Utilizing Used Rubber and Polymer in Bitumen for Highway Construction Materials

[1]Bhawna Gundal, [2]R.S.Kesharwani
[1]Research Scholar, [2]Professor
[1]Civil Engineering Department
[2]Baba Mastnath University, Rohtak, Haryana, India

ABSTRACT - Potholes, surface roughness, fractures, and other premature pavement breakdown issues have been an issue for many road authorities, which reduces the lifespan and efficiency of roads. Conversely, the number of rubbers, plastics, and other materials is growing daily. Waste materials such as plastic bottles, plastics, cups, and used tires can be recycled by grinding them into powder or mixing them with crushers. They can then be heated to coat bitumen and gravel. As a binder for aggregate and bitumen, we employed polymers and crumbed rubber in this investigation. Bitumen, grit, and gravel (of different sizes) are the materials used in bituminous roadways.materials such as bitumen, grit, and gravel (of different sizes). This research involves a number of tests on bitumen penetrating value, ductility, and softness point in addition to aggregates like crushing value, impacting value, abrasion value, along with particular gravity. This paper discusses the findings.

Keywords- Bitumen, Rubber, Waste Plastic, Pavement

I. INTRODUCTION

After being used, plastics—a substance that is useful to most people—become harmful to the environment.The main focus of current research is the environmentally friendly disposal of various plastic and rubber wastes. In comparison to roads composed of traditional materials, the authors' creative methods of using waste plastics and tire debris to create flexible pavement material would improve the roadway's stability, durability, resistance to wear, and strength.

II. CHARACTERISTICS-

Investigation of Moisture Absorption and Void heated bitumen (170 ^{0}C) is combined with heated stone aggregate (150 ^{0}C). According to IS code, the aggregate is selected based on its strength, porousness, and capacity to absorb moisture. The asphalt material is selected based on its visco-elastic, binding, and penetrating qualities. The gravel's quality in terms of voids, absorbing moisture, and soundness was enhanced when it was covered with rubber and plastic. The rubber and plastic covering improves the aggregate's overall performance and quality in the porous asphalt by reducing porosity.It should be mentioned that the standard only permits stones with less than 3% porosity.

a. Soundness Test-

The purpose of the soundness tests are to examine the aggregate's durability against weathering action. The aggregate's low quality is the cause of the weight reduction. The aggregate covered with rubber and plastic was not losing weight, indicating an increase in aggregate quality.

b. Aggregate Impact Value Test -

An investigation into how rubber and plastic coatings affect the aggregate impact value was expanded. After the aggregate was treated with 1% and 2% polymers and rubber by weight (divided into 0.5% and 1%), it was put through an Aggregate Impacts Value test, and the results were contrasted with those of the aggregate that was not coated. To obtain better results, the experiments were run twice for each percentage of waste.It is evident that adding rubber and plastic coatings raises the aggregate impact value. The quality of the stone aggregate is enhanced by covering it with rubber and plastic.

Additionally, covering low-quality aggregate with polymers and rubbers might make it usable. Consequently, this enhances the quality of pavement that's flexible.

Table-01 Aggregate Impact Values

Percentage of Plastics (%)	Percentage of rubber (%)	Aggregate Impact value (%)	Conventional value (%)
0.5	0.5	9.23	12.63
0.5	0.5	8.73	12.16
1	1	8.73	12.14
1	1	8.10	12.63

c. Value of aggregate crushing

The impact of rubber and plastic coatings on aggregate crushed value was investigated. The aggregate was subjected to aggregate crushed after being coated with 1% and 2% plastic and rubber by weight (divided in 0.5% and 1%). hardness test, and the results were contrasted with those of the aggregate that was not coated. To obtain better results, the experiments were repeated twice for each percentage of waste.

