



# A STUDY ON UTILIZATION OF WASTE PLASTIC AND WASTE RUBBER TYRE IN THE CONSTRUCTION OF FLEXIBLE HIGHWAY PAVEMENT: A RESEARCH

Arun Kumar<sup>1</sup>, Ankur Kumar<sup>2</sup>, Ashfak Ahamad<sup>3</sup>, Anurag<sup>4</sup>,  
Jitendra Kumar Bharti<sup>5</sup>

<sup>1,3,4,5</sup> Undergraduate Civil Engineering Department,

Buddha Institute of Technology Gorakhpur (India)

<sup>2</sup>Assistant Professor, Civil Engineering Department,

Buddha Institute of Technology Gorakhpur (India)

## ABSTRACT

The solid waste disposal is the major concern in our country due to this we find the solution of the solid waste disposal in the construction of the flexible pavement. The rising price of binder materials for road construction is a matter of concern. India is the second fast growing auto-mobile industry in the world and due to this large amount of waste rubber tyre is produced. Plastic is also the non-degradable substance, whenever the plastic mixed with the soil then it reduces the soil fertility and alter the growth of agriculture, which is the main source of employment in India. The plastic and rubber tyre continuously mixed with the soil is leading to decrease in the soil fertility and due to this reason the currency of India is declining day by day, as the economy of our country is dependent on agriculture. Utilization of wastes like waste plastic and waste rubber tyre as a binder material in pavement mix not only solves the problem of disposing these solid waste but also helps in the conservation of natural resources. This paper investigates the replacement of bitumen with a mix of plastic waste and crushed rubber tyre for preparation of highway flexible pavement. A modified binder has been prepared by utilizing the waste plastic and waste rubber tyre with the partial replacement of bitumen up to 14% which is known as bituminous binder. The utilization of this binder in highway pavement is estimated to reduce the cost of construction up to 4.28 lakhs rupees for 1Km of road network.

**Keywords:** Plastic, Rubber tyre, Bitumen, Modified binder, Flexible pavement.

## 1. INTRODUCTION

The construction of road in India is very old and we all know that the road fails after few days of construction. The waste plastic decrease the soil fertility because plastic is also the non degradable substance, elastic, waterproof materials and it release the poisonous chemicals. India is the second fast growing automobile industry in the world due to the reasons heavy amount of waste rubber tyre increase. The water filled waste tyre

caused the generation of mosquitoes and they also cause hazards through it such as dengue, chikungunya etc. Bitumen is hydrocarbon material it found in the form of gaseous, liquid, solid or semisolid. Bituminous material is commonly used in the construction of roads. It is used in the construction because of their binding and waterproof properties. In this project we prepare the modified binder with the help of waste plastic and waste rubber tyre in the construction of flexible highway pavement with the partial replacement of bitumen. After the various test, we find that is can be use in the construction of highways because its properties is too good as compared to the normal bitumen binders. After replacing the bitumen with waste plastic and waste rubber we reduce the cost of construction about 4.28 lakhs in 1Km.The waste rubber tyre and plastic mixed with bitumen as melted form at 160°C.

### 1.1 HARMFUL EFFECTS OF PLASTIC WASTE DISPOSAL

- 1) The waste plastic decrease the soil fertility.
- 2) The waste plastic leaves the harmful chemical to the ground and pollutes the ground water table.

### 1.2 HAZARDS DUE TO WASTE TYRE

- 1) The waste tyre produces carbon at the time of burning.
- 2) The water filled waste tyre caused the generation of mosquitoes.

## 2. MATERIAL AND DESIGN PROCEDURE

### 2.1 BITUMEN

Bitumen is highly viscous and black substance. Bitumen is hydrocarbon material it found in the form of gaseous, liquid, solid or semisolid. Bituminous material is commonly used in the construction of roads.

### 2.2 WASTE CRUMB RUBBER

The waste crumb rubber tyre is used in the form of scrap form. It contains the synthetic, natural and carbon black.



The truck tyre is less synthetic and it contains high percentage of natural rubber. In the present time lots of waste rubber tyre increases the cars tyres contain four types of natural rubber, carbon black, steel cord, bead wire, waxes, oils, pigment and lots of chemicals. The crumb rubber tyre used of size 4.75mm through the cracker Mills. The waste rubber tyre mixed with the bitumen as the melted forms at 160°C with the heated bitumen.

