpoints. In present review it is utilized fiber strengthened bituminous mix utilizing cellulose fiber as an added substance which can satisfy both perspectives.

II. EXPERIMENTAL MATERIALS

The study materials include aggregate chosen which have good and sufficient strength, hardness, toughness, water absorption values with grain size analysis fulfilling the ideal conditions of MoRTH 500-10 produced higher Stability. The results of aggregates tests for the study are shown in Table 1 as per codal provision with limits for DBM grade 2.

TABLE I : Physical Requirements for Coarse Aggregate For Dense Bituminous Macadam (As Per Morth Table : 500-10)

Sr. No.	Property	Test	Specification	Test Result
1	Cleanliness (dust)	Grain size analysis	Max 5 % passing 0.075 IS-Sieve	28mm-22mm 0.55%
				22mm-14mm 0.70%
				14mm-8mm 0.92%
2	Particle shape	Flakiness & Elongation Indices (Combined)	35% Max	27.79%
3	Strength	Aggregate Impact Value(AIV)	27 % Max	12.08%
4	Durability	Soundness		
		Magnesium Sulphate	Max 18 %	10.5%
		Sodium sulphate	Max 12 %	8.0 %
5	Water absorption value	Water absorption value	2 % Max	1.40%

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Volume 5 Issue IV, April 2017
ISSN: 2321-9653
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Sieve investigation comprising of sieving a deliberate amount of material through progressively littler sieves. The heaviness of material held on each sieves is weighted and communicated as a rate of the aggregate weight of the specimen. In this review a weight of 5 kg from each part of total is taken and afterward gone through DBM Grade 2 implied sieves. Sieves investigation mixing procedure is done by Trial and error technique, keeping in mind the end goal to get the required sum by rate of every part for the ideal mix design. The gradation curve as per the MoRTH specifications for preparing mix design for DBM grade-2 is shown in Fig-1.

Type of aggregate	28-22 mm	22-14 mm	14-8 mm	8 mm down	rock filler
Aggregate (%)	17	18	22	40	3

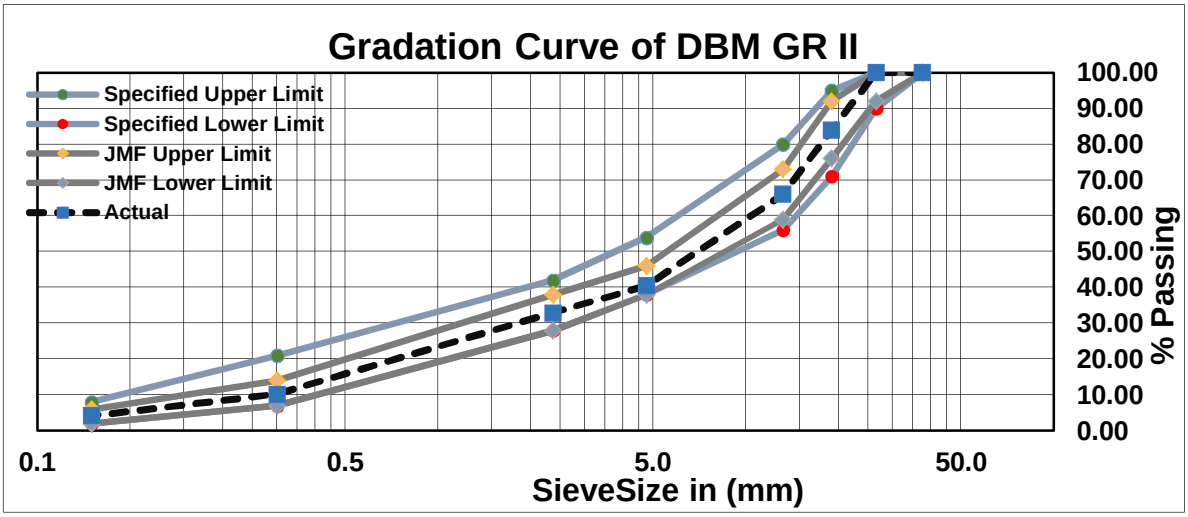


Fig.1: Aggregate gradation of DBM grade-2

Cellulose Fibre - Cellulose Fiber is utilized as a stabilizer added substance. The measurements rate as cellulose Fiber is 0.3% to 0.5% by the weight (on Loose Fiber premise) of the aggregate blend. In the present investigation it is proposed to utilize cellulose fiber in the bituminous blend. The cellulose filaments are supply from fabricate just for research work. The physical and chemical properties are given by the make are recorded beneath in Table 2.

