

## COMPARATIVE STUDY OF NORMAL ROADS WITH PLASTIC ROADS

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### ABSTRACT

*In this paper the study of some of plastic waste materials we reuse by certain processing and use in road construction. Wrappers of betel nuts, chocolates, chips, hand bags, cold drink bottles and all other forms of plastic create significant environmental and economic problem. Plastics cannot be banned as it will result in usage of natural resources like paper, wood at a great extent. It is made up of various chemical elements and is regarded as a highly pestilent material which does not easily degrade in the natural environment after its usage. Waste plastics are made up of Polyethylene Polystyrene and Polypropylene. Temperature varying between 120°C-160°C gives the softening point of these plastics. They do not produce any toxic gases heating but the softened plastics have tendency to form a lamination or coating over the aggregate, when it is sprayed over the hot aggregate at 160°C. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2- 3mm sieve using shredding machine. So that one can have a step towards further detailed information about these materials and thus be able to implement on field which will definitely improve the level of construction.*

**Keywords:** Plastic Waste, Bitumen, Aggregates, Plastic Roads.

### 1. INTRODUCTION

Plastic is everywhere in today's lifestyle. It is used for packaging, protecting, serving, and even disposing of all kinds of consumer goods. With the industrial revolution, mass production of goods started and plastic seemed to be a cheaper and effective raw material. Today, every vital sector of the economy starting from agriculture to packaging, automobile, building construction, been virtually revolutionized by the applications of communication or InfoTech has plastics. Plastic in different form is found, which is toxic in nature. It is commonly collected both urban and rural areas. It creates stagnation of water and

associated hygiene problems. Plastic waste hazard to the environment. Plastic waste can be reused productively in the construction of road.

Plastic is everywhere in today's lifestyle and its disposal is a great problem. It is a non- biodegradable product due to which these materials pose environmental pollution and problems like breast cancer, reproductive problems in humans and animals and genital abnormalities. If a ban is put on the use of plastics on emotional grounds, the real cost would be much higher, the inconvenience much more, the chances of damage or contamination much greater... Hence the question is not "plastics VS no plastics" but it is more concerned with the judicious use and re-use of plastic-waste. Both the issues when taken together lead to a single solution that we can use this waste plastic in Flexible Pavements in such a manner that it gets coated over the surface of aggregate by heating (140°C 160°C) because plastics like PE, PS, PP used in PET Bottles, Disposal glasses, handbags, and covers various appliances etc. soften up to 160°C. The experiments conducted in the laboratory depict fruitful results can substantially increase the stability and durability of roads plus, making it a very effective step towards eco-friendliness compared to conventional and traditional techniques of flexible pavements construction.

## **2. Data Collection and its Analysis**

Investigation of plastic waste materials aggregates and bitumen requires various field test lab tests as explain in previous chapter. This chapter presents material which is collected site given below for plastic coated aggregates in detail. The present chapter divided into main sections. First section presents the physical requirement of aggregates and bitumen and second section presents the properties of plastic. Third section presents the preparation plastic materials for shredding on aggregates.

### **1. AGGREGATES**

The aggregates are bound together either by bituminous materials or by cement. In a few cases, the rock dust itself when mixed with water forms slurry, which acts as a binding medium. The aggregates may be classified into natural and artificial aggregates. The natural aggregates again are classified as coarse aggregates consisting of crushed rock aggregates or gravels and fine aggregates or sand. The blast furnace slag obtained as by-product from blast furnaces is the one extensively used as road construction material. Stone aggregate used for road work should be hard, tough, durable and hydrophobic for bituminous surface. Gravel should be well graded (6.4mm to 38mm) and should have a fineness modulus of not less than 5.75. Sand should be Sharp, well graded, clean of all silts, clay and organic matter. The quantity of aggregates used in first coat of surface dressing should be 0.15 m<sup>3</sup> per 10 m<sup>2</sup> area of 12mm nominal size. On the other hand, the quantity of aggregate used in second coat of surface dressing should be 0.15 m<sup>3</sup> per 10 m<sup>2</sup> areas and of 10mm nominal size.

## 2. Bitumen

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. As per definition given by the American Society of Testing Materials bitumen has been defined as "Mixtures of hydrocarbons of natural or pyrogenous origin, or combination of both. frequently accompanied by their non- metallic derivatives, which may be gaseous, liquid, semi-solid or solid, and which are completely soluble in carbon disulphide." Bitumen found in natural state known as asphalt contains large ties of solid mineral matter. When petroleum crude is refined in a refinery, they are separated by fractional distillation in the order of decreasing volatility. On distillation of the residual bituminous residue, straight-run bitumen is obtained. This bitumen is known as penetration grade bitumen or steam refined petroleum bitumen. The grades of bitumen used for pavement construction is known as paving grades and that used for water proofing of structures known as industrial grades. The grade of straight run bitumen is chosen depending upon the climatic conditions of the region in which surface dressing is to be constructed. In most parts of India 80/100 and 180/200 grades bitumen is used. Heavier grade cut backs, rapid setting emulsions or heavier grade tars may also be used. The grade of basic bitumen is altered either by controlled refining or by mixing with diesel oil or other oils. For single dressings on WBM base course, quantity of bitumen needed ranges from 17 to 195 kg per 10 m<sup>2</sup> areas and 10 to 12 kg per 10 m<sup>2</sup> area in case of renewal of black top surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12 kg per 10 m<sup>2</sup> area. Bulk bitumen Lorries with tanks of capacity ranging from 5000 to 15000 litres are used to transport bulk bitumen. As per PMC, the bitumen content in a mix should be 4% of weight by total mix for B.M. The paving bitumen available in India is classified into two categories:

\* Paving bitumen from Assam petroleum denoted as A-type and designated as grades A35,A90, Paving bitumen from other sources denoted as S-type and designated as grades \$35, \$90.