### 2.3 WASTE PLASTIC

The waste plastic is non degradable substance. The waste plastic mixed with the bitumen and utilizes the waste plastic in the manufacturing of modified binders.



*FIG-2: WASTE PLASTIC*

### **3. MODIFIED BITUMEN BINDERS (MBB)**

The modified bitumen binder prepare with the help of waste plastic and waste rubber tyre. In preparing the modified binders, the bitumen was heated to a fluid condition and the crumb rubber tyre was heated at 160° C and then plastic and crumb rubber tyre was added. The contents are gradually mixed with mechanical stirred device and then cooled at room temperature.



*FIG-3: MODIFIED BINDERS*

## **4. EXPERIMENTAL STUDIES**

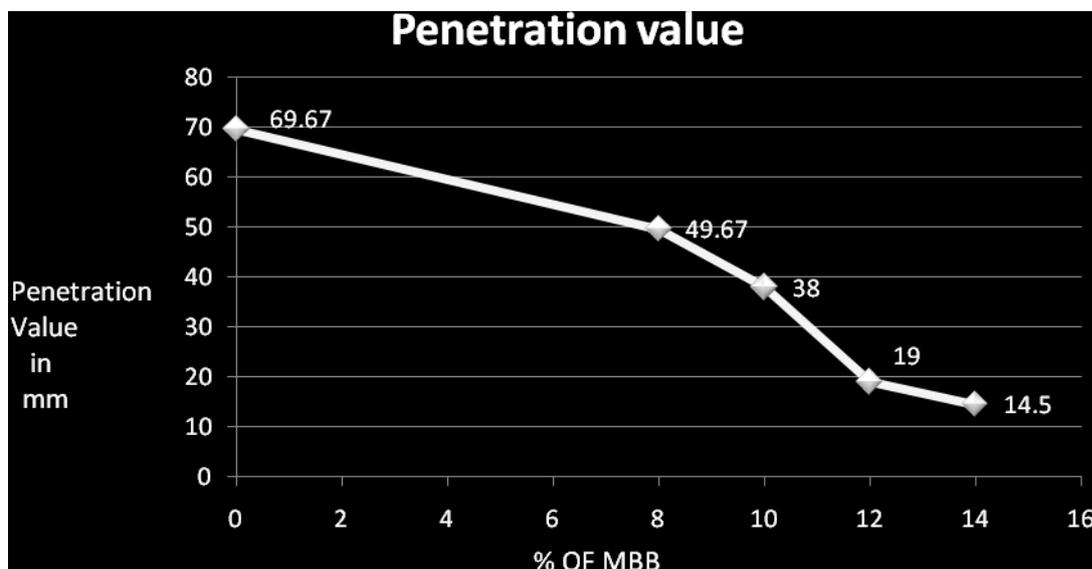
### **4.1 PENETRATION TEST**

The penetration test determine the consistency of materials for grading them by measuring the depth in tenths of a millimeter to which needle will penetrate vertically in 5 seconds and maintained the temperature at 25°C.



0% MBB	• Initial	0	0	0	Avg. =69.67 mm
	• Final	70	70	69	
8% MBB	• Initial	0	0	0	Avg. =49.67 mm
	• Final	50	50	49	
10% MBB	• Initial	0	0	0	Avg. =38mm
	• Final	37	37	40	
12% MBB	• Initial	0	0	0	Avg. =19mm
	• Final	18	19	20	
14% MBB	• Initial	0	0	0	Avg. =14.5mm
	• Final	15	15	13.5	

The test was conducted for the normal bitumen and modified bitumen binder(MBB) with 0%,8%,10%,12% and 14% .The penetration value decrease with increase the plastic and rubber waste. Lower penetration value gives the additional strength to the road and reduces the water damage.





