



# AN INNOVATIVE TECHNIQUE FOR ROAD CONSTRUCTION BY WASTE PLASTIC

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## Abstract

**The plastic waste has been increasing day by day due to increase in population, urbanization, industrialization, changes in the life style, and socio-economic conditions. The disposal of plastic waste is a menace and become a serious problem worldwide due to its non-biodegradability and unaesthetic view. It is need of the hour to use plastic waste for construction of flexible pavement to minimize the bitumen consumption, manage the plastic waste and improve the properties of the aggregates. Dry process is the most advanced technique in which plastic waste is used to coat the aggregates. The plastic coated aggregates exhibit improved soundness & specific gravity, less abrasion & impact value and extra resistant to water than that of plain aggregates. In this paper, the use of plastic waste in flexible pavement by using dry process has been examined and the properties of the plastic coated aggregates have been compared with the plain aggregate**

**Key words: Waste Plastic, Aggregate.**

## INTRODUCTION

Today, for the developing countries, Flexible pavements are one of the most important infrastructures. Any damage to this may cause lots of inconvenience to the traffic which ultimately will affect the future scenario of countries. Now-a-days it is been observed that due to increase in axel load and traffic intensity the capability of the bituminous binders is been reduced causing bleeding in hot climate, cracks in cold climate, rutting and pot holes. This makes an essentiality in modification of bitumen binder to meet the increasing demand of axel loads and traffic intensity. Rapid industrial and enormous population growth has resulted in increasing the various types of waste materials. Considerable

measures have been done for the disposal of these waste products. These plastics are considerably non-biodegradable thus can be used as a modifier in bitumen and aggregates to increase their strength. This study presents the proper utilization of waste in hot bitumen and aggregate to enhance pavement performance, to protect environment and to provide low cost roads.

## LITERATURE REVIEW

The concept of using plastic in flexible pavement has been done since several years ago in India. Plastic has played a very vital role in increasing the strength of bitumen as well as aggregate.

Prof. C.E.G.Justo etc (2002), at the Centre for Transportation Engineering of Bangalore University on the possible use of the processed plastic bags as an additive in bituminous concrete mixes. The properties of the modified bitumen were compared with ordinary bitumen. Similarly, Dr. R. Vasudevan etc. (2004) reported that waste plastic could replace about 8% by weight of bitumen. Stripping test conducted after mixing operation proved that adhesion of the plastic waste to aggregate & bitumen was excellent. Plastic waste could be successfully mixed with aggregates and bitumen at hot mix plant and the condition of the road when properly laid was good.

Vasudevan etc. (2006) reported that though plastic modified bitumen improves the quality of the roads, the process of using the plastic for the blending decides the strength of the bonding.

Rema Devi etc. Stated that the concept of utilization of waste plastic in the construction of pavement has shown better resistance to water which reduces the stripping of bitumen from aggregate.

Amit Gawande etc. investigations the use of waste plastic in road construction as an effective

way to reutilize the plastic waste.

Mohammad T. Awwad etc. (2007), polyethylene as one sort of polymers is used to investigate the potential prospects to enhance asphalt mixture properties.

### PLASTIC WASTE AND ITS SOURCE

The sources of plastic waste are shown in table 1. The plastic conforming to HDPE, LDPE, PET and polystyrene shall only be used in flexible pavement. The PVC should not be used for road construction as they produce toxic gases and cause health hazards.

Table 1: Plastic Waste and its Source

Plastic waste	Origin/ Source
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold articles, etc.
Low Density Polyethylene (LDPE)	Carry bags, sacks, milk pouches, bin lining, cosmetic and detergent bottles, etc.
Polypropylene (PP)	Bottle caps and closures, wrappers of detergent, biscuit, wafers packets, microwave trays for readymade meal, etc.
Polyethylene Terphthalate (PET)	Drinking water bottles, etc.
Polystyrene (PS)	Yoghurt pots, clear egg packs, Bottle caps. Foamed Polystyrene: food trays, egg boxes, disposable cups, protective packaging, etc.
Poly Vinyl Chloride (PVC)	Mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders and pens, medical disposables, etc.

Table 2: Plastic Consumption in India.

