Experimental Study of Flexible Pavement by Using Waste Rubber Tyres

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Abstract: Use of Crumb Rubber i.e. the rubber obtained from the waste tires of vehicles in the construction of flexible pavement is gaining importance. It is also worth mentioning that, the modifier raw-material has been sourced from disposed crumb rubber. This not only allows us to collect modifier raw material at low cost, but also provides a solution towards ecological menace posed by increased use of rubber. In the present study, an attempt has been made to use Crumb Rubber, blended using wet process .Marshal method of Bituminous mix design was carried out for varying percentages of Crumb Rubber to determine the different mix design characteristics. Marshall's mix design was carried out by changing the modified bitumen content at constant optimum rubber content and subsequent tests have been performed to determine the different mix design characteristics and for conventional bitumen (VG-30). This has resulted in much improved characteristics when compared with straight run bitumen and improve the strength of pavement Modified Bitumen is one of the important construction materials for flexible pavements.

Keywords: Crumb rubber, Wet process, flexible pavements.

1. Introduction

As it is estimated that about 60% of waste tyres causes land pollution in both urban and rural areas and per capita land is decreasing in India due to this hazardous waste, it is either land filled or incinerated which cause land and air pollution if this waste is mixed in to bitumen to improve the quality of road it would prove itself as an eco-friendly characteristics. By using the waste Crumb Rubber as a modifier the properties of bitumen will be change and this change in physical properties like softening point, penetration value, elastic recovery and Marshall stability was checked by different test. In this study we used modifier in proportion 8%, 10%, 12% and 14% by the weight of VG-30 bitumen.

2. Literature Review

Many researches were carried out by many scholars and professors of civil engineering in this field, to find the ways and crumb rubber mix in conventional bitumen to improve in engineering properties of bitumen.

Patel Chirag B (2013),By using the waste plastic and Crumb Rubber as a modifier the properties of bitumen will be change and this change in physical properties like softening point, penetration value, elastic recovery and Marshall stability was checked by different test. In this study we used modifier in proportion (1%,2%,3% and 4%) by the weight of bitumen.

R.Vasudevan et.al. (2007), Has studied that the crumb rubber modified bitumen and they construct different stretches and perform field study with the help of National Transport Planning and Research Centre, Trivandrum. From this field study they concluded that the entire road having a good skid resistance value and from bump instigator study a good surface evenness.

Shankar (2009), The crumb rubber modified bitumen (CRMB 55) was blended at specified temperatures. Marshall's mix design was carried out by changing the modified bitumen content at constant optimum rubber content and subsequent tests have been performed to determine the different mix design conventional bitumen (60/70) also. This has resulted in much improved characteristics and for characteristics when compared with straight run bitumen and that too at reduced optimum modified binder content (5.67%).

Siddharth Rokade (2012), The Crumb Rubber was added to 60/70 grade bitumen in varying percentage of 8%, 10% and 12%. The mix was prepared with 5 % bitumen and the varying percentages of Crumb Rubber. The bitumen when mixed with Crumb Rubber is termed as Crumb Rubber Modified Bitumen (CRMB). The results observed that the Marshal Stability Value are increased from 8% to 10% Crumb Rubber and then it is decreased 12% of Crumb Rubber of the weight of bitumen is the optimum dose for getting enhanced strength characteristics of mix.

Mohd Hizam HARUN & Roziawati RAZAL(2003), Public Works Department of Malaysia As bitumen additive, various forms of rubber which include scrap rubber from motor vehicle tyres (crumb rubber) have been used . The objectives of the trial were to compare the performance of bituminous overlay incorporating crumb rubber modified bitumen in mitigating reflective cracking with a similar overlay using conventional penetration grade 80-100 bitumen. A full-scale road trial was successfully constructed on Route 2. Section Nos. 340 - 345, in Kuantan, in June 2003.

Nuha S. Mashaan(2012),In their study presented the application of crumb rubber modifier in the asphalt modification of flexible

pavement. From the results of previous study, it aspires to consider crumb rubber modifier in hot mix asphalt to improve resistance to rutting and produce pavement with better durability by minimizing the distresses caused in hot mix asphalt pavement. Hence, road user would be ensured of safer and smoother roads.

Limitations: The literature which studied I found there was not achieved the standard marshal stability that is 1200 kg by mixing different percent of crumb rubber in bitumen .In present study, try to mix different percent of crumb rubber in bitumen to achieve the marshal stability value 1200kg.

3. Experimental work

3.1 General

The Bituminous Concrete (BC) mix was prepared using Marshall Method of bituminous mix design. The BC was prepared with conventional VG-30 grade bitumen, varying percentages of Crumb Rubber added with VG-30 grade bitumen. The details of the experimental programmers shown in Table 1.

