

# UTILIZATION OF PLASTIC WASTE IN CONSTRUCTION OF BITUMINOUS ROAD

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**Abstract** - The usage of recycled plastic waste in construction of a pavement facilitates in economic savings and conservation of natural assets in addition to solves problem of disposal of huge quantity of waste substances produced every yr. Considering widespread blessings of recycled plastic waste, the toll road agencies round the sector are endorsed to apply it in creation of pavements. But, use of plastic waste is not famous in India because of the shortage of specific pointers and design manner. Moreover, size and interpretation of rheological performance of RAP mixed binders require boost laboratory devices. A bendy pavement studies exceptional climate, excessive solar radiation, temperature, oxidation, and visitors loading and unloading situations, which leads to a stiffer and aged binder through the years. The waste plastic and its disposal are a primary threat to the environment, which results in pollution and global warming. The utilization of plastic waste in bituminous mixes enhances its houses and its electricity. Further, it will additionally be an approach to plastic disposal & various defects in pavement viz., potholes, corrugation, ruts, and so on. The waste plastic used are poly-ethylene, polystyrene, polypropylene. The waste plastic is shredded & coated over mixture & combined with warm bitumen and resulted blend is used for pavement construction. This can now not handily strengthen the pavement and increases its sturdiness. The titanium-dioxide is used as a smoke absorbent fabric, if you want to soak up the smoke from the vehicles. This modern era might be boon for Indian hot-humid weather. In this paper, we've got mentioned approximately the soil properties to be taken into consideration in design of pavement, pavement design, manner of construction flexible and plastic- smoke absorbent pavement.

**Key Words:** Flexible Pavement, Plastic waste, Aggregate.

## 1.INTRODUCTION

Plastic is anywhere within the present way of life. Its miles applied for bundling, safeguarding, serving, and in any occasion, discarding different types of patron products. With the contemporary transformation, mass advent of products started and plastic seemed to be a less high priced what is extra compelling natural substance. nowadays, each important region of the financial system starting from farming to bundling, auto,

constructing development, been nearly reformed by means of the uses of correspondence or InfoTech has plastics. Plastic in various structure is discovered, which is poisonous in nature. it's far in most cases gathered both metropolitan and provincial areas. It makes stagnation of water and associated cleanliness troubles. Plastic squander peril to the weather. Plastic waste can be reused beneficially in the improvement of roads.[1]

Most of the people of the cleared streets in our state have granular sub base and base; bituminous base and carrying publications. Plastic is a highly adaptable material. because of the contemporary insurgency, and its big scope advent plastic regarded to be a much less high-priced and compelling unrefined substance. nowadays, each essential region of the economic system beginning from agribusiness to bundling, vehicle, gadgets, electric, building improvement, correspondence regions has been basically altered by the makes use of plastics. Plastic is a non-biodegradable cloth and scientists noticed that because the cloth can stay on the earth for a totally long term without corruption. some investigations have tested the wellbeing hazard brought approximately by way of unwell-advised elimination of plastic waste. Plastics, a flexible material and a accomplice to common person grow to be an difficulty to the climate after its usage. removal of an assortment of plastic and elastic squanders in an eco-accommodating manner is the pushed location of the present examination. searching forward the situation of present manner of life a complete restriction at the usage of waste plastic cannot be placed, albeit the waste plastic taking the substance of a villain for the present and what is to come back age.[2]

## 2. OBJECTIVE

As plastic is non-biodegradable, it creates stagnation of water and associated hygiene troubles. If the waste plastics may be definitely applied in toll road production, the pollutants and disposal troubles can be decreased to an extraordinary quantity. Plastic waste while combined with hot bitumen, soften to form an oily coat over the combination and the mixture may be laid on the road floor like an everyday tar street. The use of plastic along with the bitumen in the production of roads no longer the handiest will increase its smoothness and existence however also makes it economically sound and environmentally pleasant. Plastic Roads constructed are located to perform higher as compared to the ones constructed with traditional bitumen. The need for bitumen can be decreased by about 10%, with the aid

of using a better percentage of plastic waste. The performance and strength of avenue are likewise accelerated. Plastic will increase the melting factor of bitumen and therefore mixing may be executed in a greater better and less complicated manner.