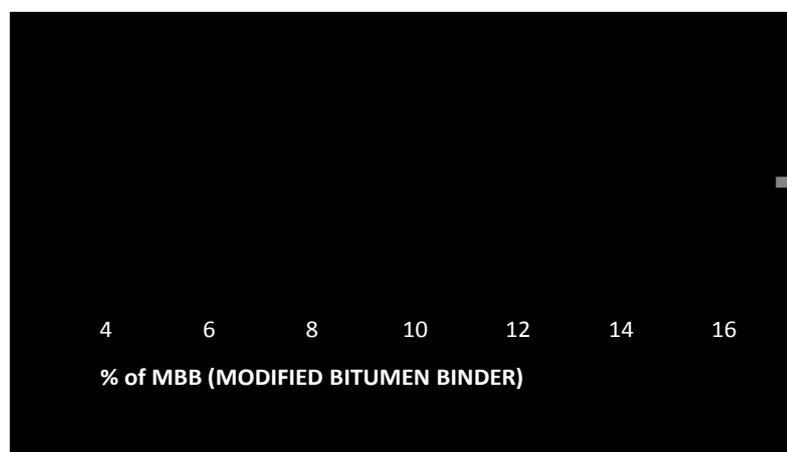
#### 4.2 SOFTENING POINT TEST

The Bitumen does not suddenly change from solid to liquid state, but as the temperature increase it gradually becomes softer until it flows readily. A semi solid state bitumen grades need sufficient fluidity before they are used for application with the aggregate mix. For this purpose bitumen is sometimes cut back with a solvent like kerosene. The common procedure however is to liquefy the bitumen by heating. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test. For bitumen it usually determined by Ring and Ball test. Brass ring test containing the test sample of bitumen is suspended in liquid like water at a given temperature. A steel ball is placed on the bitumen and liquid medium is then heated at a specified distance below the ring is recorded as the softening point of particular bitumen. The apparatus and test procedure are standardized by ISI. It obvious but harder grade bitumen posses higher softening point than softer grade bitumen. The concept of determining the softening point by Ring and Ball apparatus.

Table 1: Softening Point Test Result

% of MBB	Reading in °C	Reading in °C	Average in °C
0	45	42	43.5
8	50	51	50.5
10	51	51	51
12	50.6	50.9	51.75
14	55	55.5	55.25

The test was conducted for the normal bitumen and modified bitumen binder (MBB) with 0%, 8%, 10%, 12% and 14%. The softening point increase with adding the waste plastic and rubber.





### 4.3 DUCTILITY TEST

The ductility is the property to formation of thin wire. The ductility is defined as the distance in cm, to which the bitumen elongated without breaking. This test was conducted through the Briquette mould apparatus.

**Table 2:** Test result of Ductility value

% of MBB	Sample1 in cm	Sample2 in cm	Average in cm
0	79	78.5	78.75
8	40	42	41
10	35	35	35
12	28	27	27.5
14	22	25	23.5

The test was conducted for the normal bitumen and modified bitumen binder (MBB) with 0%, 8%, 10%, 12% and 14%. The distance stretched by moving end of the specimen up to recorded as ductility value.



### 5. CONCLUSION

The various researches investigated the utilization of waste plastic in the construction of flexible highway pavement. In this research we will investigate the utilization of a mixture of waste rubber tyre and discarded plastic material as a partial replacement for the bitumen at different proportion. The addition of tyre will lead to the enhancement of the ductility and durability of the pavement surface and will also solve the waste disposal of these hazardous substances.

### 6) ACKNOWLEDGEMENT

I take this opportunity to express my sincere gratitude to all those who helped me in various capacities in undertaking and devising the report.



I am privileged to express my sense of gratitude to my respected sir Assistant Prof. Ankur Kumar whose unparalleled knowledge, moral fiber and judgment along with his know-how, was an immense support in completing the paper.

I am taking this opportunity also to thank our friends and contemporaries for their co-operation and compliance.

#### REFERENCE

- [1] International Journal of Management, Technology And Engineering, ISSN NO: 2249-7455, Volume 8, Issue X, OCTOBER/2018.
- [2] Highway Engineering by S.K. Khanna, C.E.G. Justo, A.Veeraragavan.
- [3] Effect of Rubber tyre and Plastic waste use in Asphalt concrete pavement *F.Onyango, Salim R. Wanjala, M. Ndege, L. Masu*. International Journal of Civil and Environmental Engineering. Volume 9.No11,2015
- [4] Utilization of rubber waste in construction of flexible pavement *Nitu H. Deshmukh, Prof. D.Y. Kshirsagar*. International Journal of Advance Research and Development. Volume 2, issue7
- [5] IS Code 2386 1963 part 4.
- [6] IRC, Guidelines for design of flexible pavement.
- [7] IRC 37-1970, Indian Road Congress IRC: SP: 53, Tentative *Guidelines on the use of polymer and rubber modified Bitumen in Road construction*, IRC 2002.
- [8] IRC SP-53:2010, Guidelines on use of modified bitumen in road construction.