\*Important properties of bitumen are:

- i) Viscosity of bitumen should be adequate at the time of mixing and compaction. It is achieved by heating prior to mixing and by use of cutbacks and emulsion.
- ii) In presence of water bitumen should not strip off from aggregate.
- iii) Bitumen should be durable in all seasons.
- iv) It should not too soft during summers and develop cracks during winters.

## 3. Road Tar

This bituminous material is obtained by the destructive distillation of organic matters such as wood, coal shale etc. In the process of destructive distillation, the carbonation results in the production of crude tar which is further refined by distillation process.

### 3.1 Cut-back bitumen

The asphaltic bitumen is very often mixed with comparatively volatile solvents to improve the workability of the material. The solvent gets evaporated leaving behind the particles together. This cutback bitumen is classified into slow, medium and rapid curing depending upon the type of solvent used.

### 3.2 Emulsions

An emulsion is a mixture of normally two immiscible liquids. Asphalt gets broken up into minute globules in water in the presence of the emulsifiers. It improves the workability of bitumen or asphalt. As a result of emulsification, asphalt is available at normal temperature in the liquid form.

Bitumen:60/70, 80/100 grade bitumen

## 4. PLASTIC

Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, polyaddition, and crosslinking. There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene (PTFE) in the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulphur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky. The properties of plastics are defined chiefly by the organic chemistry of the polymer, such as hardness, density, and resistance to heat, organic solvents, oxidation, and ionizing radiation.

### 4.1 Types of Plastics

1. PET: polyethylene terephthalate
2. HDPE: high-density polyethylene LDP low-density polyethylene
3. PVC polyvinyl chloride
4. PP polypropylene
5. PS: polystyrene

Plastics are durable and degrade very slowly, the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Since the 1950s, one billion tons of plastic have been discarded and may persist for hundreds or even thousands of years. Perhaps the biggest environmental threat from plastic comes from nurdles, which are the raw material from which all plastics are made. They are tiny pre-plastic pellets that kill large numbers of fish and birds that mistake them for food. Prior to the ban on the use of CFCs in extrusion of polystyrene (and general use, except in life-critical fire suppression systems; see Montreal Protocol), the production of polystyrene contributed to the depletion of the ozone layer; however, non-CFCs are currently in the extrusion process. Thermoplastics can be remelted and reused, and thermoset plastics can be ground up and used as filler, although the purity of the material tends to degrade with each reuse cycle. There are methods by which plastics can be broken back down to a feedstock state.

### 4.2 CLASSIFICATION OF PLASTIC WASTE

a) Polyethylene:

LDPE (Low Density Poly-Ethylene):

Low density poly-ethylene this plastic waste available in the form of carry bags generally in stores these plastic bags are very thin and also easily available. HDPE (High Density Poly-Ethylene). Generally High density poly-ethylene type of plastic waste is available in the form of carry bags and easily available in the market.

b) Polypropylene:

This plastic may be available in the form of carry bags or solid plastic it's depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

#### 4.3 PREPARATION OF PLASTIC WASTE MATERIAL

##### 4.3.1 Plastic Waste Scenario

The use of plastic materials such as carry bags, cups, etc. is constantly increasing. The consumption of plastics has increased from 4000 tons/annum to 4 million tons/annum and it is expected to rise 8 million tons/annum during the year 2010. Nearly 50 to 60% of the total plastics are consumed for packing

##### 4.3.2 Waste plastic shredding

Shredding is the process of cutting the plastic into small sizes between 2.36mm to 4.75mm with the help of the plastic shredding machine viz. Agglomerate and Scrap Grinder. In Agglomerate, thin films of poly-ethylene and polypropylene carry bags are shredded and in Scrap Grinder a solid plastic material are shredded i.e., plastic bottles, drip lines, electric cable lines etc.

#### 4.4 WHY USE OF PLASTIC

Polymers have a number of vital properties, which exploited alone or together make a significant and expanding contribution to construction needs.

1. Durable & corrosion resistant.
2. Good insulation for heat & sound saving energy and reducing noise pollution
3. It is economical and has a longer life.
4. Maintenance free.
5. Hygienic & problems.
6. Ease of processing/ installation.
7. Light weight.

