

# *USE OF PLASTIC BITUMINOUS ROAD*

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## **ABSTRACT**

The waste plastic and its disposal is a major threat to the environment, which results in pollution and global warming. The utilization of plastic waste in bituminous mixes enhances its properties and also its strength. In addition, it will also be a solution to plastic disposal & various defects in pavement viz., pot holes, corrugation, ruts, etc. the waste plastic used are poly-ethylene, polystyrene, poly-propylene. The waste plastic is shredded & coated over aggregate & mixed with hot bitumen and resulted mix is used for pavement construction. This will not only strengthen the pavement and also increases its durability. The titanium-dioxide is used as a smoke absorbent material, which will absorb the smoke from the vehicles. This innovative technology will be boon for Indian hot-humid climate. It's economical and eco-friendly. In this paper, we have discussed about the soil properties to be considered in design of pavement, pavement design, process of construction flexible and plastic-smoke absorbent pavement.

India has a road network of over 5,472,144 kilo-meters (3,400,233 mi) second largest road network in the world. The plastic wastes can be used in road

construction and the field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. Plastic use in road construction is not new. It is already in use as PVC or HDPE pipe mat crossings built by cabling together PVC (polyvinyl chloride) or HDPE (high-density polyethylene) pipes to form plastic mats. The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. The use of the innovative technology not only strengthened the road construction but also increased the road life as well as will help to improve the environment and also creating a source of income.

Bottle, containers and packing strips etc. is increasing day by day. As a result, amount of waste plastic also increases. This leads to various environmental problems. Therefore, it is necessary to utilize waste effectively with technical development in each field. Many by-products are being produced using the plastic wastes. Plastic waste, consisting of carry bags, cups and other utilized plastic can be used as a coating over aggregate and this coated stone can be used for road construction. The mix polymer coated aggregate and tyre modified bitumen have shown higher strength. Use of this mix for road construction helps to use plastic waste effectively. Now a day's waste plastic is used in bituminous road construction. This technology is not a new concept but rather not practiced widely.

## CHAPTER 1

### INTRODUCTION

#### 1.1 GENERAL

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as “Plastic”. Plastic waste is a huge threat to the environment. In 2005, after monsoon rains flooded Mumbai, plastic bags were blamed for clogging the underground drainage system and intensifying the effect of the floods. In areas frequented by tourists, like Goa, heavy consumption of bottled water has resulted in trash on beaches, creating eyesores and endangering marine life. Even India’s cows, considered sacred, have not been spared. After 3,000 cows died in Lucknow in 2000, the city investigated and found plastic bags in their stomachs. Apparently the bags had been ingested as the animals grazed at dump sites. With more than 35 tons of plastic waste generated by every Indian state, each day India is confronted with the big question of how to get rid of this non-biodegradable menace?

Table 1.1: Plastic Scenario

PLASTIC SCENARIO
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Plastic Common Man's  
Friend Energy Saving  
Superior Priority  
Convenient to  
Carry  
Energy For Transportation Cost is less

Plastic is boon for humans. As it has cheap cost, easy to transport, can be used for different purpose. For Packaging purpose mainly, we use jute bags, paper bags, cloth bags which is heavy and not economical for transport. So for overcoming it we prefer plastic bags or carry bags. In a Survey it was found that a plastic can be long lasting more than 4000 years. It was good to know that life of plastic is more than any other packaging material. Plastics, are versatile packing materials and commonly used by man but they become problem to the environment.



Mostly used plastics products are bags, cups, films and foams, made up of polyethylene, polypropylene or polystyrene. In our country we use so many plastics in our daily use.

Plastic is the most widely used material in the present times. It is light in weight, moisture resistant, flexible and very inexpensive. These qualities increase our propensity towards plastic and hence making its use very common. Today

plastic is used in every vital sector of the economy, ranging from agriculture to automobile, electronics, construction, etc. It has revolutionized all spheres of life. But this plastic ultimately becomes a waste. It is a common site both in urban and rural areas to see plastic wastes littering the roads. It forms the major portion of the total municipal solid wastes (MSW). Tons of plastic wastes which include polyethene, cups, bags, etc. are discarded every year, polluting land, rivers, seas, oceans, etc. plastic is a non-biodegradable material and it has been found that it can remain on earth for about 4500 years without showing any signs of degradation. Its improper disposal can cause serious health hazards in humans. Based on the present usage scenario of plastics, its complete ban will not be justified; hence we have to find the alternatives to reuse the plastics.

## **1.2 OBJECTIVES**

- The objectives of this project are:
- To carry out the soil test.
- To design the flexible pavement
- To design the asphalt pavement with aggregate- plastic- bitumen mix.
- To coat the aggregate with plastic and incorporate titanium di-oxide.
- To test the bitumen and the modified bitumen.

