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Experimental Study on Effect of Incorporation of Polypropylene Fiber in Porous Bituminous Mix

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Abstract - *Porous bituminous pavement is an effective way to collect the run-off from the surrounding area and recharging the ground water table. Porous pavements have relatively lower strength compared to the standard pavements which restrict their use in heavy traffic areas leading their limited use in recreational areas, parking lots, low traffic roads, etc. Therefore, the pavements need to be strengthened and the study aims to investigate the performance of porous pavement by incorporating polypropylene fiber in the extent of 1.5%, 2%, and 2.5% to assess the Marshall mix design parameters and Permeability.*

Key Words: Porous bituminous pavement, Polypropylene fiber, Marshall mix design parameters.

1. INTRODUCTION

In the Porous bituminous pavements, the top 50-100 mm layer is specially designed so as to make it porous by increasing the %air voids. Porous bituminous pavement is an effective way to collect the run-off from the surrounding area and recharging the ground water table. This type of bituminous pavement make the wearing course porous and hence we can allow rain water to infiltrate through this layer which makes the pavement permeable and further this water can be collected.

This type of pavement can be used in areas where the ground water is depleting at a greater rate. The water will infiltrate through the pavement and with the help of this discharging beds and stone pitching, the collected water shall slowly infiltrate into the water tables, as a result the areas having low underground water level can be rejuvenated resulting in the increase in ground water table The only limitation of these type of pavements is that the provide lower strength compared to the standard bituminous pavement pavements which restrict their use in heavy traffic areas leading their limited use in recreational areas, parking lots, low traffic roads, etc. Therefore, the pavements need to be strengthened and the study focuses on effect of addition of polypropylene fiber in the porous mix in the extent of 1.5%, 2%, and 2.5% on the Marshall mix design parameters and Permeability.

1.1 Advantages of Porous Bituminous Pavements

- Reduction in contamination of water runoff and sediment loading.
- Recharging of groundwater supplies.
- Low-impact development and cost-effective technology for storm water management by reducing need for drainage structures.
- Construction is economical.
- Storm water runoff volume reduces.

2. MATERIAL AND METHOD

2.1 The materials used for the experiment are

a) Bitumen
b) Aggregates
c) Polypropylene Fibers

2.2 Method Adopted

In this experimentation by using a trial gradation of Porous mix, a comparative study of Marshall Mix Design parameters and permeability before and after the addition of polypropylene fiber is carried out.

2.2.1 Overview

The wet mix design procedure is used to determine the optimum binder content. The mix design procedure can be done in various ways which vary in size of test specimen, degree of compaction, and other test specifications. The most popular Marshall method of mix design is discussed below.

2.2.2 Marshall mix design

The Marshall mix design parameters i.e. stability and flow test provides the performance prediction measure for the Marshall mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute. Load is applied to the specimen till failure, and the maximum load is designated as stability. During the loading, an attached

dial gauge measures the specimen's plastic flow (deformation) due to the loading. The flow value is recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load is recorded. The important steps involved in marshal mix design are summarized next.

2.2.3 Specimen preparation

Approximately 1250gm of aggregates and filler is heated to a temperature of 170−190°C. Bitumen is heated to a temperature of 115 – 125°C with the first trial percentage of bitumen (say 3.5 or 4% by weight of the mineral aggregates). The heated aggregates and bitumen are thoroughly mixed at a temperature of 150 – 160°C. The mix is placed in a preheated mould and compacted by a rammer with 75 blows on either side at temperature of 130°C to 140°C. Vary the bitumen content in the next trial by +0.5% and repeat the above procedure. Number of trials is predetermined.

2.3.4 Gradation

The trial gradation adopted is as follows

Table -1: Trial Gradation

IS sieve size (mm)	Cumulative Passing %
19	100
12.5	85
9.5	70
4.75	15
2.36	8
0.075	3
Pan	0

3. RESULTS AND DISCUSSION

Table -2: Results for trial gradation without addition of polypropylene fiber

Sr. No.	Bitumen content %	Air Voids %	Stability (kN)	Flow (mm)
1	4	12.390	3.27	1.67
2	4.5	12.067	3.60	1.85
3	**5**	11.431	4.22	1.97
4	5.5	10.995	4.26	2.01
5	6	9.287	3.25	2.02

Average permeability value= 3.10 X 10^{-3}cm/sec.

From the above results Optimum Bitumen Content is 5% as the stability is more compared to the flow value.

Hence three more samples for the above stated trial gradation are prepared by addition of polypropylene fiber in the extent of 1.5%, 2%, and 2.5% of the total weight of mix.