### 3. LITERATURE SURVEY

They have got cited that, the Quantitative adjustments in Viscosity, Softening factor, Penetration cost, Marshal stability and DSR test. Which is used to explain the viscous and elastic behavior of the changed bitumen at distinctive temperature. in line with the look at it's far located that, blending distinct level of plastic in bitumen indicates high-quality outcome on the precise take a look at achieved at some stage in this paper. The vacillation of check records with different degree of plastic blended in bitumen is switching round to perfect stage then it either suggests damaging final results or stays unaltered. inside the modern-day investigation of various lab test, the ideal plastic substance changed into viewed as 8% by weight of bitumen [5].

The plastic introduction over the world has crossed four hundred million heaps and the reusing of plastic is simply 10%. unique checks are being directed to paintings at the properties of bituminous street. the new headway in that look at is utilization of waste plastic in road development. Plastic road has much less dampness ingestion than typical roads. durability of road is increments whilst contrasted with typical street. The hotness treatment of plastic may additionally prompt arrival of hurtful gases to air [7].

They have got cited that, the removal of destroyed biomedical plastic waste (BMPW) with the aid of involving it in bituminous road construction. The work become confined to the utilization of biomedical plastic waste just and it was completed through adding dealt with autoclaved needle plastic waste. So here in these studied comparisons among the two techniques were achieved and the exceptional technique became cautioned. Its smarter to utilize plastic covered totals than involving it as a modifier in bitumen. There by way of we will supply solid, sturdy and eco-accommodating roads – which alleviate the earth from all type of plastic-squander [3].

They have cited that, make use of Non- Degradable Plastic, Carbon Rubber in Bitumen. And compare the electricity Characters of everyday Bitumen And (Waste Plastic& Carbon Rubber) introduced Bitumen 5% 7% 9%. on this project venture contrasted the ordinary bitumen homes and the waste plastic and waste degrees bitumen at diverse rates. the suitable degree of plastic and tires to be added is 7% [9]. they have noted that, soil test, layout the bendy pavement, layout the asphalt pavement with aggregate- plastic- bitumen blend, coat. The aggregate with plastic and incorporate titanium di-oxide, take a look at the bitumen and the changed bitumen. The plastic blended in with bitumen and totals is utilized for the better overall performance of the roads. The polymer protected on totals decreases the voids and dampness retention. The utilization of smoke spongy material (titanium di-oxide) by means of 10% of polymer content material can lessen the vehicular infection [6].

They have got mentioned that, the finest percentage of waste plastic to be introduced within the bitumen blend for

buying the specified electricity. The research methodology for present look at has adopted Six Marshall stability tests could be prepared out of which 3 can be with the plastic of changing price (5%, 10%, and 15%) and three examples without plastic waste. investigation of the conduct of plastic waste modified BC, we can cause that the altered blend has similarly advanced Marshall traits. Its miles seen that Marshall balance esteem increments with plastic substance and we noticed that the Marshall go with the flow esteem diminishes upon growth of polythene [4].

### 4. METHODOLOGY

#### 4.1 Road Construction Materials:

The main road constructing materials are as follows,

1. Bitumen
2. Coarse aggregates
3. Fine aggregates
4. Plastic waste

##### 4.1.1 Bitumen

A black or darkish brown non-crystalline stable or viscous cloth having adhesive residences, derived from petroleum either by means of herbal or refinery methods and appreciably soluble in carbon disulphide. Crude petroleum acquired from distinct locations is quite extraordinary of their composition. The portion of bituminous fabric present inside the petroleum might also widely differ depending at the supply. nearly all the crude petroleum comprises good sized amounts of water in conjunction with crude oil. as a result, the petroleum should be dehydrated earlier than wearing out the distillation. popular types of distillation tactics are fractional distillation and unfavorable distillation. In fractional distillation the numerous volatile components are separated at successively higher temperatures without vast chemical alternate.

