FRACTIONAL REPLACEMENT OF BITUMEN WITH CRMB & PMB AND COMPARING THEIR PERFORMANCE -A REVIEW

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Abstract-The project aims at the utilization of waste rubber or plastics in road construction as these substances are very hazardous for health and deteriorate the environmental conditions at large scale. It was estimated that there was a rise of 2.85 million tones rise in diseases on human health due to these waste products. The project aims to study the performance of different materials which may help in utilizing the waste to improve the quality of roads and make them stable , durable and long lasting. In this study, the bitumen is partially replaced with PMB & CRMB and their performance evaluation were carried out and the results were compared. It was shown that the utilization of CRMB & PMB proved to be more efficient and stable.

1. INTRODUCTION

Road network is the mode of transportation which serves as the feeder system as it is the nearest to the people. So the roads are to be maintained in good condition. The quality of roads depends on materials used for construction [1]. Due to urbanization, industrialization and large increase of populations, accompanied with uplift in the standard of living, road vehicle numbers have increased dramatically which, consequently, has resulted in a lot of end-of-use tires every year. The estimated number of tires manufactured in the world per annum is about 1.5 billon tires [2].

Keeping in mind the need for bulk use of these solid wastes in India, it was thought expedient to test these materials and to develop specifications to enhance the use of waste tyres and plastic materials in road making in which higher economic returns may be possible. The necessary specifications will be formulated and attempts are to be made to maximize the use of solid wastes in different layers of the road pavement [3].

Each year approximately millions of tires are added to stockpiles, landfills or illegal dumps across the United States. The estimated number of accumulated tires is slightly over half a million. The large number of tires accumulated over the years and currently being generated creates a disposal problem in the rural areas [2]. Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. Also, cost of extracting good quality of natural material is increasing [4].

A common method to improve the quality of bitumen is by modifying the Engineering properties of bitumen by blending with organic synthetic polymers like rubber and plastics [5].

Post construction pavement performance studies are to be done for these waste materials for construction of low Volume roads with two major benefits [6]:

- It will help clear valuable land of huge dumps of wastes.
- It will also help to preserve the natural reserves of aggregates, thus protecting the environment. Rubber tyres are user friendly but not eco-friendly as they are non-biodegradable generally.

The main aim of this project is to be focus on using the available waste/recycled PMB & CRMB present in abundant which can be used economically and conveniently. The use of these materials as a road construction proves eco-friendly, economical and use of plastic will also give strength in the sub-base course of the pavement [7].

It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive. Therefore the life of the pavement surfacing using the modified bitumen is also expected to increase substantially in comparison to the use of ordinary bitumen [8].

CRMB- Crumb rubber is actually small pieces of waste tyre scrapped from light motor vehicles and whose disposal is a serious menace. The annual available capacity for procured tyres is retreading [9].

PMB- Plastic is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be molded into solid objects [10].

2. METHODS

2.1 Experimental Program

The Bituminous Concrete mix will be preparing using Marshall Stability Method of bitumen mix design. The BC will be prepared with conventional grades of Bitumen and adding various percentages of PMB and CRMB as mentioned below [10].

Table 2.1 Detail of Sample Constitution & % Constituents

S. No.	Sample Preparation	Sample Constitution	% of Constituent by weight of bitumen
1	Wet Process	Bitumen Mix	-

2	Dry Process	Bitumen + PMB	PMB: 3% PMB: 6% PMB: 9%
3	Wet Process	Bitumen + CRMB	CRMB: 8% CRMB: 10% CRMB: 12%

2.2 Marshall Stability Test

Before preparing the specimens for Marshall Test, it is required that following steps.

- Material proposed for use the gradation requirements of the project specifications.
- The blend combinations meet the gradation requirements of the project specifications.
- Therefore use in density and voids analysis the pulse specific gravity of all aggregate used in the blend and the specific gravity of asphalt are determined.

After this, the other parameters like Unit Weight (gm/cc), Specific Gravity of mix (Gmm), Air Voids (%), Voids in mineral aggregates (%), Voids filled with bitumen (%), etc. are calculated by derived formulas.