Table-02 Aggregate crushing Value

Percentage of Plastics (%)	Percentage of rubber (%)	Aggregate crushing value (%)	Conventional value (%)
0.5	0.5	11.41	23.66
0.5	0.5	12.27	22.37
1	1	11.30	23.70
1	1	11.32	23.86

d. Abrasion Test-

The road's surface will experience some wear and tear from the vehicle's frequent movements when it has rubber tires or iron wheels. The Los Angeles abrasive research is used to calculate this aggregate's wear and tear %. This investigation shows that, in comparison to the traditional values, the % of wear and tear readings of the 1% and 2% plastic and rubber coating aggregate are in a decreasing sequence. The Los Angeles abrasion research is used to calculate this aggregate's wear and tear %.Ordinary aggregates have lower Los Angeles abrasion ratings than polymer and rubber-treated aggregates when compared with plain materials and plastic and rubber-coated aggregates.

Table-03 Los Angels Abrasion Test

Percentage of Plastics (%)	Percentage of rubber (%)	Los Angeles value (%)	Conventional value (%)
0.5	0.5	14.64	17.51
0.5	0.5	14.72	17.42
1	1	13.77	17.46
1	1	13.85	17.43

III. CHARACTERISTICS OF MODIFIED BITUMEN

Another application for discarded rubber and plastic is being researched, which involves combining the two materials with bitumen to create the mixture. The used tires are ground into a powder using specialized grinding equipment. The powder is gathered and applied to bitumen modification. After heating the bitumen to 120–140 degrees Celsius, plastic and crumb rubber powder are added by volume and well mixed with a mechanical blender.The mixture was used to investigate bitumen's fundamental characteristics, such as its ductility, penetration point, and softness point. Here, 10% and 20% of the weight is made up of plastics and crumbed rubber, which are divided into 5% and 10%. To obtain better results, experiments were run twice for each percentage of waste.When compared to the traditional value were shown to be superior. Therefore, the durability and life of the road material may be significantly increased by employing waste plastics and waste rubber.

IV. MARSHALL STABILITY TEST

The purpose of this test is to evaluate the bituminous blend's stability, or its capacity to withstand plastic flow, using cylindrical specimens pressed on the lateral surface at 60 degrees Celsius. This is the Dense Bituminous Macadam that we have created.

The test may be used with bitumen and gravel up to 25 mm in diameter in hot mix configurations. This technique measures the cylindrical piece's resistance to deformation caused by plastic. When the same is loaded at the perimeter at a rate of 5 cm per minute, the mix of bituminous material is measured. Bituminous pavement mixtures are designed and evaluated using this test approach.When it comes to evaluating road materials, Marshall Stability is crucial. Therefore, the Marshall Stability test results demonstrate the true strength and load-bearing capability of the road materials.

"Figure-01"

VI. PREPARATION OF MODIFIED BITUMEN MIX WITH RUBBER

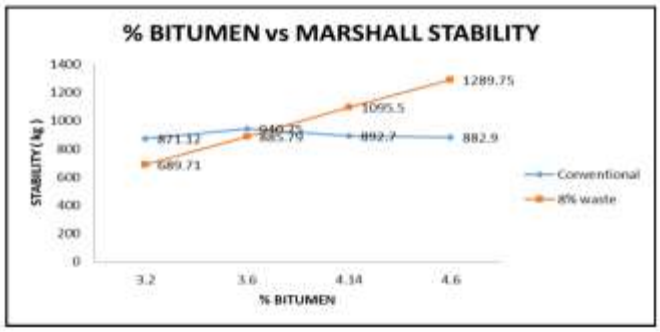
They took 1200 grams of mix. 63.5 mm should be the thickness. Roughly 1200 grams of filler and aggregate are heated to 200 degrees Celsius. The rammer and compaction mold assembly are warmed to between 100 and 150 degrees Celsius.Asphalt is added to the aggregate at the proper proportion after being heated to 130–140 degrees Celsius.In a similar manner, 8% of the bitumen's weight is made up of polymer and shredded rubber, or 4% plastic and 4% processed rubber, respectively. 160–180 ^{0}C is used to heat 80/100 bitumen. In this manner, the block is made available for testing while the additional mix samples are prepared.Three bitumen composition gradations are being prepared in order to create the block and enable Marshall Stability. Fifteen samples are made using the usual mix design, with three samples each having a constant bitumen %. The percentage rises by 0.5%, and so on, until the bitumen concentration reaches 5%.The Marshall Stability experiment is used to assess a bituminous combination's stability, or its capacity to withstand plastic flow, by loading cubes of the mixture onto a lateral surface at 60 degrees Celsius. Here, the densely Bituminous Macadam will be developed designed.