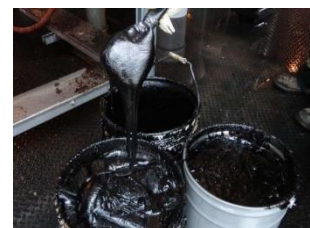


Fig.1: Bitumen

The successive fractions acquired yield gasoline, naphtha, kerosene and lubricating oil; the residue could be petroleum bitumen. The system is commonly carried out for the manufacture of tar. Steam distillation of petroleum is employed to produce steam refine petroleum bitumen with a view to put off excessive boiling point components including heavy lubricating oils without causing chemical adjustments. whilst the residue is distilled to a specific consistency without in addition treatment, the bitumen obtained as residue is called immediately run bitumen.

#### 4.1.2 Coarse Aggregate

Aggregate constitutes the granular part in bituminous concrete mixtures which contributes up to 90-95 % of the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture. Hence, the quality and physical properties of the aggregates should be controlled to ensure a good pavement.

The aggregates of size ranging from 4.75mm to 75mm are known as coarse aggregates. Coarse aggregate should be screened crushed rock, angular in shape, free from dust particles, clay, vegetations and organic matters.



Fig. 2: Coarse Aggregates.

#### 4.1.3 Fine aggregates

The aggregates passing through 4.75mm sieve are known as fine aggregates or sand. Fine aggregate should be clean screened quarry dusts. It should be free from clay, loam, vegetation or organic matter.



Fig. 3: Fine Aggregates.

#### 4.1.4 Plastic waste

Plastic is a material consisting of any of a wide range of synthetic or semi-synthetic organics that are malleable and can be molded into solid objects of diverse shapes.

Plastics are divided into two main types according to how they behave when heated;

- **Thermoplastics**

Thermoplastic plastics undergo strong molecular motion when heated, which causes them to soften. They harden when cooled, and repeated heating and cooling allows them to be molded into a variety of different shapes. Uses include containers and packaging material (Film, sheet, bottles), daily necessities, household appliances and automobiles.

- **Thermosetting Plastic**

Thermosetting Plastic undergoes relatively weak molecular motion but once softened by heat and treated they undergo a chemical reaction which causes them to form a high molecular weight 3D matrix structure. This means that once they have set they cannot be softened again by heat. Uses include food containers, circuit boards for electrical equipments, shafts for golf clubs and tennis rackets, and fiber-reinforced plastic boats.



Fig. 4: Waste Plastic.

#### 4.2 Laboratory testing

Tests Taken into Consideration:

1. Ductility Test.
2. Penetration Test.
3. Softening Point Test.
4. Marshal Stability Test.

##### 4.2.1 Ductility Test.

Ductility can be defined as the property of substance which permits it to be reduced in cross sectional area without fracture or in other words ductility is defined as distance in cm to which standard bitumen can be stretched before the thread breaks. The briquette is stretched at a rate of 50mm/minute  $\pm 25$ mm per minute at a temperature of  $27^\circ\text{C} \pm 0.5^\circ\text{C}$ .

Table 1: Ductility Values with Different Percentage of Plastic

Sr. No.	Percentage of Plastic Waste	Ductility Value in cm
1	0 %	40
2.	1 %	29.4
3.	2 %	25
4.	3 %	21.8
5.	5 %	15.1

#### 4.2.2 Penetration Test.

The Penetration of a bituminous material is the distance in tenths of millimeter that a standard needle will penetrate vertically into a sample of the material under standard conditions of Temperature, Load and Time.

Table 2: Penetration Values with Different Percentage of Plastic

Sr. No.	Percentage of Plastic Waste	Penetration Value in 1/10th of mm
1	0 %	46
2.	1 %	44
3.	2 %	40
4.	3 %	33
5.	5 %	24

#### 4.2.3 Softening Point Test

The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test.

Table 3: Softening Point with Different Percentage of Plastic

Sr. No.	Percentage of Plastic Waste	Softening Point in °C
1	0 %	48
2.	1 %	54
3.	2 %	58
4.	3 %	65
5.	%	86

#### 4.2.4 Marshall stability test

In this method, the resistance to plastic deformation of a compacted cylindrical specimen of bituminous mixture is measured when the specimen is loaded diametrically at a deformation rate 53 of 50 mm per minute.