Table 2: Properties of cellulose fibre

Sr no.	Discription	Properties
1	Cellulose content	Approx.80%
2	Oxide Ash	Approx.15%
3	pH-value	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

Bitumen: - Bitumen is a material which is a repercussion of oil refining process. It is very gooey at temperature over 100°C and is strong at room temperature. Thickness review bitumen VG 30 utilized as a cover in this exploration for arrangement of blend. The physical prerequisites explored in the research center are as appeared in Table 3.

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Volume 5 Issue IV, April 2017
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TABLE 3: Physical Requirements for VG 30 grade bitumen for DBM Grade-2

Serial No.	Test	Test Readings	VG 30 (IS: 73- 2013)	Test Method
1	Ductility test	58 cm	min 40	IS: 1208 – 1978
2	Penetration Test	52 mm	min 45	IS: 1203- 1978
3	Softening Point	52.55 °C	min 47 °C	IS: 1205- 1978
4	Specific Gravity	1.05	0.97-1.20	IS: 1202- 1978
5	Stripping Value	96%	min 95%	IS:6241-1971
6	Absolute Viscosity at 60 (C°)	2483	2 400-3600	IS: 1206 (part 2)

III. MARSHALL MIX DESIGN FOR DBM-II WITHOUT CELLULOSE FIBRES

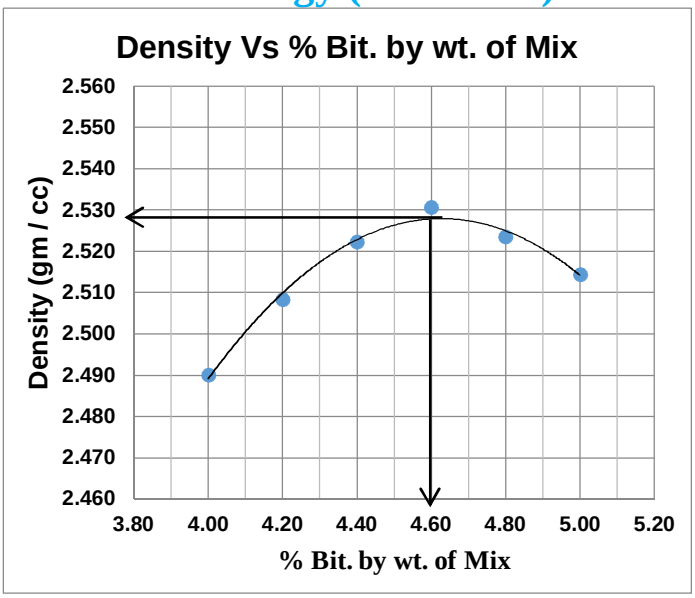
Properties of total and VG 30 bitumen is completed deductively in the research facility, likewise degree is worked out according to codal arrangement. Marshall Method according to Asphalt Institute Manual (MS 2, 1997) of blend configuration was accomplished for this review. The Marshall Test examples were organized by including 4.0, 4.2, 4.4, 4.6, 4.8, 5.0 each percent of bitumen by weight of blend. Stability Flow investigation and Volumetric examination was completed and test values got are plotted graphically as shown in figure 2. The OBC is observed to be 4.62% by weight of blend. The properties of the Marshall Plan and points of confinement for DBM review 2 according to MoRTH details are given in Table 4.