## **1.3 SCOPE OF THE PROJECT**

- To eradicate potholes
- To minimize the global warming, greenhouse gases and pollution.
- The lifespan of the roads can be increased.
- Eco-friendly in nature.

## 1.4 ADVANTAGES

- Reduce the need of bitumen by around 10%.
- Develop a technology which is eco-friendly.
- Improvements in fatigue life of roads
- Increase the strength and better performance of the road.
- Use higher percentage of plastic waste.
- The gases released during traffic conditions are absorbed by smoke absorbent.
- The heating of aggregate and binder is not required.
- It is an environmental friendly approach which conserves energy. An impressive 50% of energy saving in case of cold mix over hot mix has been reported. Therefore, it can be considered to be a green bituminous mix for road construction.
- It is a straightforward preparation using only a small set up on site. A manual production for small scale job is also feasible.
- It is a suitable method particularly for construction of roads in remote and isolated areas of a country.
- The method is suitable for road construction in wet or humid condition.
- Cold mix is a versatile method due to availability of a large number of grades of emulsion and cut backs.
- It offers an economical and high production approach. The dry process employing 8% plastic waste as a partial replacement.

## 1.5 DISADVANTAGES

- Toxic present in the co-mingled plastic wastes would start leaching.
- But the presence of chlorine will definitely release HCL gas.

## **1.6 TESTS**

The following laboratory test were conducted:

- Test on aggregates
  - i. Aggregate crushing test
  - ii. Los Angeles abrasion test
  - iii. Impact test
  
- Test on bitumen
  - i. Penetration test
  - ii. Softening point test
  - iii. Viscosity test
  - iv. Marshall Stability test.

## **1.7 GUIDELINES FOR THE PLASTIC BITUMINOUS ROADS**

**1.1** Safe disposal of waste plastic is a serious environmental problem. Being a nonbiodegradable material it does not decay over time and even if dumped in landfills, finds its way back in the environment through air and water erosion, can choke the drains and drainage channels, can be eaten by unsuspecting grazing animals causing them illness and death, can contaminate the construction fill, etc. The best way of disposal of waste plastic is its recycling to the maximum extent and many developed countries have recycled waste plastics to manufacture various products, including some used in heavy construction, e.g. railway sleepers.

**1.2** Studies have revealed that waste plastics have great potential for use in bituminous construction as its addition in small doses, about 5-10%, by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous mix, leading to improved longevity and pavement performance. The use of waste plastic thus contributes to construction of green roads.

**1.3** Depending on their physical properties, they may be classified as thermoplastic and thermosetting materials. Thermoplastic materials can be formed into desired shapes under heat and pressure and become solids on cooling. On subjected to the same conditions of heat and pressure, they can be remolded. Thermosetting materials which once shaped cannot be softened/remolded by the application of heat. The examples of some typical Thermoplastic and Thermosetting materials are tabulated in Table 1. Thermosetting materials are not used in pavement construction.

## **CHAPTER 3**

### **METHODOLOGY**

#### **3.1 GENERAL**



The objective of the current research is to analyze practices followed by plastic recovery and recycling units in, India. Disposal of waste plastic is a major problem Plastic is everywhere in today's lifestyle and its disposal is a great problem. It is nonbiodegradable and it mainly consists of low-density polyethylene. Burning of these waste plastic bags causes environmental pollution. To find its utility in bituminous mixes for road construction, Laboratory performance studies were conducted on bituminous mixes. Improvement in properties of bituminous mix provides the solution for disposal in a useful way. Plastic in different forms is found to be almost 5% in municipal solid waste, which is toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. Polymer modified bitumen is emerging as one of the important construction materials for flexible pavements. Use of plastic waste in the construction of flexible pavement is gaining importance because of the various reasons. Use of higher percentage of plastic waste reduces the need of bitumen by 10% to 12 %. The use of virgin polyethylene as an additive to asphaltic concrete is not new; however, two new processes also use recycled plastic as an asphalt cement additive: NOVOPHALTR and PolyphaltR . (11, 12, 13) These latter two processes both use recycled low-density polyethylene resin which is generally obtained from plastic trash and sandwich bags. The recycled plastic is made into pellets and added to asphalt cement at a rate of 4 to 7 percent by weight of binder (0.25 percent to 0.50 percent by weight of total mix). (12,13). Plastic waste after sieving, shredding, and processing is cut into a size such that it passes through sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable.

### **3.2 PLASTIC INDUSTRY AND GENERATION OF PLASTIC WASTE IN INDIA**

A boom in the consumption of plastic is experienced with the economic liberalization since 1991. Plastic consumption in India has more than doubled from 0.85 million tonnes during 1990-91 to 1.79 million tons during 1995-96. Various resins of plastic Polyethylene tetratene, Density polyethylene(HDPE), Vinyl(Poly vinyl chloride or PVC), Low density polyethylene(LDPE), Polypropylene(PP). According to central pollution control board India generates 56 lakh tonnes of plastic waste annually. As per the CPCB report in 2014-15, 51.4 million tonnes of solid waste were generated in the country, of which 91 percent was collected, and 27 per cent was treated and remaining 73 per cent disposed of at dump.