Table 4: Marshal test Average data

% Bit. By Weight of Mix	Bulk Sp. Gr. (Gmb)	Stability (kN)	Voids in Mineral Agg. VMA (%)	v
Limits	-	Min. 9	Min. 13.5	<b>65 - 75</b>

4.00	2.412	13.22	15.91	51.89
4.50	2.431	14.51	15.67	63.97
5.00	2.440	15.53	15.81	71.63
5.50	2.441	15.92	16.24	76.82
6.00	2.430	15.41	17.06	78.11
6.50	2.410	14.25	18.18	77.73

Flow (mm)	Air Voids VA (%)	Marshall Quotient	Vb (%)	Parameter	Binder Content (%)
2 - 4	3 - 5	2-5			
2.17	7.66	6.10	9.62	Bulk Sp. Gr.	5.40
2.43	5.65	5.96	10.91	Stability (kN)	5.50
2.97	4.49	5.24	12.16	VFB (%)	5.25
3.27	3.76	4.87	13.38	Air Voids (%)	5.55
3.63	3.73	4.24	14.53		
4.17	4.05	3.42	15.62		
				Average (OBC in %)	5.43

### 3. CONCLUSIONS

Following conclusion can be drawn from the study of Utilization of Plastic Waste in Bitumen,

1. The results of this study conclude that, the addition of waste plastic has improved the properties of penetration, ductility, and softening temperature of the modified bitumen.
2. There is significant decrease in penetration values for modified bitumen, indicating the improvement in their temperature susceptibility resistant characteristics.
3. The Plastic waste which is hazardous to our environment, it is the best way to get rid of from these waste by utilizing it without hampering the



environment.

4. Plastic road would be a boon for India's hot and extremely humid climate where durable and eco-friendly roads which relieve the earth from plastic waste.
5. Hence from our study, we can state up to 2% replacement of bitumen is feasible. As the 2% of replacement shows good Binding and other desirable properties.

11. IS : 1203 – 1978, "Determination of Penetration", Bureau of Indian Standards, New Delhi, 2007.
12. IS : 1205 – 1978, "Determination of Softening Point", Bureau of Indian Standards, New Delhi, 2007.
13. IS : 1208 – 1978, "Determination of Ductility", Bureau of Indian Standards, New Delhi, 2007.
14. IS : 73 – 2013, "Paving Bitumen – Specification", Bureau of Indian Standards, New Delhi, 2013.

## REFERENCES

1. Mrs. Vidula Swami, Abhijeet Jirge, Karan Patil, Suhas Patil, Sushil Patil, Karan Salokhe, "Use of waste plastic in construction of bituminous road", International Journal of Engineering Science and Technology (IJEST), Volume 4, May 2012.
2. Amit Gawande, G. Zamre and V. C. Renge, "Utilization Of Waste Plastic In Asphaltting Of Roads", Journal of Engineering Research and Studies (JERS), Volume 3, April 2012.
3. Rokade S, "Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway pavements", International Conference on Future Environment and Energy.
4. Biswanath Prusty, "Use of Waste Polyethylene In Bituminous Concrete Mixes", National Institute of Technology", Rourkela May 2012.
5. Afroz Sultana, "Utilization of Waste Plastic as a Strength Modifier in Surface Course of Flexible and Rigid Pavements", International Journal of Engineering Research and Applications (IJERA), Volume 2, July 2012.
6. S.S. Verma, "Roads from plastic waste", The Indian Concrete Journal, Nov 2008
7. R. Sathishkumar, Dr. S. P. Jeyapriya, "Comparison of strength properties of bitumen mixed with waste materials as modifier", International Journal of Civil Engineering and Technology (IJCIET) Volume 4, July 2013.
8. Patel Chirag, Prof. S. M. Damodariya, "Study on Effect of waste plastic and crumb rubber on physical properties of bitumen", International Journal of Scientific Research (IJSR) Volume 2, May 2012.
9. Dr. Abhaykumar S Wayal, Mudassir D. Wagle, "Use of waste plastic and waste rubber in aggregate and bitumen for road materials", International Journal of Emerging Technology and Advanced Engineering (IJETAEE), Volume 3, July 2013.
10. Miss. Apurva J Chavan, "Use of Plastic Waste in Flexible Pavements", International Journal of Application or Innovation in Engineering and Management (IIAEM), Volume 2, April 2013.