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EXPERIMENTAL STUDIES ON RUBBERISED BITUMEN AND BITUMINOUS MIX

MR. ANUP R. SOMWANSHI[1], MR. VAIBHAV S. UMAP[2]

1. M.E. (Transportation Engineering and Management), IBSS COE, Amravati. Amravati, India.
2. Faculty of Civil Engineering Department, IBSS COE, Amravati. Amravati, India.

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Abstract: The use of four wheelers, two wheelers vehicles are increasing day by day. As a result amount of waste tires also increasing. This indisposed tyre is user friendly but not eco-friendly and leads to various environmental problems. As the disposal of tyre is a major problem, there is need to use that tyre waste productively and properly. India is having 3rd largest road network in the world. Since from first road plan of IRC, Network of the road in India is increasing day by day. The roads are one of the vast area where we can use that rubber in large quantity without compromising with properties of road material. This waste tyre crumb rubber is use to modify the properties of bitumen. We can mix these crumb rubber in hot bitumen and various experiments were performed on these rubberized bitumen and bituminous mix with varying percentage of rubber.it is found that crumb rubber is work as a good bitumen modifier.

Keywords: Rubberised Bitumen, Bitumen Modifier

Corresponding Author: MR. ANUP R. SOMWANSHI

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INTRODUCTION

Rubberised bitumen is a mixture of hot bitumen and crumb rubber derived from post-consumer waste or scrap tyres. It is used extensively in the highway paving industry in the USA, particularly in the states of Arizona, California and Texas. In India, it is estimated that over 33 lacks kilometers of road exists. Investigations have revealed that properties of bitumen and bituminous mixes can be improved to meet requirements of pavement with the addition of certain additives. These additives are called as “Bitumen Modifiers” and the bitumen premixed with these modifiers is known as modified bitumen. Modified bitumen is expected to give higher life of surfacing (up to 100%) depending upon the modification and type of additives. Crumb Rubber is also work as a bitumen modifier.

2. REVIEW OF LITERATURE:

There is a large body of experience in America using rubber as a bitumen modifier. This is mainly related to the introduction of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. While this document was mainly concerned with funding of road maintenance and construction, section 1038 (d) of ISTEA required that all states use a certain percentage of rubber in their asphalt pavements, starting in 1994, or their funding would be reduced. While some states had already trailed using rubber as a modifier in asphalt, this act caused many more to conduct trials of the feasibility of using rubber in asphalt.- Florida Department of Transport (FDOT).

Rubberised bitumen has resulted in much improved characteristics when compared with straight run bitumen and that too at reduced optimum modified binder content (5.67 %).- Prof. Shankar (2009).

The mix prepared with modifiers shows: - Higher resistance to permanent deformation at higher temperature. - Mohd. Imtiyaz (2002)

At the Centre for Transportation Engineering of Bangalore University compare the properties of the modified bitumen with ordinary bitumen. It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive, up to 12 percent by weight. 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.- Prof. Justo (2002).

3. EXPERIMENTAL PROGRAM

In laboratory, The Semi Dense Bituminous Concrete (SDBC) mix was prepared with conventional 60/70 grade (VG30) bitumen, using Marshall Method of bituminous mix design. These SDBC was prepared with varying different percentage of crumb rubber i.e. 2%, 4%, 6%, 8%, 10% and 12%.

3.1 Ministry of Road Transport and Highways Specifications for SDBC:

Ministry of Road Transport and Highways (MORT&H) has provided specifications for road and bridge works. The specifications for SDBC are as follows:

Table-1 Specification for SDBC

S. No.	Parameter	Specified Limits
1	Minimum stability (Kg at 60^0 C)	820
2	Minimum flow (mm)	2
3	Maximum flow (mm)	4
4	Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
5	Percent air voids	3-5
6	Per cent voids filled with bitumen (VFB)	65-78

4. RESULT AND DISCUSSION

To find out optimum bitumen content of 60/70 grade bitumen, The SDBC was prepared by Marshall method and the various mix design characteristics of the Marshal stability value, Flow value, Bulk Density , Air Voids (Vv) , Voids in mineral aggregate (VMA) , Voids filled with bitumen(VFB) were found out. The results of SDBC Marshall Mix Design using 60/70 Grade Bitumen are shown in table no 2.

