WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Study on Waste Tyre Rubber in the Construction of Flexible Pavements

Manikanta B [a], Vijaya Nandu CH [b], Chandrarjun K [c] *

[a,b,c] *Aditya Engineering College, Suramapalem, 533437, India*

A B S T R A C T

In developing countries like India, the network of road transportation is increasing rapidly. As the number of vehicles is increasing, so the number of discarded rubber tyres also increased. These waste rubber tyres are either filled in land or incinerated which causes land and air pollution. In this project, an effort has been made to utilize these waste rubbers in flexible pavements to improve the properties of pavement and to produce an eco-friendly road. The waste rubber blended at specific temperature of 150-160˚c is used in the construction of flexible pavement. Physical tests are performed that are used to determine the optimum bituminous pavement by changing the proportion of waste rubber as 0%, 2%, 4%, 6%, 8%, 10%, 12% by the weight of bitumen. The expectations from this study is to develop a modified bituminous pavement with waste rubber that would minimize the cost, eco-friendly and provide better physical properties compared to normal conventional bituminous pavement based on the tests going to be conducted.

Keywords: Flexible pavement, waste rubber, bitumen, modified bituminous pavement.

1. INTRODUCTION

In India, Transportation is the important criteria to be considered. Road transport is an easiest way of transport that is available to all people. Due to the rapid rise in transport through roads the usage of automobiles is greatly increased. Hence the usage of rubber tyres is rapidly increased. The tyres of vehicles must be replaced after its usable period is over. Due to this, excess quantity of waste tyres is produced. These waste rubber tyres are either filled in land or incinerated which causes land and air pollution. In this project, an effort has been made to utilize these waste rubbers in flexible pavements to improve the properties of pavement and to produce an eco-friendly road.

FLEXIBLE PAVEMENT:

Flexible pavements were also known as bituminous roads. Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain transfer through the points of contact in the granular structure. Flexible pavement layers reflect the deformation of the lower layers on to the surface layer (e.g., if there is any undulation in sub-grade then it will be transferred to the surface layer). Hence the surface layer which is also known as wearing course should be hard enough to resist any deformation. In this study, waste rubber mixed with bitumen is laid as wearing course/surface course to improve the properties of bitumen to resist those deformations.

2. LITERATURE REVIEW

- **Nabin Rana Magar, (2014):** Investigates the performance of crumb rubber modified bitumen by varying the sizes of crumb rubber. The test results of common laboratory test on plain bitumen and crumb rubber modified bitumen shows that the penetration values and softening points of plain bitumen can be improved significantly by modifying it with the addition of crumb rubber which is a major environmental pollutant. The best size to be used for crumb rubber modification is suggested as (0.3-0.15mm) size for commercial production of CRMB.
- **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.
- **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.

- **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.

3. MATERIALS USED

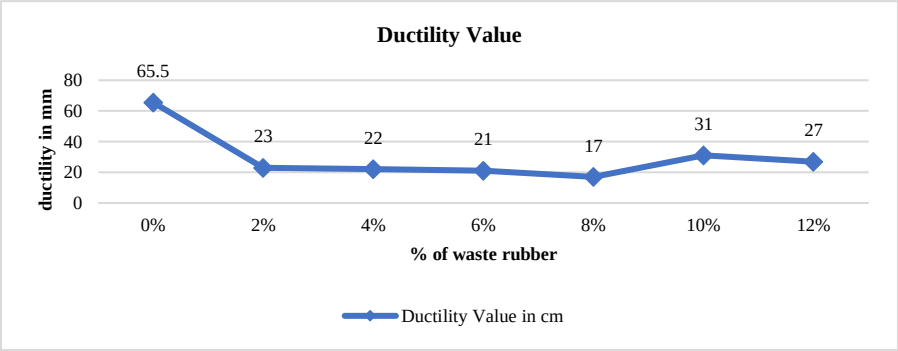
1. **Bitumen**: In this study penetration grade of 80/100 bitumen is used, which is used for the construction of roads in Rajamahendravaram.
2. **Waste tyre shredded pieces**: waste rubber tyres processed/ shredded into granules (small size) by removing the inherent reinforcing materials such as steel and fiber of sizes ranging from 0.100-0.300mm is used for the study.

