

How to Use Plastic Waste to Construct Rural 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. Of this various waste materials, plastic waste and municipal solid waste are of great concern. On the other side, the road traffic is increasing. The traffic intensity is increasing. The load bearing capacities of the road are to be increased. 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, poly-styrene, 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. The main object is to analyze & study how the waste plastic will be effectively utilized in construction of flexible pavement as a binder material for replacing the content of bitumen and in detail process & its successful application.

Keywords: Plastic Waste, Aggregates, Bitumen

I. INTRODUCTION

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" 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". Today, every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. The use of waste plastics in road construction is gaining importance these days because plastic roads perform better than ordinary ones and the plastic waste considered to be a pollution menace, can find its use. The uses of plastic waste help in substantially improving the abrasion and slip resistance of flexible pavement and also allow to obtaining values of splitting tensile strength satisfied the specified limits while plastic waste content is beyond 30% by weight of mix.

As plastic is non-biodegradable in nature, it remains in environment for several years and disposing plastic wastes at landfill are unsafe since toxic chemicals leach out into the soil, and under-ground water and pollute the water bodies. Due to littering habits, inadequate waste management system

infrastructure, plastic waste disposal continue to be a major problem for the civic authorities, especially in the urban areas. As stated above,

Plastic disposal is one of the major problems for developing countries like India. Plastic is a material made to last forever, and due to the same chemical composition, plastic cannot biodegrade; it breaks down into smaller and smaller pieces. When buried in a landfill, plastic lies untreated. When oceanic creatures and even birds consume plastic inadvertently, they choke on it which causes a steady decline in their population. The harmful effects of plastic on aquatic life are devastating, and accelerating.

A. Various types of Plastic-

- 1) Polyethylene terephthalate (PET,PETE)
- 2) High Density polyethylene (HDPE)
- 3) Vinyl (Poly vinyl chloride or (PVC)
- 4) Low Density Polyethylene (LDPE)
- 5) Polypropylene (PP)
- 6) Polystyrene (PS)



Fig. 1: Various types of Plastic

II. METHODOLOGY

A. Construction of plastic road procedure-

Waste plastic is made powder and varying percent plastic is mixed with bitumen. Plastic increase the melting point of the bitumen and makes the road flexible during winters resulting in its long life. By mixing plastic with bitumen the brittleness overcomes and elastic nature enhances. The plastic waste is melted and mixed with bitumen in a particular ratio. There are two important processes used for bitumen mix flexible pavement, they are

- Dryprocess
- Wetprocess

B. Materials used and the tests conducted

The materials used for carrying out the present research are:

- 1) Aggregates
- 2) Bitumen
- 3) Plastic waste

The various laboratory tests were carried out on these materials and the results were computed.

1) Aggregates

Aggregates form the major portion of pavement structure and they form the prime materials used in pavement construction. Aggregates have to bear stresses occurring due to the wheel loads on the pavement and on the surface course. They also have to resist wear due to abrasive action of traffic. These are used in pavement construction in cement concrete, bituminous concrete and other bituminous constructions and also as granular base course underlying the superior pavement layers. Therefore the properties of the aggregates are of considerable significance to the highway engineer. Some of the desired properties of these aggregates are strength, durability, toughness, hardness, etc.

2) Bitumen

Bitumen is most commonly used a binder in pavements constructions. According to the definition given by the American Society of Testing Materials bitumen has been defined as "Mixtures of hydrocarbons of natural or hydrogenous 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 is available in various grades and types. To judge the suitability of these binders various physical tests have been specified by agencies like ASTM, Asphalt Institute, British Standards Institution and the ISI. These tests include penetration tests, ductility tests, softening test, flash and fire point tests, viscosity tests, etc.

3) Plastic Waste

As plastic is non-biodegradable in nature, it remains in environment for several years and disposing plastic wastes at landfill are unsafe since toxic chemicals leach out into the soil, and under-ground water and pollute the water bodies. Due to littering habits, inadequate waste management system / infrastructure, plastic waste disposal continue to be a major problem for the civic authorities, especially in the urban areas. As stated above, plastic disposal is one of the major problems for developing countries like India. Plastic is a material made to last forever, and due to the same chemical composition, plastic cannot biodegrade; it breaks down into smaller and smaller pieces. When buried in a landfill, plastic lies untreated. The plastic waste such as carry bags, cups, disposables, road side waste etc. are shredded in the shredding machine and then sprayed in different percentages over the hot aggregates. The details of the process are given below



Fig. 2: Road Side Waste



Fig. 3: Plastic Carry Bags

C. Processing Details:

- 1) Collection of waste plastic
- 2) Cleaning and shredding of waste plastic.
- 3) Mixing of shredded waste plastic, aggregate and bitumen.

1) Collection of waste plastic:

Waste plastic is collected from roads, garbage trucks, dumpsites or compost plants, or from school collection programs, or by purchase from rag-pickers or waste-buyers at Rs 5-6 per kg Rag-pickers.

D. 2. Cleaning and shredding of waste plastic:

Waste plastic litter in the form of thin-film carry-bags, use-and-throw cups, PET bottles, etc. these are sorted, de-dusted, washed if necessary. Fig. cleaning process Plastic waste which is cleaned is cut into a size between 1.18mm.

1) Mixing of shredded waste plastic, aggregate and bitumen-

The aggregate mix is heated to 160oc (as per the HRS specification). Similarly the bitumen is to be heated up to a maximum of 160°C. The 8% of waste plastic to the weight of bitumen are added. The mixer of aggregate and bitumen is forming to get the well mixer of bitumen and aggregate the thoroughly mixing is done after few minutes. Finally the mixer is formed which consists of hot bitumen, aggregate and plastic which is invisible form. The mixer is pour on the surface of plywood as see in the following image:



Fig. 4: Heat aggregate and Bitumen at 160°C



Fig. 5: Add shredded of plastic



Fig. 6: Lay the prepared mixture on surface

III. RESULTS AND DISCUSSION

In this section, results of the present work are as follows.

SN.	Aggregate	Plastic Content (%)	Aggregate Crushing test	Aggregate Impact Test	Los Angeles Test
1	Without plastic	0	25%	10.79%	12.85%
2	With plastic	10	15%	9.27%	11.70%

Table 1: Test on Aggregate

SN.	%age of Bitumen	%age of plastic	Softening Point (C)	Penetration (mm)	Ductility (mm)
1	100	0	48.25	74	63
2	90	10	60	45	42

Table 2: Test on Bitumen

It is evident from the above values that the aggregates coated with plastics give lower values of impact and abrasion which is good for the aggregates to be used in the road construction as they are subjected to wear and tear from the traffic playing on the roads.

IV. CONCLUSION

As the values obtained in the aggregate test both with or without plastic is less but the values are mainly less when the plastic waste is used. Thus the plastic road has good toughness, hardness and good abrasion thus automatically the strength of plastic road, appearance and life span (durability is increased). The strength of road depends mainly depends upon the strength of aggregate for knowing the strength the various tests are to be preferred.

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.

In short we can conclude that, using plastic waste in mix will help reduction in need of bitumen by around 10%, increase the strength and performance of road, avoid use of anti-stripping agent, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco-friendly.



Fig. 7: Plastic Raod Model

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