Table 1: Detail of sample constitution and percent constituents.

Sample Constitution	Sample Preparation	% Constituent by Weight of Bitumen
VG-30 Grade bitumen	Wet Process	
VG-30 Grade Bitumen + Crumb Rubber	Wet process	Crumb Rubber: 8% Crumb Rubber: 10% Crumb Rubber: 12% Crumb Rubber: 14%

3.2Softening point properties

The viscosity refers to the fluid property of the bitumen, and it is a gauge of flow resistance. the potential of the resulting paving mixes. During compaction or mixing, the low or high viscosity has been observed to result in lower stability values. The softening point refers to the temperature at which the bitumen attains a particular degree of softening. The use of crumb rubber in bitumen modification leads to an increase in the softening point and viscosity as rubber crumb content increases claimed that there is a consistent relationship between viscosity and softening point at different aging phases of rubberized bitumen binder. Also, it is reported that the higher crumb rubber content leads to higher viscosity and softening point. The viscosity is a continuously increasing nonlinear function of rubber content and the relative increase is a factor related to the application of temperature.

3.4 Penetration properties

The penetration is a measure of hardness or softness of bitumen binder which shows an effect by adding crumb rubber to bitumen binder; it decreases as rubber content is increased. The penetration shows lower values as rubber content increases at different mix conditions of Rubberized bitumen binder, indicating that the binder becomes stiff and more viscous investigated the properties of rubberized bitumen prepared by physical blending of bitumen penetration grade with different crumb rubber content and various aging phases. The results of penetration values decreased over the aging as well as before aging by increasing the rubber content in the mix. Also, the modified binders have lower penetration values than unmodified binders.

3.3 Elastic recovery properties

The elastic recovery or elasticity describes the ability of a bitumen binder to elongate when the tension is applied and to recover its original shape when the tension is released. The degree of elastic recovery was used as an indicator of permanent deformation in pavement Materials the elastic recovery property is very important in both fatigue and rutting resistance selection and evaluation. The elastic recovery is a property that indicates the quality of polymer components in bitumen binders concluded from his study, that the elastic recovery of rubberized bitumen binders leads to an increase as the rubber particle size decreases. Modified bitumen binders showed a significant enhancement on the elastic recovery, and, in contrast, the ductility decreased with respect to unmodified binders.

3.4 Result of bituminous concrete mix design using crumb rubber modified bitumen (CRMB).

The results show that with 5% bitumen content higher value of Marshall Stability value and greater density was achieved. All other parameters were also well within the specifications of IRC: SP: 53-2002 and MORT&H. Hence with 5% bitumen content of VG-30 grade bitumen varying percentages of Crumb Rubber was added and bituminous concrete mix was prepared. The results of different properties of CRMB & bituminous concrete mix with varying percentage are shown in Table 2.

Table 2: Different properties of crumb rubber modified bitumen

S. No	Crumb Rubber %	Bitumen %	Softening point	Penetration	Elastic recovery	Marshal stability (Kg)
1	8	5	55	61	52	883.86
2	10	5	60	54	57	1049.59
3	12	5	63	48	60	1230.78
4	14	5	65	45	63	1137.97