4. MIXING PROCESS OF BITUMEN AND WASTE RUBBER:

- Scrap tire rubber can be incorporated into asphalt paving mixes using two different methods, which are referred to as the wet process and the dry process.
- In the wet process, crumb rubber acts as an asphalt cement modifier, while in the dry process, granulated or ground rubber and/or crumb rubber is used as a portion of the fine aggregate.
- In this study, Waste rubber modified bitumen is produced by the wet process in which waste rubber is added to hot bitumen of temperature around 150 -160ºC and the mixture is mixed mechanically until there is a reaction between the bitumen and crumb rubber.
- In the reaction, rubber particles absorb the aromatic oils from the bitumen into its polymer chains which called diffusion. Swelling and Diffusion are the main processes which are responsible for the reaction between bitumen and rubber.

5. TESTS, RESULTS AND DISCUSSIONS

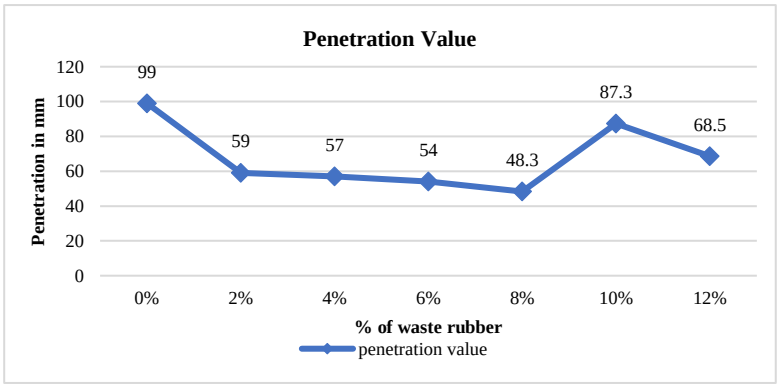
- **DUCTILITY TEST:** Ductility is the property of bitumen that permits it to undergo great deformation or elongation. Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking.



Description of Ductility Test:

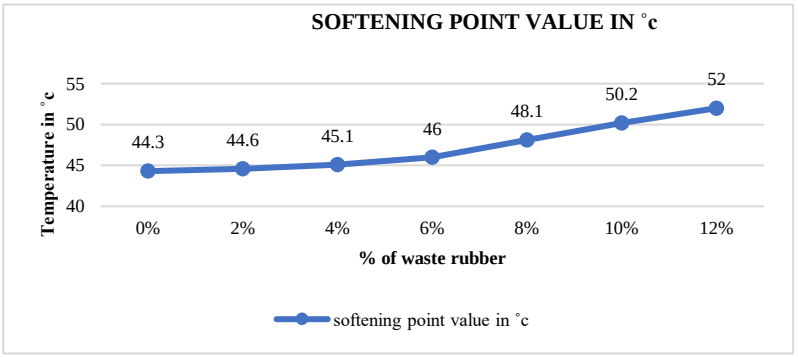
Ductility test was done for normal bitumen and modified bitumen with 0%, 2%, 4%, 6%, 8%, and 10% of rubber waste content. The result was shown in Table 1. The result shows that the rubber waste added will harden the bitumen. The bitumen becomes more viscous and harden, which would be useful to obtain stiffer bitumen asphalt.

- **Penetration test:** It measures the hardness or softness of bitumen by measuring the depth in millimetre to which a standard loaded needle will penetrate vertically in 5 seconds.



Description of Penetration Test: Penetration Test were done for normal bitumen and modified bitumen with 0%, 2%, 4%, 6%, 8%, 10% and 12% of rubber waste content. From the result of the test, the penetration value for normal bitumen was 99 mm. Penetration value decreased with the increased amount of the rubber waste added. Lower penetration value making harder grade of asphalt, giving additional strength to the road and reduces water damage. At 10%, bitumen behaves as per the specifications (80-100mm). Hence the optimum waste rubber percentage is 10%.