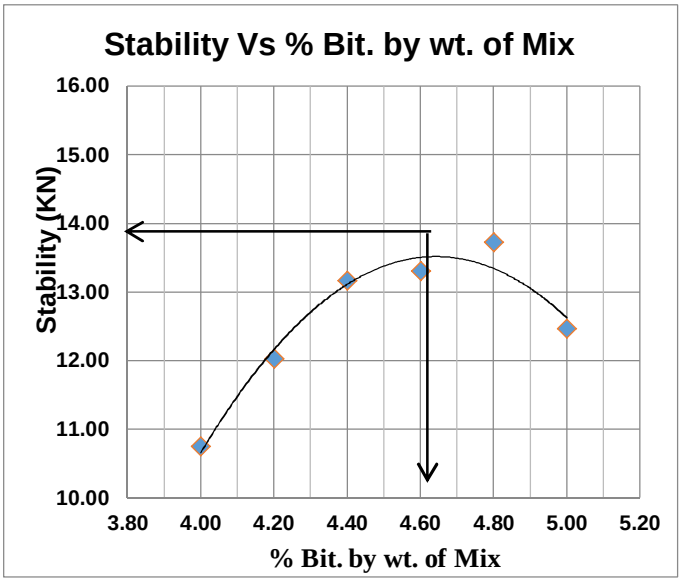
TABLE 4: Summary of VG 30 grade Bituminous Mix Design for DBM Grade 2

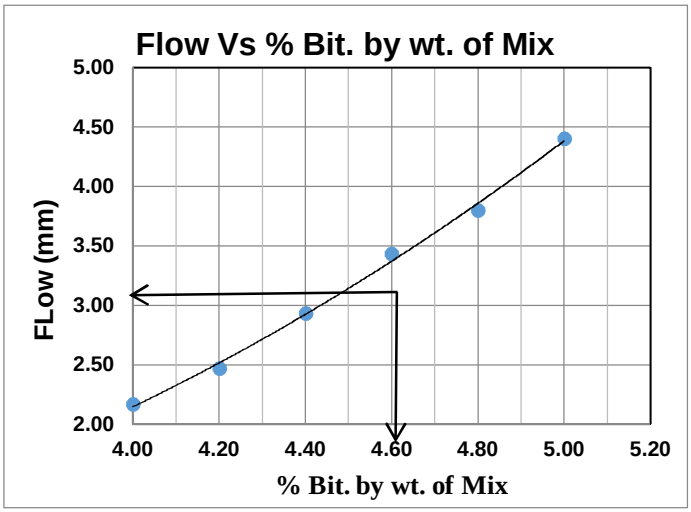
% Bit. By Weight of Mix	Bulk Sp. Gr. (Gmb)	Stability (KN)	Voids in Mineral Agg. VMA (%)	Voids Filled with Bitumen VFB(%)	Flow (mm)	Air Voids VA (%)
4.00	2.490	10.75	15.29	48.84	2.17	7.82
4.20	2.508	12.03	14.85	56.77	2.47	6.42
4.40	2.522	13.16	14.56	63.05	2.93	5.38
4.60	2.531	13.30	14.45	68.22	3.43	4.59
4.80	2.523	13.72	14.87	72.15	3.80	4.14
5.00	2.514	12.46	15.36	74.41	4.40	3.93
Limits(MoRTH Table-500 :11)	.....	Min 9 kN	12-15	65-75	2-4	3-5

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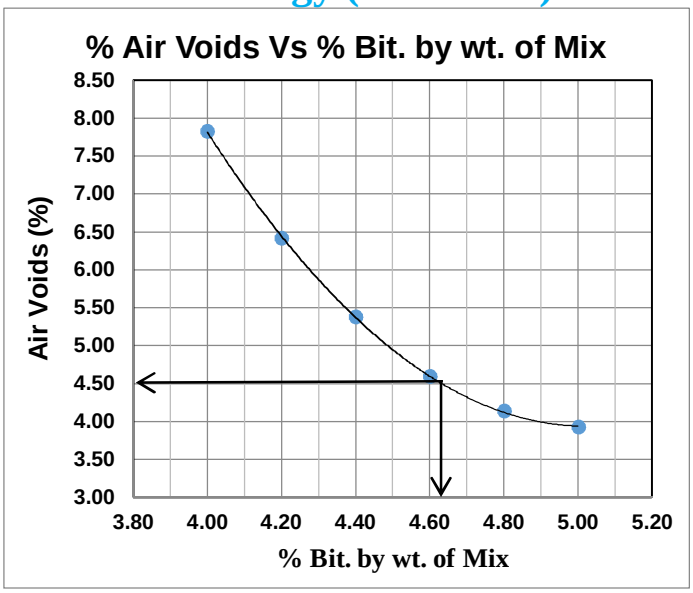