typical bituminous mix parameters. table 04: Crumbed rubber mixture and polymer ratios..

Table- 04 Values of Modified Mix With Crumbed Rubber And Plastic

% Bitumen	Sample Wt. gm	Marshall stability kg	Flow mm	Gmb gm/cm^3	Gt gm/cm^3	Vb %	AV %	VMA %	VFB %
3.22	1046	689.71	3.0	2.120	2.49	6.5	18.9	25.44	25.51
3.68	1089	885.79	3.5	2.167	2.47	7.9	12.3	20.24	39.39
4.14	1106	1095.50	3.3	2.210	2.43	9.1	9.05	18.20	50.27
4.6	1120	1289.75	3.5	2.298	2.39	10	3.85	14.41	73.35

Table- 05



V. CONCLUSION-

As can be observed from the findings and graphs above, the Marshall tests values—Marshall Stability (kg), Flow (mm)—continue to rise in comparison to the conventional mix when 8% polymer and crumbed rubber are added to the mix. This demonstrates and demonstrates how bitumen may be strengthened and made more resilient by adding a certain quantity of garbage. Rubber powder and melted waste plastics are applied to stone aggregate.Rubber and plastic covering increase soundness and decrease porosity and moisture absorption. Therefore, one of the greatest ways to dispose of garbage easily is to use discarded plastics and rubber tires as powder for flexible roadway material. In many ways, using polymer and crumbed rubber-coated aggregate is superior to using traditional aggregates. It is evident from the table that there is a significant discrepancy between the mix's values and the traditional value. There are more than 3.3 million kilometers of roads in India. There will be less waste plastic and waste tires on the road if it is built as a plastic-rubber tar road. The procedure is environmentally benign.

REFERENCES

[1] Souza and Weissman (1994) “Laboratory Investigation of Different Standards of Phase Separation in Crumb Rubber Modified Asphalt Binders”.
[2] Shankar (2009) “Use of Waste Rubber Tyre in Flexible Pavement”, International Journal of Application or Innovation in Engineering and Management.
[3] Nuha S. Mashaan et al. (2012) “An overview of crumb rubber modified asphalt”, International Journal of the Physical Sciences Vol. 7(2).
[4] Sharma Pavan Kumar (2013) “Experimental Study of Flexible Pavement by Using Waste Rubber Tyres”, International Journal of Engineering Research & Technology (IJERT).

[5] Mohd Rasdan Ibrahim, Herda Yati Katman, Mohamed Rehan Karim, Suhana Koting and Nuha S. Mashaan (2013) "A Review on the Effect of Crumb Rubber Addition to the Rheology of Crumb Rubber Modified Bitumen", Hindawi Publishing Corporation in Advances in Materials Science and Engineering.
[6] Harpalsinh Raol et al. (2014) "EFFECT OF THE USE OF CRUMB RUBBER IN CONVENTIONAL BITUMEN ON THE MARSHALL STABILITY VALUE", International Journal of Research in Engineering and Technology.
[7] Nabin Rana Magar,"A Study on the Performance of Crumb Rubber Modified Bitumen by Varying the Sizes of Crumb Rubber", International Journal of Engineering Trends and Technology (IJETT).
[8] Baha Kok and Hakan Colak (2011) "Laboratory comparison of the crumbrubber and SBS modified bitumen and hot mix asphalt", Firat University Engineering Faculty, Civil Engineering Department Elazig, Turkey