### 3. Analytic Estimation of Normal Roads with Plastic Roads

Reusing plastic waste to pave roads is an experiment that has been successfully conducted in many places, such as Kalamassery in Kerala and in Kolkata and Bangalore. The first technology approach, developed by Bangalore-based K K Plastic. Waste Management Limited, entails using plastic waste along

with bitumen - the ingredient conventionally used to take roads. Not only does the road become a receptacle for plastic waste, but it also has a better grip this dry process helps to use good quantity of plastic waste in road construction so the total waste generated could be used for road laying. The life of the road is increased and hence the maintenance expenditure is reduced. Based on the experimental evidences and the amount of raw materials used for 25mm Semi Dense Bituminous Concrete (SDBC- this top layer of the bituminous road 10M2 SDBC road the following calculation has been arrived.

Material Needed	Plain bitumen Process	Plastic Coated aggregate (PCA)
80/100 Bitumen	11250 KG	10125 KG
Plastic Waste	NIL	1125 KG
Cost	RS. 393750/-	(BIT)RS.354375 + (PLASTIC) RS 13500 =RS 367875/-
Cost reduced	NIL	RS 2875.00
Carbon credit achieved on avoiding burning of Plastic	NIL	3.5 TONNES

Table No.1 Estimated Cost

\*Cost bitumen approx. 35000/ton and waste plastic: Rs. 12000/tons

\*Saving of bitumen-1 ton

\*Use of plastic waste (1125000) carry bags (1.125) ton

\*Bitumen needed-10125kg

\*Plastic waste needed -1125kg

Three kilograms of bitumen were saved and three kilograms of waste plastics were used. The cost of bitumen is much higher than that of plastics and this process also helps to save the natural resources. There is no maintenance cost for a minimum period of five years. Hence the process is cheap and eco-friendly.

#### 4. Result and Discussion

- 1) Utilization of waste plastic improves the binding property of mix.
- 2) The optimum result of waste plastic came out to be 8% from the experiments conducted.
- 3) The properties of bitumen such as penetration, softening point improved with the addition of the waste fiber.
- 4) Plastic roads can also be constructed in the areas having high temperatures (50°C).
- 5) Waste plastic in roads increases the stability value and durability to a great extent.

Sr.No	Bitumen	Plastic	Compressive Strength KN/mm <sup>2</sup>
1	10	0	12.95
2	8	2	11.09
3	6	4	9.23
4	5	5	16.00
5	4	6	9.23
6	3	8	11.09
7	2	10	10.00

Table No 2. Observation Table

#### 4.1 SALIENT FEATURES OF ROAD

In India more than 4.25 million Km of road is available. If only some of them are constructed or repaired using this technique there will be less waste plastic littered on the road. The process is eco-friendly Segregating plastic from the MSW at municipal yard involves application of resources, the cost of which runs into corer of rupees. A substantial amount of this can be saved.

Lab tests and real time tests have revealed that the life expectancy of a plastic road, compared to a normal road is at least 100% more. This technique adds a cumulative benefit to National Economy also gives contribution to environmental benefits, employment generation and agricultural efficiency.

- i) Stronger road with increased Marshall Stability value.
- ii) Better resistance towards rain water and water stagnation so no stripping and no potholes
- iii) Increase binding and better bonding of the mix thus reduction in pores in aggregate and hence less rutting a ravelling
- iv) No leaching of plastics. No effect of radiation like UV.
- v) The load withstanding property increases. It helps to satisfy today's need of increased road transport.
- vi) Value addition to the waste plastics (cost per kg. increases from Rs. 4 to Rs. 12.)
- vii) The cost of road construction is also decreased and the maintenance cost is almost nil.



#### 4.2 COMPARISON

1. The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix.
2. While a normal highway quality road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years.
3. Rainwater will not seep through because of the plastic in the tar
4. The cost of plastic road construction may be slightly higher compared to the conventional method.
5. The maintenance cost is low as compared to conventional method.
6. Its initial cost is slightly more as compared to conventional method.

### 5. Future Scope

This study will be conducted to explore the idea about use of waste material in bituminous concrete with detailed laboratory Investigation will be carry out to find whether it is viable to use or not in terms of suitability, economically and environmentally. The present study will focus basically on these following points:

1. To study the basic physical and mechanical properties of waste plastic in order to contribute a better knowledge of its properties.
2. To study the effect on Marshall Stability of bituminous mix with the addition of waste plastic.
3. To reduce the bitumen content by the addition of Waste plastic in bituminous mix. The laboratory investigations on the bituminous mix have been carried out as per the Indian Standards used for the road construction. The field application is out of the scope of work.

### 6. Conclusion

Waste Plastic can be used as coating material in bituminous concrete mixture for road construction .Properties of BC can be further improved by use of waste plastic. Use of waste plastic 0.76% by weight of aggregate and 3% filler significantly improve the volumetric properties of bituminous mixes resulting better performance of BC with plastic waste than control mix(without plastic waste).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. Help to improve the environment. Plastic road would be a boon for India's hot and extremely humid climate where durable and eco-friendly roads which will relive the earth from all type of plastic waste. This small investigation not only utilizes beneficially, the waste non-degradable plastics but also provides us an improved pavement with better strength and longer life period.



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