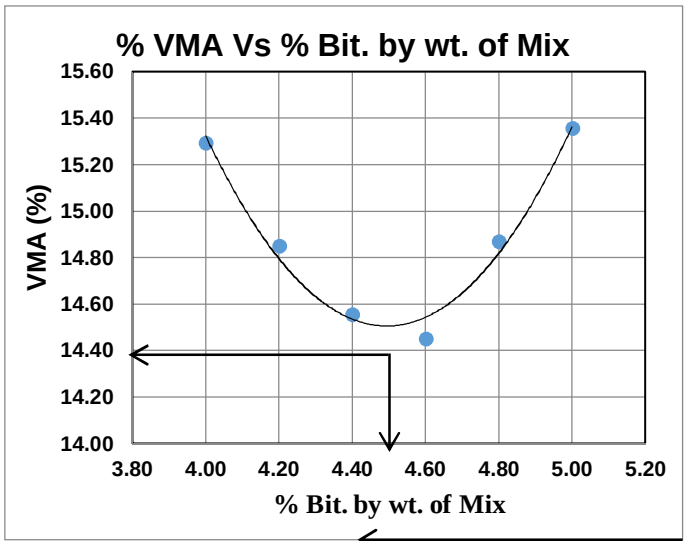




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Volume 5 Issue IV, April 2017
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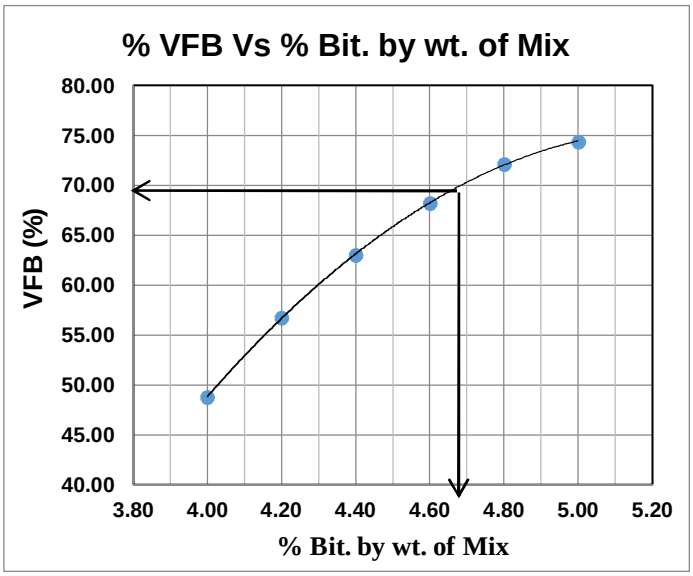


Fig. 2: Marshal graphical plots of Bituminous mix for DBM grade -2 without fibres

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IV. MARSHALL MIXES DESIGN FOR DBM-II WITH CELLULOSE FIBRES

The volumetric examination of different parameters in bituminous blend outlines at 4.62 OBC with and without cellulose filaments were performed. Marshall Samples were made utilizing Cellulose filaments and furthermore computed for different tests for volumetric investigation.

TABLE5: Summary of VG 30 grade Bituminous Mix Design with Glass fibres for DBM Grade 2

Bitumen/Fibre content(%) by wt. of total mix	Bulk Sp. Gr. (Gmb)	Stability (KN)	Voids in Mineral Agg. VMA (%)	Voids Filled with Bitumen VFB (%)	Flow (mm)	Air Voids VA (%)
4.62	2.529	12.88	14.52	67.62	3.47	4.7
0.30	2.533	13.69	14.57	68.69	3.34	4.90
0.40	2.544	15.53	14.19	70.84	3.12	4.53
0.50	2.550	14.78	13.99	72.02	2.78	5.57
Limits (MoRTH Table-500 :11)	----	Min 9 kN	12 to 15	65-75	2 to 4	3 to 5

V. CONCLUSIONS

Based on the results and discussion of experimental investigation carried out on mixes following conclusion are drawn based on the effect of cellulose fibers in mix at 4.62 OBC. The best value noted is with 0.40 % cellulose fiber. The key findings are as shown below:

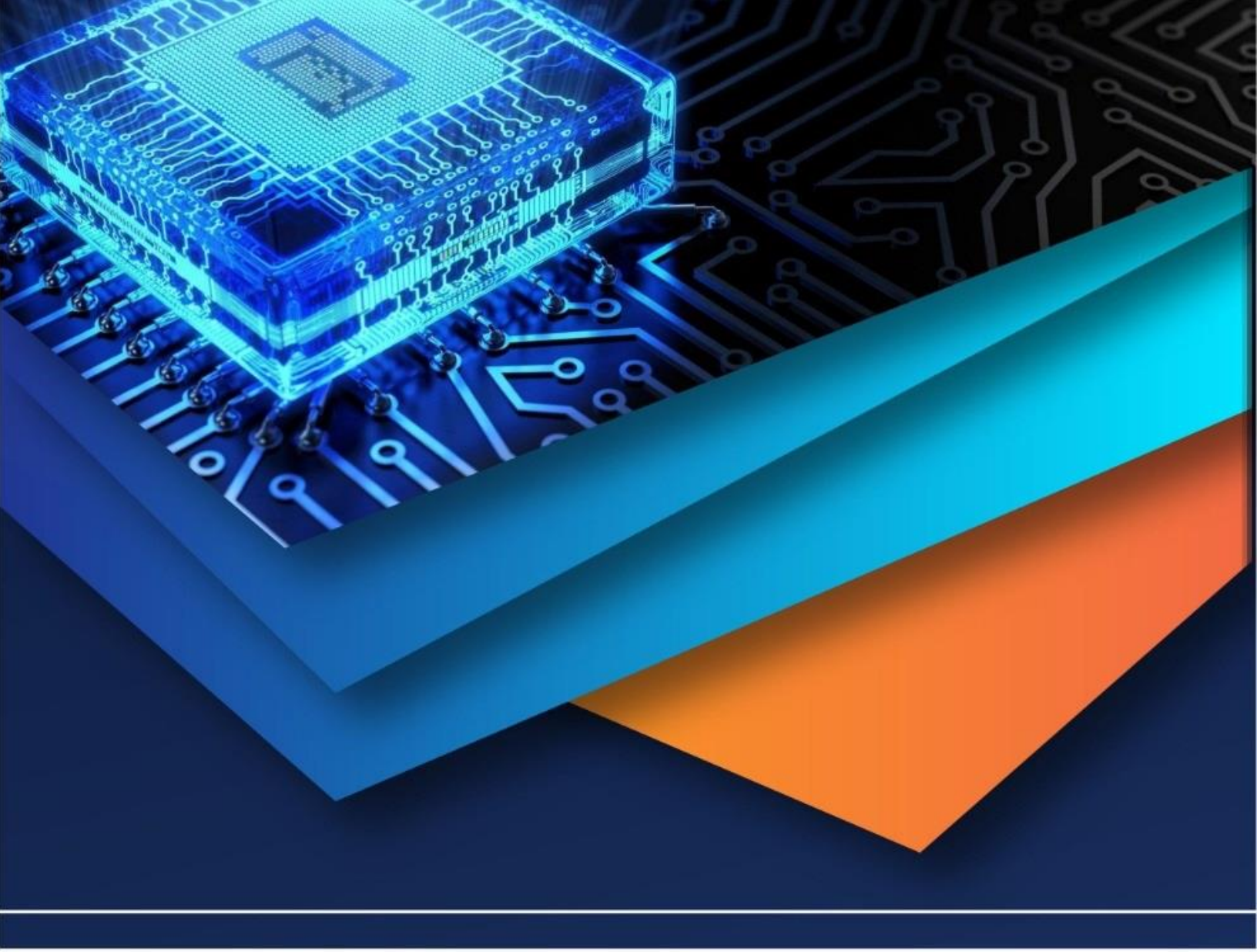
A. Marshall stability value increases with increase cellulose fiber content and further addition of decreases.
B. It is observed that with the flow values goes on decreasing with the addition of fibers but is within permissible limit.
C. It is observed that bulk specific gravity increases with increase in fiber content.
D. The observation recorded for voids filled with bitumen indicates that it is in increasing trend up to 0.4 % fibers and then a downward trend is noted.
E. Due to addition of fibers the rising trend is seen in case of air voids but downward trend is noted afterwards. At 0.4% fibers with 4.62 % OBC it satisfies the conditions.
F. VMA trend is initially a rising one up to 0.4% fiber then a decline pattern is seen.

It can be suggested that addition of 0.4% cellulose fibers with 4.62% OBC, the DBM Grade 2 mix can be fruitful to pavement designers and highway contractors too.

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