**Table 1: Reprocessing in Recycling Industry:  
Region wise and Polymer wise in kTA**

Region	PVC	HDPE	LD/LLD/ H/M	PP	Other	Total
West	60	113	78	65	12	328
North	135	45	38	35	14	267
South	53	41	30	29	09	162
East	34	29	04	20	04	91

It was suggested that one million tonne of waste plastic would have been recycled or otherwise reused in 1996 - including 40% of 1995 consumption of virgin plastic and 30 % of pre 1995 production which had been reprocessed before.

## Chapter 4

### Results and Discussions

- The crushing value reduces from 23.32 to 14.22 for normal and plastic coated aggregate. The value was reduced by 40%. Lower the aggregate crushing value higher is the strength.
- The aggregate impact value of plastic coated aggregate was reduced by 9% than the normal aggregate. It's the higher toughness of plastic coated aggregates.
- Los Angeles abrasion value indicates the hardness of the aggregates. The abrasion value plastic coated aggregates were 21% less than the normal aggregates.
- The penetration value of bitumen is higher than the bitumen mixed with the plastic.
- The bitumen softens 10°C less than the bitumen replaced with plastic.
- The stability of modified bitumen (10% bitumen replaced by plastic) is higher than the normal bitumen.

A well-constructed plastic road will result in following advantages:

Strength and performance of the road increases.

Reduces the bitumen requirement by around 10% resulting in reduction of overall cost.

No stripping and no potholes.

The maintenance expenditures reduces to almost nil. Generates employment for rag pickers.

The road life sustainably increases.

Helps in disposal of plastic waste. Hence minimizing the pollution.

Some disadvantages of plastic roads:

Cleaning Process: Toxic present in the co-mingled plastic wastes would start leaching.

During the road laying process: The presence of chlorine will definitely release HCL gas.

After the road laying: Once the road has been laid, its components, are no inert. The first rain may cause leaching problem. As the plastic, will merely form a sticky layer. Once the road is started to be used will cause their release of fine polymer particles.

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The abrasion value of plastic coated aggregates were 21% less than the normal aggregates.

The penetration value of bitumen is higher than the bitumen mixed with plastic.

The bitumen softens 10 C less than the bitumen replaced with plastic. Higher than the bitumen modified bitumen (10% bitumen replaced by plastic) is

Difference between Plastic road and Ordinary road:

Properties	Plastic Road	Ordinary Road
Marshall Stability Value	More	Less
Binding Property	Better	Good
Softening Point	Less	More
Penetration value	More	Less
Tensile Strength	High	Less
Rutting	Less	More
Stripping(Pot Holes)	No	More

Seepage of water	No	Yes
Durability of the roads	Better	Good

## Chapter 5

### Conclusions

The generation of waste plastics is increasing day by day. The plastics show adhesion property in their molten state. Plastics will increase the melting point of the bitumen. Hence, the use of waste plastics for pavement is one of the best methods for easy disposal of waste plastics. Moreover, plastic is not recyclable and using them in road construction will help in the disposal of these plastic wastes in an eco-friendly manner. The use of the innovative technology will not only strengthen the road construction but also make it economical as well as increase the life span of roads. Plastic roads will be most feasible for a country like India, where temperature is around 50-degree C and the heavy monsoons too create havoc, leaving the roads with potholes and ruts. It is hoped that in near future we will have strong, durable and eco-friendly roads that will relieve the earth from all type of plastic waste.

Plastic coating on aggregates is used for the better performance of roads. This helps to have a better binding of bitumen with plastic wasted coated aggregate due to increased bonding and increased area of contact between polymers and bitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reducing rutting, raveling and there is no pothole formation. The roads can withstand heavy traffic and show better durability.

Aggregate Impact value of control specimen was 5.43%. It reduced to 4.91% for PP8 and 4.26% for PP10. Reduction in value was 10% for PP8 and 22% for PP10. This shows that the toughness of the aggregate was increased to face the impacts.

Crushing Value was reduced from 19.2% to 13.33% and 9.82% for PP8 and PP10 respectively. Value reduced by 30% for PP8 and 48% for PP10. Low aggregate crushing value indicates strong aggregates, as the crushed fraction is low.

Specific Gravity of the aggregate increases from 2.45 for control specimen to 2.7 for PP8 and 2.85 for PP10 due to plastic coating.

Stripping Value was reduced from 8% for control specimen to nil for PP8 and PP10. This shows that coated aggregate is more suitable for bituminous construction than plain aggregates.

Water Absorption is also reduced to nil for PP8 and PP10 from 1.7% for control specimen.

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