

# Use of Plastic Waste in Pavement

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**Abstract**— Plastic waste is recycled in India in an unorganized way. About 60% of the plastic-waste collected and segregated gets recycled back into materials for further processing into consumer products, while the balance is left unutilized. So, for utilizing the remaining plastic waste the other way can be beneficial for saving the environment. The plastic wastes could be used in road construction and the field tests withstood the stress and proved that the plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. Plastic will increase the melting point of the bitumen. use of the innovative technology not only strengthened the road construction but also increased the road life and also helpful to improve the environment. Plastic road would be a boon for India at hot and extremely humid where durable and eco-friendly roads which will relieve the earth from all types of plastic waste. This paper deal with the use of plastic waste in road construction along with utilizing process and show the very huge amount of plastic waste can be used for gaining better performance of roads.

**Keywords:** Plastic Waste, Concrete, Green Concrete, Economic Development

## I. INTRODUCTION

The major threat to the environment is the disposal of waste plastic. In a highway, the potholes and corrugation is the major problem<sup>9</sup>. Plastic pavement will be a better solution to the above stated problems. A material that contain one or more organic polymer of large molecular weight, solid in its finished state, can be shaped by its flow is called as "plastic". The durability of plastic is high and it degrades very slowly. And also plastic has high resistant to degradation. Plastic can be divided into two major categories- thermoses & thermoplastics<sup>2,3</sup>. Thermosets have high durability and strength because it solidifies irreversibly when heated, henceforth can be used primarily in construction application. Plastic is a non-degradable waste, causes greenhouse effect and global warming. The various experiments have been carried out whether the waste plastic can be reused productively. The various literature indicated that the waste plastic when added to hot aggregates will form a fine coat of plastic over the aggregate and such aggregates when mixed with binder is found to have higher strength, higher resistance and better performance over a period of time. Along with bitumen, use waste plastic increases its life and smoothness. It is economical and eco-friendly. Addition of plastic waste in construction of pavements reduces the plastic shrinkage and drying shrinkage. The use of waste plastic improves the abrasion & slip resistance of asphalt pavement<sup>4</sup>. In India, because of hot and extremely humid climate, plastic pavements of greatest advantage.

In order absorb the smoke from the vehicles; titanium di-oxide can be used. It also enhances the

mechanical properties of the plastic, resulting in higher strength and high resistance.

### A. 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.

## II. PLASTICS ROADS - GENERAL INTRODUCTION

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 plastic roads include transition mats to ease the passage of tyres up to and down from the crossing. Both options help protect wetland haul roads from rutting by distributing the load across the surface. But the use of plastic-waste has been a concern for scientists and engineers for a quite long time<sup>6</sup>. Recent studies in this direction have shown some hope in terms of using plastic-waste in road construction i.e., Plastic roads. A Bangalore-based firm and a team of engineers from R. V. College of Engineering, Bangalore, have developed a way of using plastic waste for road construction. An initial study was conducted in 1997 by the team to test for strength and durability. Plastic roads mainly use plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction material. When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road.

### A. Plastic – The Binder:

Bitumen is a useful binder for road construction. The steady increase in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demand improved road characteristics. Any improvement in the property of the binder is needed. Waste plastics on heating soften at around 130°C. Thermo gravimetric analysis has shown that there is no gas evolution in the temperature range of 130-180°C. Moreover the softened plastics have a binding property.



Fig. 1: Shredded Plastic Waste

**B. Different Type of Waste Plastic (Polymer):**

TYPES	SOURCES
Low density Polyethylene (LDPE)	Bags, sacks, bin lining and squeezable detergent bottles etc.
High Density Polyethylene (HDPE)	Bottles of pharmaceuticals, disinfectants, milk, fruit juices, bottle caps etc.
Polypropylene (PP)	Bottle cap and closures, film wrapping for biscuits, microwave trays for ready-made meals etc.
Polystyrene (PS)	Yoghurt pots, clear egg packs, bottle caps.
Foamed Polystyrene	Food trays, egg boxes, disposable cups, protective packaging etc.
Polyvinyl Chloride (PVC)	Mineral water bottles, credit cards, toys, pipes and gutters, electrical fittings, furniture, folders and pens; medical disposables; etc

Table 1: Different Types and Sources of Waste Plastic (Polymer)

**C. Purpose of Bitumen modification:**

- To obtain softer blends at low temperature for reducing cracks.
- To increase the stability and strength of mixtures.
- To improve the asphalt cohesive strength in pavements.
- To improve oxidation and resist aging.
- To reduce costs of pavement.