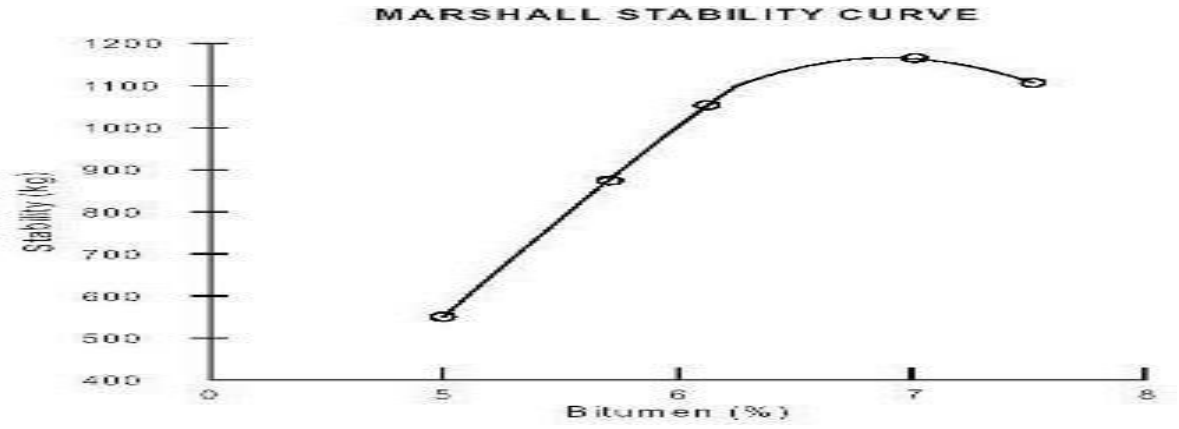
2.3 Specimen Preparation

According to IRC: 29-1988 1200gm of aggregates and filler is heated to a temperature of 175-190ºC. Bitumen is heated to a temperature of 121-125ºC 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 154-160ºC . The mix is placed in a preheated mould and compacted by a rammer with 50 blows on either side at temperature of 138-149ºC. The weight of mixed aggregates taken for the preparation of the specimen may be suitably altered to obtain a compacted thickness of 63.5+/-3 mm. Vary the bitumen content in the next trial by +0:5% and repeat the above procedure. Number of trials is predetermined.

Table 2.3 Marshal Mix Design Specification

Sl.No.	Test Property	Specified Value
1	Marshall stability, kg	340 (minimum)
2	Flow value, 0.25 mm units	8 - 17
3	Percent air voids in the mix vv %	3 - 5
4	Voids filled with bitumen VFB %	75 - 85

Then, Plot % of bitumen content on the X-axis and stability in kg on the Y-axis to get maximum Marshall Stability of the bitumen mix. A sample plot is given,



2.4 Tests on Bitumen

Table 2.4 Tests on Bitumen & their Results

S. No.	Laboratory Test	Reference	Inference
1	Penetration Test	IS: 1203-1978	Penetration Value: 30/40, 60/70, 80/100 (For Normal Climatic Conditions) Penetration Value: 180/200 (For colder Conditions)

2	Ductility Test	IS: 1208-1978	**penetration grade**	**Min. ductility value (cms)**
			Assam Petroleum A25	5
			A35	10
			A45	12
			A65, A90 and A200	15
			S35	50
			S45, S65 and S90	75
3	Softening Point Test	IS: 1205-1978	Higher softening point indicates lower temperature susceptibility	
4	Specific Gravity Test	IS: 1202-1978	0.97 to 1.02	
5	Viscosity Test	IS: 1206-1978	Orifice Size – 4 mm: Viscus-25 to 250 Orifice Size – 10 mm: Viscus-10 to 140	
6	Flash And Fire Point Test	IS: 1209-1978	minimum value of flash point – 175^0C	

2.5 Tests on CRMB

Table 2.5 Tests on CRMB & their Results

Sl. No.	Laboratory Test	Inference
1	Penetration Test	Penetration Value: 60/70
2	Ductility Test	100 cm
3	Softening Point Test	48-50^0C
4	Specific Gravity Test	1-1.15
5	Flash And Fire Point Test	minimum value of flash point – 300-325^0C

2.6 Tests on PMB

Table 2.6 Tests on PMB & their Results

Sl. No.	Laboratory Test	Inference
1	Penetration Test	Variation in 65 to 70 mm
2	Ductility Test	Variation in 35 to 70 cm
3	Softening Point Test	120-150^0C
4	Specific Gravity Test	0.91-1.4
5	Flash And Fire Point Test	minimum value of flash point – 240-320^0C

2.6 Tests on Aggregates

Table 2.6 Tests on Aggregates & their Results

Sl. No.	Laboratory Test	Reference	Inference
1	Crushing test	IS: 2386 part-IV	<10 - Strong Aggregate >35 – Weak Aggregate
2	Abrasion Test	IS: 2386 part IV	<40% - WBM base course <35% - Bituminous Concrete

3	Impact Test	IS: 2386 part IV	<30% - Wearing Coarse <35% - Bituminous Macadam = 40% - WBM
4	Shape Test 1. Flakiness Index 2. Elongation Index	IS: 2386 part-I IS: 2386 part-I	least dimension is <0.6 times their mean size greatest dimension (length) is 1.8 times their meandimension
5	Specific Gravity and Water Absorption test	IS: 2386 part-III	Specific Gravity: 2.5 to 2.9 Water Absorption: 0.1 to 2%

3. RESULTS & DISCUSSIONS

The use of Crumb Rubber in Flexible Pavements has a lot of advantages when compared to the disadvantages. The use of Warm mix bitumen has clearly shown that the cost can be significantly bought down by using CRMB & PMB over conventional bitumen pavements has shown that the load carried by CRMB pavements is higher than that of the conventional bituminous pavements and by adding crumb rubber to the bituminous pavements the waste tires which are used as landfill can be significantly bought down.
Likewise CRMB & PMB of Hot Mix Role in Flexible Pavements for a Sustainable Future. The fumes from hot mix asphalt are known to be potential health hazards, especially for the construction workers. Reduced temperature of the mix avoids this health hazard.

CONCLUSION

It can be seen that the modified bitumen showing better results compared to the normal bitumen. This method contributes for improved disposal of waste tyres and waste plastics. Decrease in penetration point, increases load – bearing capacity of the road. The Marshall Stability value is high hence increases life of the road. While using CRMB & PMB, the melting point of bitumen will be increased. Waste tyre modified bituminous surface of road increases their life period especially the pavement requires low maintenance costs.

ACKNOLEDGMENTS

The author would like to extend her deepest gratitude and gratefulness to mentors for providing with the right ways of thinking and concepts of this research. The author wishes deeply thankful to all his friends for the encouragement which have been helpful in his research to attain the destination without any trouble.

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