Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 4, Issue 2; April-June, 2017, pp. 121-123

http://www.krishisanskriti.org/Publication.html

Experimental Study of Materials Used in Flexible Pavement Using Waste Plastic and Crumb Rubber

Rajneesh Vashisht[1] and Mukesh Saini[2]

[1]B.Tech (Civil) Department of Civil Engineering Maharishi Markandeshwar University Mullana, Ambala, India
[2]Department of Civil Engineering Maharishi Markandeshwar University Mullana, Ambala, India
E-mail: rajneeshvashishtid@gmail.com

Abstract—*In this study, an approach made to understand the improved properties of flexible pavement materials by introducing waste plastic and crumb rubber. The coating of waste plastic over aggregates was done and blending of bitumen with both waste plastic and crumb rubber was done. Rheological experimentations was done to get the improved values. The enhancement in the impact value along with specific gravity and water absorption of the aggregates was recorded. Also, enhancement in the bituminous properties like penetration value and ductility was observed. It was seen that about 16% accumulation of waste plastic and crumb rubber shows highly anticipated results.*

Keywords*: - Waste plastic, Crumb rubber, Bitumen, Aggregate, Impact Value, Water absorption, Penetration, Ductility.*

1. INTRODUCTION

The usage of plastic in India increased day by day. Plastic is used for packing, protecting devotions like packed food, packed water, packing of any material. It is also used for overthrowing off waste. The used plastic once unnerved to the environment it would not get putrefied, it is a non-bio-degradable material. It causes most of the pollution and hazards in the environment. The waste plastic used as landfill or they incinerated, both the processes are hazards to environment. These cause land and air pollution. In case of rubber, mostly waste tyres are disposed in the environment. The risks of waste tyres caused air pollution while open burning of tyres leads to discharge of hydrocarbons, nitrogen, dioxin, oxides and shows visual impression in the atmosphere [5]. Even they cannot be re-used for same purpose. As a whole plastic is not an eco-friendly material. In this research paper, an approach is made to use the waste plastic and crumb rubber as properties enlightening materials for construction of flexible pavement. The combination of these wastes with aggregates and bitumen revealed great results. As the HDPE (high-density polyethylene) can be used as the blending material to develop quality of roads [1]. The flexible pavement agonizes may fails during monsoon and under high impact loading due to the brakes of moving vehicles. The introduction of waste plastic and crumb rubber blended pavement shown great results against such failures [4]. Therefore, use of waste plastic and crumb rubber in road construction could be a great achievement to save our environment against hazards of these non-bio-degradable materials. Also helps to advance the flexible pavements properties. Previously few studies reported following trends.

[2]Chaudhary, A.K. et.al (2010) used Kharkai River, Jamsedhpur, Jharkhand (India) soil along with HDPE waste from local rag picker. The waste strips were cut into 12mm length and placed arbitrarily in the soil sample with different percentage of 0.25%, 0.5%, 1.0%, 2.0% and 4.0% waste. The CBR test was completed over the test specimens and it was determined that the CBR value of the specimens increased almost three times than that of the controlled sample.

[3]Naskar, M et.al.(2010) used 60/70 grade bitumen as controlled sample and blended it with waste plastic films of 2mm x 2mm size. The deliberation of waste to bitumen in blend was taken as 0,1,3,5 and 7% by weight of bitumen. Tests for thermal, rheological and physical properties were done and it was concluded that bitumen ability was improved by blending it with waste plastic. The optimum waste plastic content was taken as 5%.

[4]Ahmadinia, E. et.al. (2011) reported that using PET (polyethylene Terephthalate) blend the Marshall Stability results 6% optimum content.

[5]Vasudevan, R. et.al.(2011) worked on the plastic coated aggregates along with plastic blend mixture of bitumen basic properties were checked and field assessment was also reported. It was determined that using dry process the plastic coated aggregates shown greater results and can improve the flexible pavement properties. By field valuation, it was seen that high percentage of plastic waste could be used. Possibly 10% of bitumen can be reduced to get better results. This process can reduce the coast of the pavement along with

increase in the strength. Due to better binding, these roads can be used for heavy traffic.

[6]Rokade S. (2012) concluded that maximum of 25% Marshal Stability values can be increased by using LDPE (Low-density polyethylene) and CRMB (Crumb rubber modified bitumen). Also the dry process was concluded that a huge improvement in the aggregate properties.