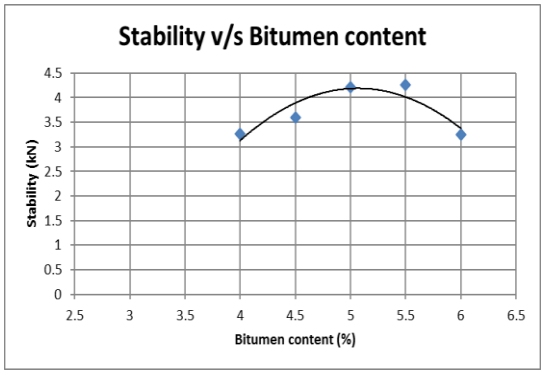

Chart -1: Stability v/s Bitumen content

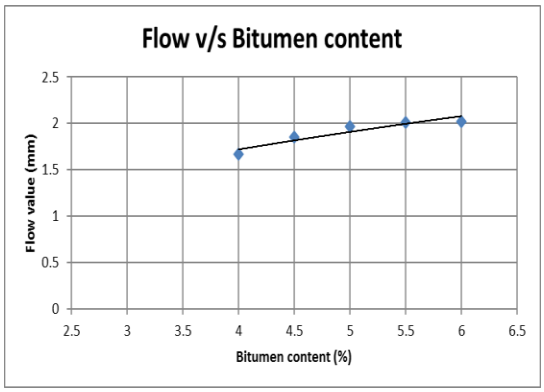

Chart -2: Flow v/s Bitumen content

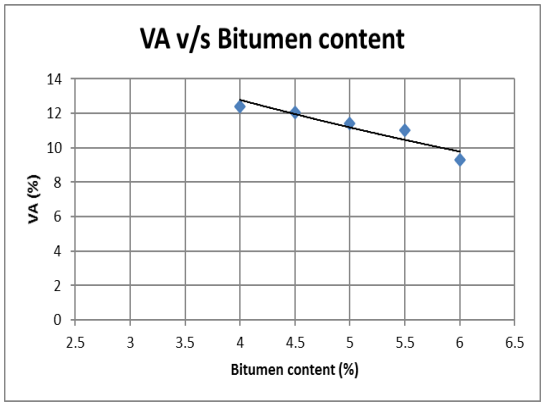

Chart -3: VA v/s Bitumen content

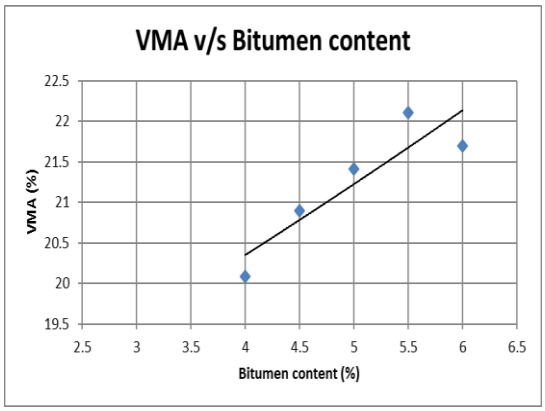

Chart -4: VMA v/s Bitumen content

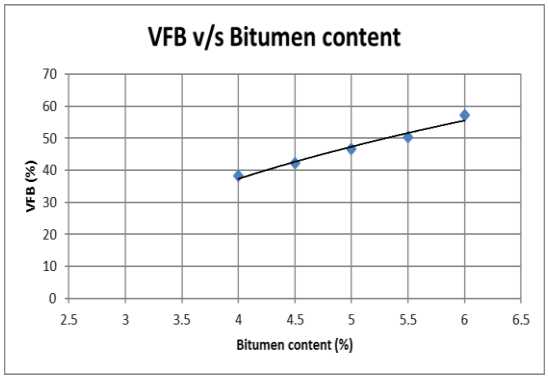

Chart -5: VFB v/s Bitumen content

Table -3: Results for trial gradation with addition of polypropylene fiber

% Polypropylene fiber	1.5	2	2.5
Stability (kN)	3.84	6.46	4.85
Air void (%)	10.13	9.86	9.55
Flow (mm)	0.14	0.13	0.22

Average permeability value= 2.96 X 10^{-3}cm/sec.

4. CONCLUSIONS

1. Due to the incorporation of polypropylene fiber to the porous mix a significant increase in the stability is obtained. The stability for porous mix without addition of fiber was 4.22kN whereas for the mixture with addition of 2% polypropylene fiber the stability value increased to 6.46 kN.

2. The recognizable reduction in the flow value was also observed. The average flow value for porous mix without fiber was 1.90mm whereas for the mixture with addition of fiber the average flow value reduced to 0.16mm.

3. The addition of fiber increased the overall strength but the % of air voids reduced hence a small reduction in permeability value was observed.

5. ACKNOWLEDGEMENT

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