Sr.No.	Year	Plastic Consumption in India (in Tones)
1.	1996	61000
2.	2001	400000
3.	2006	700000
4.	2011	13500000

Table 3: Plastic Waste in World (Per/Capita/Year)

Sr. Nr.	Country/Continent Consumption	Per/Capita/Year in Kg.
1.	India	14
2.	East Europe	10
3.	South East Asia	10
4.	China	24
5.	West Europe	65
6.	North America	90
7.	World Average	25

### COST ANALYSIS

Assuming Cost of plastics waste (collection, segregation and processing) = Rs. 5/- per Kg.

Cost of Bitumen per drum (200 Kg) = 10000/-

Cost of Bitumen per Kg = 50/-

Cost of bitumen per ton = 50000/-

Generally roads in India are constructed in basic width of 3.75 m.

Consider 1 Km length road to lay 1km of road 10 tons of bitumen is required,

Cost of bitumen required per Km = Rs. 5,00,000

Assuming Optimum percentage of plastic as per the test results of literature reviewed is around 10% (by % wt. of bitumen)

Total quantity of bitumen required = 9 tons

Total quantity of plastic waste required = 1 ton

Cost of bitumen for 9 tons = Rs. 4,50,000

Cost of plastic waste = Rs. 5000

Total cost of bitumen and plastic = Rs. 4,55,000

Total savings = 5,00,000 - 4,55,000 = Rs.45,000 per Km.

## CHARACTERIZATION OF WASTE PLASTICS PENETRATION TEST (IS: 1203-1978)

Plastic is a good binder

Table 4: Binding Property of Plastic

% of Plastic Coating Over Aggregate	Compressive Strength (mpa)	Bending Strength (mpa)
10%	250	325
20%	270	335
30%	290	350
40%	320	390.

### ADVANTAGES OF PLASTIC ROAD

- Use higher percentage of plastic waste.
- Reduce the need of bitumen by around 10%.
- Increase the strength and performance of the road.
- Reduce the cost
- Generate jobs for rag pickers
- Develop a technology, which is eco-friendly.

### DISADVANTAGES OF PLASTIC ROADS

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

### MARSHAL STABILITY TEST

In Marshal Stability Test, the deformation of specimen of bituminous mixture is measured when the same load is applied. This test procedure is used in designing and evaluating bituminous paving mixes. The marshal stability of mix is defined as a maximum load carried by a compacted specimen.

The following results of Marshal Stability test are shown in Table 5.

Table 5: Observation for the Marshal Stability

Sr.Nr.	Plastic Added (%)	Stability (kg)
1.	0	1010
2.	5	1680
3.	10	1957
4.	15	1181.23

The penetration test is carried out to know the hardness or softness of bitumen used in road construction by measuring the distance to which the needle penetrates. Samples having different percentage of plastic waste in bitumen is prepared and their penetration values are determined as per IS code. The penetration values of the blends are decreasing depending upon the percentage of polymer added.

As per IRC recommendation the penetration values of Bitumen is from 20-225 mm. The following results of penetration test are shown in Table 6.

Table OBSERVATION FOR PENETRATION TEST

% of Bitumen	% of Polymer	Penetration Value in mm
100	0	70
95	5	68
90	10	67
85	15	64

### OUT COME OF REVIEW

It shows that with the increase of waste plastic in bitumen increases the properties of aggregate and bitumen. Use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements. The optimum use of plastic can be done up to 10%, based on Marshal Stability test. This has added more value in minimizing the disposal of plastic waste as an eco-friendly technique. Coating of polymer on the surface of the aggregate has resulted in many advantages, which ultimately helps to improve the quality of flexible pavement.

### CONCLUSION

The main objective of this paper is to discuss the significance of plastic in terms of cost reduction, increase in strength and durability when these plastics are heated and coated upon the aggregates (160°C) to compensate the air voids with plastic and binds with aggregate to provide stability. The polymer coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows higher Marshall Stability value. Hence the use of waste plastics for flexible pavement is recommended.

### **SCOPE FOR FUTURE WORK**

The Laboratory tests are carried out by adding different percentages of plastic waste. It is given to understand that trial of plastic waste use by replacing 1 to 2 percent Bitumen has been started in rural roads in Madhya Pradesh. The monitoring of those roads is under progress. The capital cost of roads shall decrease, but the examination of maintenance cost is to be done. In addition to this the environmental test for different gas contents is to be carried out after the construction of plastic coated aggregate roads.

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