The above results of table 2 shows that the higher value of Marshall Stability and greater density was achieved with 5% bitumen content. All other parameters were also well as per the specifications of MORT&H. Hence 5% bitumen content is the optimum bitumen content for 60/70 grade bituminous mix. So by taking 5% bitumen content with varying percentages of Crumb Rubber was added and SDBC mix was prepared. The results of SDBC mix with varying percentage of Crumb rubber are shown in the following table 3.

From the above results of table 3 of Marshal test, it is observed that the Marshal Stability Value are increased with increasing the percentage of crumb rubber in the bitumen from 6% to 12% and then it is decreased on 14%. So it is 12% of Crumb Rubber of the weight of bitumen is the optimum rubber content for getting enhanced strength characteristics of SDBC mix. The bulk

density also shows increasing trend and the values of other parameters are also within the required specification limits.

Table 2. Results of SDBC Mix Design using 60/70 Grade Bitumen

S. No.	Bitumen %	Marshal stability (Kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids % Vv	VMA	VFB %
1	4.25	830	2.40	2.232	4.98	14.01	64.45
2	4.50	845	2.75	2.235	4.82	14.39	66.50
3	4.75	880	3.10	2.238	4.46	14.58	69.41
4	5.00	940	3.35	2.245	3.62	14.31	74.70
5	5.25	890	3.70	2.234	3.26	14.43	77.40

Table 4. Results of SDBC Mix for Varying Percentages of Crumb Rubber

S. No.	Crumb rubber %	Bitumen %	Marshal stability (Kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids % Vv	VMA	VFB %
1	6	5	1040	3.10	2.23	3.88	15.08	74.27
2	8	5	1090	3.25	2.24	3.85	15.29	74.82
3	10	5	1160	3.40	2.25	3.82	15.51	75.37
4	12	5	1240	3.65	2.26	3.83	15.77	75.71
5	14	5	1180	3.90	2.28	3.96	15.68	76.55

At the same time, To compare the physical properties of these Crumb Rubber modified Bitumen (CRMB) having 12% of Crumb rubber with Straight run 60/70 grade bitumen, various test of bitumen is carried out on neat bitumen and 12% CRMB i.e. Penetration test, Ductility test, Softening point test. The results of these test are shown in the following table 4.

Table 4- Effects of crumb rubber on bitumen

S. No.	Test of bitumen	Neat bitumen 60/70	CRMB 12%
1	Penetration test (dmm)	64	46
2	Softening point test (^{0}C)	44	57.5
3	Ductility test (cm)	102	72

From the penetration test results, It is observed that penetration value is reducing with increase in concentration of Crumb rubber. This is an indication of increase in stiffness and shear strength of binder. The penetration value of neat bitumen reduces from 64 dmm to 46 dmm at 12% of CR content. Absorption of maltene phase by CR increases the asphaltene part of bitumen. Furthermore, the stiffness of CR particles is more than bitumen. Hence, increasing the CR content leads to increased stiffness.

The softening point refers to the temperature at which the bitumen attains a particular degree of softening. From the softening point test results, it is observed that, the use of crumb rubber in bitumen leads to an increase in the softening point and viscosity. The softening point increases from 440C to 570C at 12% of CR content. Crumb rubber absorbs the light oily components of bitumen in CR-bitumen matrix, which reduces the content of free radicals which leads to higher softening point.

The Ductility test is again an empirical test which measures the cohesive strength of bitumen. However, from the ductility test result it is observed that the ductility of the bitumen reduces from 102 cm to 78 cm. with increase 12% of Crumb rubber in bitumen. The reduction of oily material in CR-bitumen mix and presence of CR particles in specimen which have no deformation properties results in reduction of ductility.

5 CONCLUSION

On the basis of laboratory investigations and obtained results in this study of rubberized bitumen and bituminous mix, the following conclusions can be drawn.

The study on the use of CRMB reveals that the Marshal Stability value, which is the strength parameter of SDBC has shown increasing trend. The density of the mix has also increased in CRMB when compared with 60/70 grade bitumen.

The use of crumb rubber as a modifier seems to have positive effects on physical and strength properties of the binders, including improved penetration, softening point and Viscosity.

However the ductility of the binder reduces with increase in Crumb rubber content. It is therefore recommended to use the 8% to 10% of Crumb rubber to keep the ductility value within required specification limit.

This will provide more stable and durable mix for the flexible pavements. The serviceability and resistance to moisture will also be better when compared to the conventional method of construction

The crumb rubber is work as a good bitumen modifier, Also the use of crumb rubber as a bitumen modifier would reduce pollution problems and protect our environment as well.

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