[7]Patel, C.B. et.al. (2013) worked on the wet process and resulted that softening point, penetration and ductility of blended bitumen were improved. Penetration and ductility was decreased while softening point increased.

[8]Wayal, A.S. et.al. (2013) this study gives results of both wet and dry processes and determined an increase in the strength due to accumulation of waste to the bitumen. The toughness of coarse aggregates was improved by coated rubber powder and waste plastic. Also reduces the porosity, absorption of moisture and enhancement in the ductility recorded.

All these studies helped to think about the improvement of flexible pavement construction materials by introducing waste plastic and crumb rubber.

2. MATERIALS AND METHODS

Preparation of Modified Bitumen: -

The modified bitumen prepared by two processes wet process and dry process. The samples were prepared according to the MORTH specifications.

Wet Process: -

Bitumen sample was heated to 160°C to a fluid condition. The mixing was performed in the laboratory with the help of stirrer, the stirring was continuous and rapid. After softening the bitumen, temperature was recorded. The waste plastic or crumb rubber by weight of bitumen was added slowly in order to avoid agglomeration of the material. The sample preparation took 1 hour of blending. 1 hour of settling time was required for the sample after complete blending. Each sample was prepared similarly. The percentage of modifier varied from 1% to 16%. Total five samples were prepared control, 8% mixing of waste plastic and crumb rubber, 16% mixing of waste plastic and crumb rubber by weight of bitumen.

Dry Process: -

Plastic waste (bags, cups, etc.) cut into small size of about 3mm – 6mm using scissors. PVC waste should be eliminated because during melting it release harmful gases. The aggregate mix was heated to 165°C and transferred to mixing dish. Similarly, the bitumen was heated up to a maximum of 160°C to have good binding and to prevent weak bonding temperature was maintained to 160°C. The waste plastic and crumb rubber that was cut into small pieces of size about 3 mm – 6mm was added to the aggregate samples. It was coated uniformly over the aggregate within 1 minute and gives shining oily look. Total three samples were prepared control, 8% mixing of waste plastic, 16% mixing of waste plastic. An improper bonding between crumb rubber and aggregates was seen. Therefore, no sample of crumb rubber and aggregate was not prepared.

Tests Performed: -

General rheological properties were tested by following tests;

a) Aggregate Impact Value,
b) Specific gravity and Water absorption test,
c) Penetration Value of Bitumen, and
d) Ductility of Bitumen.

Aggregate Impact Value: -

This test was performed according to IS: 5640-1970. The test sample aggregates consist of sized 10mm - 12.5mm. Aggregates may be dried by heating at 100°C - 110°C for a period of 4 hours and cooled. Sample were sieved through 12.5 mm and 10mm IS sieves. The aggregates passed 12.5mm sieve and retained the 10mm IS sieve were taken as testing aggregates and impact value was obtained by using Impact value apparatus as per IS: 2386 (IV) – 1963. The impact value was taken as

$$\text{Aggregate impact value} = (C/A) \times 100$$

Where; C = weight of the fines found, and

A = weight of the oven dried sample.

Specific gravity and Water absorption test: -

About 2 kg of aggregates were washed and placed in the wire basket and immersed in distilled water for 24 hours. The basket and sample were removed from water and allowed to drain for few minutes, after which the aggregates were surface dried and weighed after that the aggregates were placed in oven at 110°C for 24 hours. Then the aggregates were placed in airtight container and remained to cooled down. The specific gravity was obtained by dry weight of the aggregate/weight of equal volume of water and apparent specific gravity was taken as dry weight of the aggregate/weight of equal volume of water excluding air voids in aggregate.

Penetration Value of Bitumen: -

The bitumen samples were softening to easy pouring at a temperature of about 90°C. It was stir properly until it was freed from air bubbles and achieved homogeneity. The whole procedure was done according to the IS: 1203 – 1978. The procedure was followed to obtain the results of each sample. This test was performed to obtain the hardness or consistency of the samples.