The corresponding graphs for above results are shown in Fig.1-4

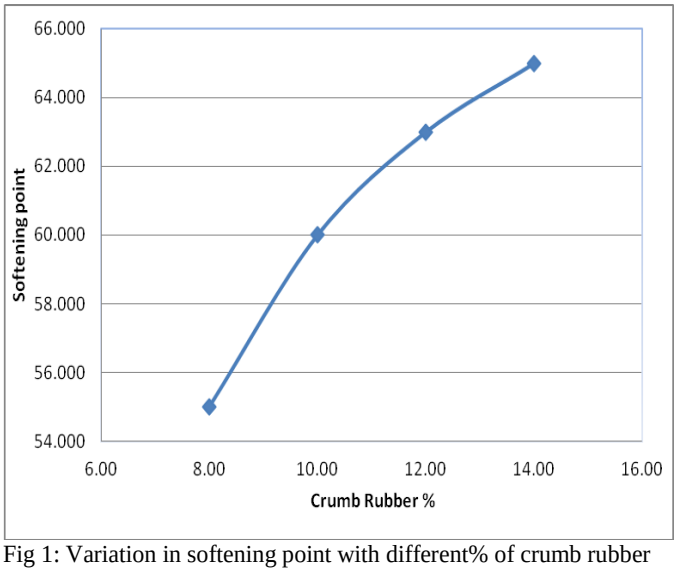

Fig 1: Variation in softening point with different% of crumb rubber

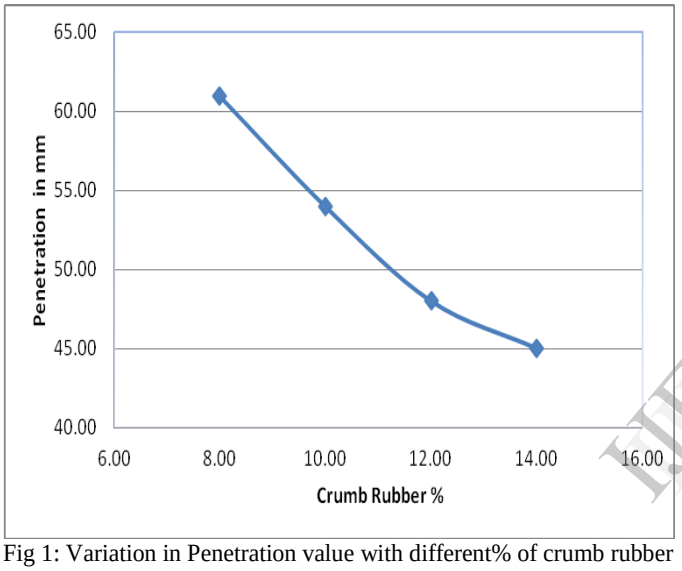

Fig 1: Variation in Penetration value with different% of crumb rubber

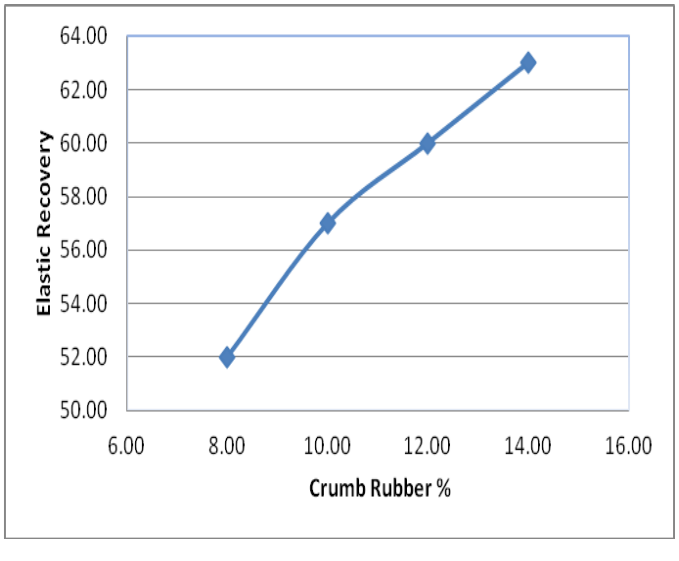

Fig 1: Variation in Elastic recovery with different% of crumb rubber

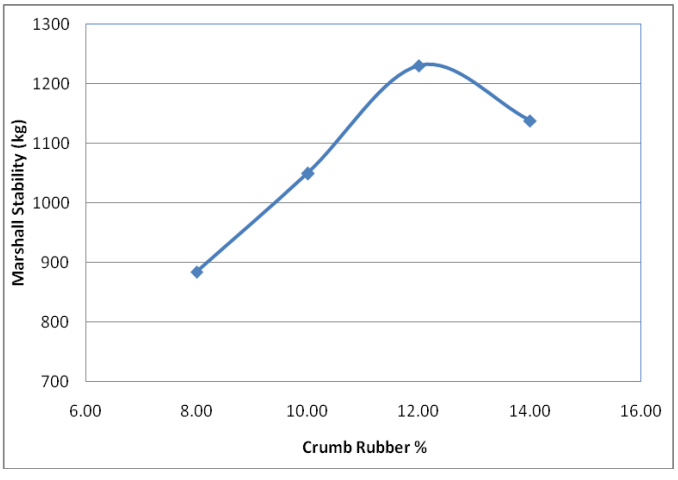

Fig 1: Variation in Marshall stability with different% of crumb rubber

4. CONCLUSION

The values of different parameters i.e. Softening point, Penetration, Elastic recovery and Marshall stability in the cases of crumb rubber modified bitumen have found out to be within required specifications. It is observed crumb rubber modified bitumen reveals that the Marshal Stability value, which is the strength parameter of bituminous concrete, has shown increasing trend and the maximum values have increased by about 18 % by addition of crumb rubber. This experiment will not only constructively utilize the waste tyres in road construction industry but also effectively enhance the important parameters which will ultimately have better and long living roads. This will provide more stable and durable mix for the flexible pavements. Thus, these processes are socially highly relevant, giving better infrastructure

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