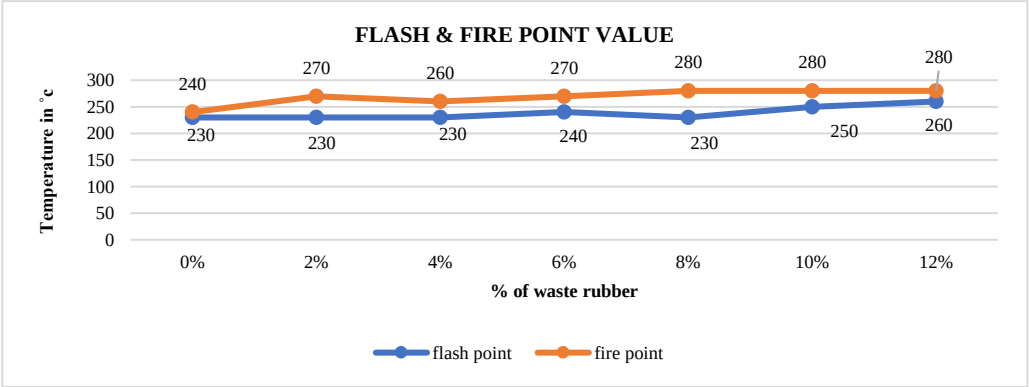
- **Softening Point Test:** Softening point implies the temperature at which the bitumen attains a particular degree of softening under the specified condition of test.



Description of penetration test: The Softening point for the bitumen of penetration grade of 80/100 as per IS specifications is 42˚C - 52˚C. Softening Point Test was done for normal bitumen and modified bitumen with 0%, 2%, 4%, 6%, 8%, 10%, and 12% of rubber waste content. The result was shown in Table. The observations shows that the softening point of normal bitumen increases by adding the waste rubber. It shows that the bitumen becomes less susceptible to temperature changes. The softening point of bitumen with 10% of bitumen is 50.2˚c which is in limits as per the IS specifications.

- **Flash and Fire Point Test:**

At high temperatures depending upon the grades of bitumen materials leave out volatiles. And these volatiles catch fire which is very hazardous and therefore it is essential to qualify this temperature for each bitumen grade. BIS defined the ash point as the temperature at which the vapour of bitumen momentarily catches fire in the form of ash under specified test conditions. The fire point is defined as the lowest temperature under specified test conditions at which the bituminous material gets ignited and burns.



Description of Flash and Fire Point Test: The IS specifications for the Flash point of penetration grade of 80/100 bitumen is minimum of 225˚c (>225 ˚c). The flash point values are obtained as per the specifications. Hence, the mixing of waste rubber in bitumen doesn't decrease the flash point property.

So the bitumen doesn't catch the fire easily due to the higher flash point and it can be used in the construction of pavements in the areas of higher temperatures.

CONCLUSIONS:

- Ductility test result shows that the rubber waste added will harden the bitumen. The bitumen becomes more viscous and hardens, which would be useful to obtain stiffer asphalt.
- Increase in softening point makes the bitumen less susceptible to temperature changes, and hence giving the bitumen protection against hot climate.
- Adhesion is improved between aggregates and bitumen due to the addition of Waste Rubber.
- Addition of Waste rubber increases the physical properties of bitumen and making the eco-friendly pavement construction.

FUTURE SCOPE:

In the future we will continue study on long-term performance of the waste rubber modified bitumen pavement and compare with normal bituminous pavement. Future work could also include studying the effects of different types of rubber waste and the influence of environmental factors on the pavements performance.

REFERENCES

1. "Evaluation of modified bituminous concrete mix developed using rubber and plastic waste materials", ShubhamBansal, AnilKumar, MisraPurnimaBajpai. Haryana, India. 20 August 2017.
2. "An experimental investigation on partial replacement of bitumen using rubber tyre", A. Rangaraj, P. Mukesh , 31 may 2019.
3. "Experimental investigation of modified bituminous concrete mix using nitrile butadiene rubber (NBR)", AvaniChopra, SandeepSingh, Gharuan, Mohali, India. 18 June 2020.
4. NuhaS. Mashaan*, Asim Hassan Ali, Mohamed RehanKarim and MahrezAbdelaziz "An overview of crumb rubber modified asphalt". International journal of the physical sciences vol. 7(2), pp. 166 - 170, 9 January, 2012.
5. IRC SP-53:2010, "Guidelines on use of modified bitumen in road construction"
6. IRC: 37 -1970, Indian Roads Con IRC: SP: 53, 'Tentative Guidelines on the use of polymer and Rubber modified Bitumen in Road construction', Indian Road Congress (IRC), 2002.
7. IS: 1203-1978, "Method for testing tar and bitumen materials determination of penetration"
8. IS: 1205-1978, "Method for testing tar and bitumen materials determination of softening point"
9. IS: 1208-1978, "Method for testing tar and bitumen materials determination of Ductility''.