Ductility of Bitumen: -

This test was performed to get the adhesiveness of the sample. The bitumen samples were melt at 90°C and stir properly all the air bubbles were removed and homogeneous sample was prepared. All samples were poured in the briquette moulds. After 40 minutes, the samples were placed in the water bath. The temperature of water bath was maintained up-to room temperature for half an hour. After that, the demoulding of sides of briquette mould was performed and the plate were placed in the machine and hooked with clips tightly without causing any initial strain. The machine was adjusted to horizontal speed of 50mm/min. The final distance was measured when the bitumen thread was broken into two parts. The experiment was done according to the IS: 1208 – 1978.

3. RESULTS

Results obtained from experimental analysis were as following;

Table 1: Results of Aggregate Impact Value.

Sr. No.	Sample	Aggregate Impact Value
1.	Plain Aggregate	19.1
2.	8% waste plastic coated aggregate	9.5
3.	16% waste plastic coated aggregate	8.25

Table 2: Results of Water absorption and Specific gravity.

Sr. No.	Sample	Water absorption value	Specific gravity
1.	Plain Aggregate	0.44 %	2.67
2.	8% waste plastic coated aggregate	0.34%	2.63
3.	16% waste plastic coated aggregate	0.19%	2.60

Table 3: Results of Penetration.

Sr. No.	Sample	Penetration (mm)
1.	Plain Bitumen	69
2.	8% waste plastic mix	44
3.	16% waste plastic mix	40
4.	8% waste crumb rubber mix	61
5.	16% waste crumb rubber mix	58

Table 4: Results of Ductility.

Sr. No.	Sample	Ductility (cm)
1.	Plain Bitumen	75
2.	8% waste plastic mix	57
3.	16% waste plastic mix	52
4.	8% waste crumb rubber mix	73.6
5.	16% waste crumb rubber mix	70

4. CONCLUSION

The present study on the topic "Experimental study of materials used in flexible pavement using waste plastic and crumb rubber" has been carried out to assess the effect of waste plastic & crumb rubber in mix design. The properties of plain aggregate were compared with that of waste plastic coated aggregates and properties of bitumen were compared with that of plastic and crumb rubber blended bitumen. The main conclusions from the study were

- It was observed that the impact value of aggregate possibly be improved up-to 10% by coating them with waste plastic. Great improvement in the quality of aggregate was recorded.
- It was found that the water content was lower in case of plastic coated aggregate samples. This shows that the coating of plastic plugs the voids. Hence, the coating of plastic over aggregate helps to improve the quality of the aggregate.
- The specific gravity of waste plastic coated aggregate is nearly equal to the plain aggregate.
- It was observed that the modified samples were lower as compared to that of controlled sample in case of penetration value.
- Similar results were recorded in case of ductility of the samples; the control sample was highly ductile compared to that of modified samples.

REFERENCES

[1] S.S. Verma, "Roads from plastic waste," in *The Indian Concrete Journal*, 2008, pp. 42-43.

[2] A.K. Choudhary et.al. "A Study on CBR Behaviour of Waste Plastic Strip Reinforced Soil," in *Emirates Journal for Engineering Research*, 15(1), 51-57(2010).

[3] M.Naskar et.al. "Effect of waste plastic as modifier on thermal stability and degradation kinetics of bitumen/waste plastic blend," in *Thermochimica Acta* 509 (2010) 128-134.

[4] Esmaeil Ahmadinia et.al. "Using waste plastic bottles as additive for stone mastic asphalt," in *Materials and Design* 32 (2011) 4844-4849.

[5] R. Vasudevan et.al. "A technique to dispose waste plastic in an eco-friendly way – Application in construction of flexible pavements," in *Construction and Building Materials* 28 (2012) 311-320.

[6] Rokade S. "Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements," in *International Conference on Future Environment and Energy IPCBEE*, Vol.28 (2012), IACSIT Press, Singapore, pp. 105-108.

[7] Patel Chirag B and Prof. S. M. Damodariya "Study on Effect of Waste Plastic and Crumb Rubber on Physical Properties of Bitumen," in *International Journal of Scientific Research*, Vol. 2, Issue: 5, 2013, pp. 163-166.

[8] Dr. Abhaykumar S Wayal and Mudassir D. Wagle "Use of Waste Plastic and Waste Rubber in Aggregate and Bitumen for Road Materials," in *International Journal of Emerging Technology and Advanced Engineering*, Vol. 3, Issue: 7, 2013, pp. 301-306.