Effect of Crum Rubber Modified Binder on Bituminous Concrete Mix – A Review Paper

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Abstract

The aim of the study was to utilize the waste materials i.e., crumb rubber waste for mass scale utilization such as in highway construction in an environmentally safe manner. As a first part of this study, an attempt was made to assess the stabilization of the bitumen containing crumb rubber waste in shredded form by performing basic tests such as Penetration Test, Ductility Test, Softening Point Test, Viscosity Test and Flash & Fire Point Tests. On the basis of the performance of the modified bitumen, the range of optimum percentages of crumb rubber waste modified binder on bituminous concrete mixes will be decided. The dimension of used CR ranges from 0 to 2.36 mm, which is not too coarse for promoting the CR–bitumen interaction and not too fine for facilitating the production of CR. The content of CR was increased gradually from 3 to 5 to examine the effects of CR content on the engineering properties and determine the optimal content in the mixture.

Keywords: bituminous concrete, Marshall Properties (flow value, stability), optimum bitumen content, crumb rubber waste.

1. Introduction

Crumb rubber is recycled rubber produced from automobiles and truck scraped tires. During the recycling process of this rubber crumb, steel and tire cord (fluff) are removed, and tire rubber are produced with a granular consistency. India has a road network of over 4,689,842 kilometers in 2013, the second largest road network in the world. It has primarily flexible pavement design which constitutes more than 98% of the total road network. India being a very vast country has widely varying climates, terrains, construction materials and mixed traffic conditions both in terms of loads and volumes. Increased traffic factors such as heavier loads, higher traffic volume and higher tyre pressure demand higher performance pavements. So to minimize the damage of pavement surface and increase durability of flexible pavement, the conventional bitumen needs to be improved. There are many modification processes and additives that are currently used in bitumen modifications such as styrene butadiene Styrene (SBS), styrene-butadiene rubber (SBR), ethylene vinyl acetate (EVA) and crumb rubber modifier (CRM). Crumb rubber is the term usually applied to recycled rubber from automotive and truck scrap tires. Several studies show improved performance of asphalt modified by crumb rubber, resulting in reduced cracking and increased fatigue life, strength, resilience, viscosity and adhesion.

2. Objective

- The present study envisages the use of waste material i.e., waste tyres mixed with bitumen, which has potential use in highway and construction industry.
- To determine the density – voids analysis for the given bituminous mixture.
- To determine the strength (Marshall's Stability Value) and flexibility (flow value) for the given bituminous mixture 003B
- To determine the suitability of the bituminous mixture to meet the specified criteria for the surface course.

3. Scope

- The performance study can be carried out where this material is used in the pavement construction.
- Scope for usage of Crumb Rubber material in other bituminous layers like Bituminous Macadam, Semi-Dense Bituminous Macadam and DBM can be explored.
- Statistical analysis also can be carried out for different Crumb Rubber content.

4. Literature of Review

H.T Tai Nguyen, T. Nhan Tran (September 2017)
Effects of crumb rubber content and curing time on the properties of asphalt concrete and stone mastic asphalt using dry process

- In this work, the authors aim to study the effects of crumb rubber (CR) on the mechanical properties, especially the rutting resistance, of CR modified asphalt concrete (AC) and stone mastic asphalt (SMA) by varying two factors-namely, the content of additive and the curing time.
- It was observed that the optimal content is 1.5–2%, while the optimal curing time that contributes to the maximal increase in the mechanical characteristics of both mixtures could not be determined.

Material Physical Properties

Table 1. Specific Gravity of Aggregates

Size of Material	Specific Gravity	Water Absorption %
10mm	2.82	0.76
6mm (natural)	2.79	0.75
Stone Dust	2.64	0.825
Crumb rubber	1.01	

Table 2. Physical Properties of Aggregate

Sr. No.	Description of Test	Test Method	Test Result Observed	Specification as per MORT&H Table-500-18
1	Aggregate Impactvalue (%)	IS-2386 (P-IV)	9.69%	Max 24%
2	Aggregate Crushing value (%)	IS-2386 (P-IV)	15.7%	Max 10-25
3	Los Angle Abrasion value (%)	IS-2386 (P-IV)	17.5%	Max 30%
4	Flakiness and elongation Index (%)	IS-2386 (P-I)	23.53%	Max 30%
5	Water absorption (%)	IS-2386 (P-III)	0.76%	Max 2%
6	Stripping (%)	IS-6241-1971	99.5%	Minimum retained coating 95%

Crumb Rubber Waste

Crumb rubber waste is used in present investigation as additive in bitumen. The physical properties of bitumen and modified bitumen (Containing Crumb rubber) are given in Table.

Table 3. Physical Properties of Bitumen

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.001	0.99 Min.
2	Penetration	IS:1203	55	50-70mm
3	Ductility	IS:1208	95	Min. 40cm
4	Softening Point	IS:1205	49.5	Min.47°c
5	Absolute Viscosity	IS:1206	2855	2400 poise
6	Kinematic Viscosity	IS:1206	380	Min-350 cst

Table 4. Physical Properties of CRMB 3% Crumb Rubber

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	52	50-70mm
3	Ductility	IS:1208	89	Min. 40cm
4	Softening Point	IS:1205	48	Min.47°c
5	Absolute Viscosity	IS:1206	3000	2400 poise
6	Kinematic Viscosity	IS:1206	395	Min-350 cst

Table 5. Physical Properties of CRMB 4% Crumb Rubber

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	50.5	50-70mm
3	Ductility	IS:1208	87	Min. 40cm
4	Softening Point	IS:1205	47.5	Min.47°c
5	Absolute Viscosity	IS:1206	3050	2400 poise
6	Kinematic Viscosity	IS:1206	395	Min-350 cst

Table 6. Physical Properties of CRMB 5% Crumb Rubber

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	50	50-70°
3	Ductility	IS:1208	85	Min. 40cm
4	Softening Point	IS:1205	46	Min.47°c
5	Absolute Viscosity	IS:1206	3100	2400 poise
6	Kinematic Viscosity	IS:1206	400	Min-350 cst

Table 7. Gradation Of Aggregates for BC

Sieve size (mm)	Percentage passing	Achieved Result
19	100	100
13.2	79-100	100
9.5	70-88	85.94
4.75	53-71	61.59
2.36	42-58	49.76
1.18	34-48	39.59
0.6	26-38	30.87
0.3	18-28	22.16
0.15	12-20	14.81
0.075	4-10	4.69

5. Conclusion

- The Physical properties of modified bitumen and aggregate were identified. Based on the test result obtained following conclusions are drawn.
- It was observed that with increase of crum rubber from 3 to 5% softening point of bitumen decreases from 52 to 460C.
- With increase of crum rubber from 3 to 5% ductility of modified bitumen gets decreases.

- Stripping value test also have been performed, Result obtained from test represents that modified bitumen provide sufficient coating over the natural aggregate and satisfy minimum criteria for MORTH specification.
- Test result obtained for all the different proportion of modified mixes satisfy the minimum criteria of IS code specification.
- From Physical parameter of modified mixes, it can be concluded that crum rubber can be utilize as partial replacement of bitumen. The patterns obtained in the flow values indicate that Crumb Rubber will deform more under the traffic loads and will have more flexibility.
- It was concluded that Crumb Rubber industrial waste can be utilized as a partial replacement for bitumen in bituminous concrete mixes. The utilization of Crumb Rubber in the asphalt concrete mixes may solve the significant disposal problem to save the environment.

References

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