**D. Advantages:**

- The ability of the aggregate to resist weather conditions is improved.
- Rebound deflection is minimized.
- Higher resistance to rain and water logging.
- Load withstanding property of the road is improved and caters to the increasing road transport.
- Increase the strength and better performance of the road.

**III. CENTRAL MIXING PLANT (CMP)**

The dry process can also be carried out using central mixing plant. The shredded plastic is added along with the aggregate in the conveyor belt. This is transferred into the hot cylinder. There aggregate is coated with plastic first and then with the bitumen. The mixer so prepared is then loaded in the dipper

lorry and transported for road laying. CMP helps to have better control of temperature and better mixing of this material thus helping to have a uniform coating. This is adopted in our project.

The comparative study is done by testing the normal aggregates & plastic coated aggregates, and the bitumen and modified bitumen (10% of bitumen replaced by plastic). The various tests that are carried out for the comparative study are:

**A. Test on Aggregates**

- 1) Aggregate crushing test
- 2) Los Angeles abrasion test
- 3) Impact test

**1) Aggregate Crushing Test:**

The strength of the coarse aggregate may be assessed by aggregate crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under gradually applied compressive load. To achieve a high quality of pavement, aggregates possessing high resistance to crushing or low aggregate crushing value re preferred.

**2) Abrasion Test:**

Due to the movements of traffic, the road stones used in the surface course are subjected to wearing action at the top. Hence road stones should be hard enough to resist the abrasion due to traffic. Abrasion tests are carried out to test the hardness property of stones and to decide whether they are suitable for the different road construction works.

**3) Los Angeles Abrasion Test:**

The principle of Los Angeles abrasion test is to find the percentage wear due to the relative rubbing action between the aggregate and steel balls used as abrasive charge. Pounding action of these balls also exists during the test and hence the resistance to wear and impact is evaluated by this test.

**B. Test on bitumen**

- 1) Penetration test
- 2) Softening point test
- 3) Viscosity test
- 4) Marshall Stability test.

**1) Penetration Test**

Penetration test is to determine the hardness of the bitumen. The penetration of a bitumen is the distance in tenths of millimeter that a standard needle will penetrate into the bitumen under a load of 100 gm applied for 50 seconds at 25° c. Penetration value indicates the softness of bitumen higher the penetration softer is the bitumen).

**2) Softening Point Test**

The principle behind this test is that softening point is the temperature at which the substance attains a particular degree of softening under specified condition of the test. Softening point denotes the temperature at which the bitumen attains a particular degree of softening under the specifications of this test.

The test is conducted by ring and ball apparatus. A brass ring containing test sample of bitumen is suspended in liquid like water or glycerin at a given temperature. A steel ball is placed upon the bitumen sample and the liquid medium is heated at a rate of C minute. Temperature is noted when the softened bitumen touches the metal plate which is at a

specified distance below. Generally, higher softening point indicates lower temperature susceptibility and is preferred in hot climates.

### 3) Viscosity Test

Viscosity is defined as the inverse of fluidity. Viscosity thus defines the fluid property of bituminous material. Viscosity is the general term for consistency and is the measure of resistance to flow. Many researchers believe that grading of bitumen should be by absolute viscosity units instead of the conventional penetration units.

### 4) Marshall Stability Test:

The stability of the mix is defined as a maximum load carried by a compacted specimen at a standard test temperature of 60°C. The flow is measured as the deformation in units of 0.25 mm between no load and maximum load carried by the specimen during stability test (flow value may also be measured by deformation units of 0.1 mm). This test attempts to get the optimum binder content for the aggregate mix type and traffic intensity. This is the test which helps us to draw Marshall Stability vs. % bitumen.

Marshall Stability plays a very important role in the testing of road materials. Hence the values obtained by the Marshall Stability test shows the actual strength and load carrying capacity of the road material.

## IV. RESULT

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.

## V. CONCLUSION

The use of waste plastic in construction of roads brings out a better performance.

Since, there is better binding of bitumen with plastic. The frequency of voids is also reduced due to increased bonding and area of contact between polymers and bitumen. This ultimately helps in decreasing the moisture absorption and oxidation of bitumen by entrapped air. Hence, the roads can withstand heavy traffic, thereby making them more durable. The plastic waste can be used as well sized aggregate in the various bituminous mixes if it is cut in the form of aggregate and can be called as plastic aggregate. This not only minimizes the pollution occurred due to plastic waste but also minimizes the use of conventional aggregate which is available in exhaustible quantity.

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