

Ecofriendly Approach to Build Road by Using Waste Plastics

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Abstract- Disposal of waste plastic is an act of threatening and is becoming a serious problem globally due to their non-biodegradability and toxicity. These wastes are not disposed scientifically & pose a threat causing ground-water pollution. In the present paper we have presented techniques to use plastic waste for construction purpose of roads. In conventional road making process, bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made, which can be used as a top layer coat. Plastics roads mainly use plastic carry bags, disposable cups, and bottles that are collected from garbage dumps. This waste plastic modified bitumen mix shows better binding property, stability, density and is more resistant to water.

Index Terms- Plastic waste, Non-biodegradability, Toxicity, Bitumen mix.

I. INTRODUCTION

The threat of plastic disposal will not be solved until the practical steps are not initiated at the ground level. Field tests proved that plastic wastes after proper processing can be used as an additive to enhance the life of the roads and also solve environmental problems. [1]

Plastic is a synthetic or semi-synthetic organic amorphous solid used in the manufacture of industrial products. Plastics are typically polymers of high molecular masses and may contain other substances to improve performance. Due to the industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Researchers found that the material can remain on earth for 4500 years without degradation. [2]

Studies have proven the health hazards caused by improper disposal of plastic wastes. These hazards include reproductive problems in humans and animals, genital abnormalities etc. Looking forward to the scenario of present life style, a complete ban on the use of plastic is next to impossible, although the waste plastic is taking the face of devil for the present

and future generations. We cannot ban the use of plastics but we can reuse the plastic wastes. [3]

The concept of utilization of waste plastic in construction of flexible road pavements has been implemented in India since 2000. In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It also helps to improve the strength and life of road pavement. But its resistance towards water is poor. A common method to improve the quality of bitumen is by modifying the properties of bitumen by blending with synthetic polymers like rubber and plastics. The use of recycled plastics composed predominantly of polypropylene and low density polyethylene in plain bituminous concrete mixtures with increased durability and improved fatigue life. [4]

II. WASTE PLASTIC AND ITS SOURCES

Common plastic wastes and its sources:-

- Low Density Polyethylene (LDPE):-Carry bags, wash bottles, tubing, laboratory equipment etc.
- High Density Polyethylene (HDPE):-Bottle caps, banners, fuel tanks etc.
- Polyethylene Terephthalate (PET):-Drinking bottles, microwavable packaging etc.
- Polypropylene (PP):- Bottle caps, detergent wrappers, trays, appliances etc.,
- Polystyrene (PS):-Yoghurt pots, clear egg packs etc.
- Polyvinyl Chloride (PVC):-Credit cards, pipes and gutters; electrical fittings etc.[5]

III. DATA ON PLASTIC CONSUMPTION AND GENERATION OF PLASTIC WASTE

Plastics constitute two major category of plastics; (i) Thermoplastics and (ii) Thermoset plastics. The thermoplastics, constitutes 80% and thermoset constitutes approximately 20% of total postconsumer plastics waste generated. The following table 1, 2 and 3 describes the average municipal solid waste production per capita per day in India:

Table 1: Municipal Solid Waste in Indian Cities

Population Range (Millions)	Average per Capita Value
0.1-0.5	0.21
0.5-1.0	0.25
1.0-2.0	0.27
2.0-5.0	0.35
> 5	0.50

Table 2: Plastic Consumption in India

S. No	Year	Consumption (Tones)
1	1996	61,000
2	2001	400,000
3	2006	700,000
4	2011	13500,000

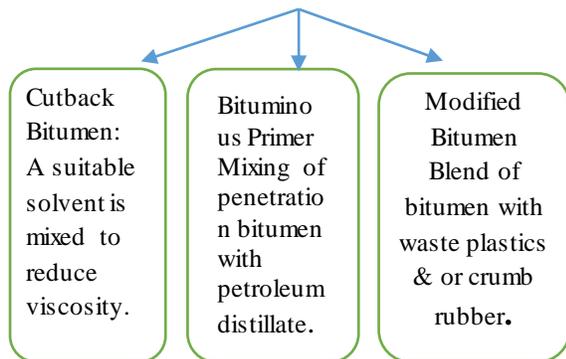
Table 3: Plastic Waste Consumption (P/C/YEAR)

S. No	Country/Continent	Per Year Consumption (Kg)
1	India	19.4
2	Sri Lanka	16.8
3	China	50.0
4	Europe	80.0
5	United States	109.0

IV. BITUMEN

Bitumen is a sticky, black and highly viscous liquid or semi-solid of petroleum. It is a residue from the distillation process of crude oils. Bitumen composed primarily of highly condensed polycyclic aromatic hydrocarbons containing carbon, hydrogen, sulphur, nitrogen, oxygen etc. It is a mixture of about 300 - 2000 chemical components. It is the heaviest fraction of crude oil, the one with highest boiling point. [6]

DIFFERENT FORMS OF BITUMEN



THE DESIRABLE PROPERTY OF BITUMEN FOR PAVEMENT

- Good cohesive and adhesive binding property.
- Water repellent property.
- It is its thermoplastic nature (stiff when cold liquid when hot) that makes bitumen so useful.[7]

DRAWBACKS OF BITUMEN

- ❖ Temperature Effect: At high temperature bleeding of road occurs reducing performance of road.
- ❖ Oxidation Effect: Due to oxidation bitumen may led to cracking & crazing phenomenon.
- ❖ Water Effect: Due to water, bitumen strips off from the aggregate forming pothole on roads as being water repellent material. Reducing life of roads.
- ❖ High Cost - Being petroleum product it costs much higher.[8]

V. PROCESSES AND TESTS INVOLVED IN PLASTIC AGGREGATE

Moisture Absorption and Void Measurement

Hot stone aggregate (170°C) is mixed with hot bitumen (160°C) and the mix is used for road laying. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity as per IS coding. The aggregate, when coated with plastics, improves its quality with respect to voids, moisture absorption and soundness. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement. [9]

Soundness Test

Soundness test is intended to study the resistance of aggregate to weathering action. The weight loss is attributed to the poor quality of the aggregate. If the plastic coated aggregate, did not shows any weight loss it conforms the improvement in the quality of the aggregate.

Aggregated Impact Value

A study on the effect of plastic coating was extended to study on the aggregate impact value.

Aggregate was coated with 1% & 2% plastics by weight and the plastic coated aggregate was submitted to Aggregate Impact Value test and the values were compared with values for non-coated aggregate.

Los Angeles' Abrasion Test

The repeated movement of the vehicle with iron wheeled or rubber tire will produce some wear and tear over the surface of the pavement. This wear and tear percentage of an aggregate is determined with

the help of this test. Under this study the percentage of wear and tear values of the plastic coated aggregate is found to be in decreasing order with respect to the percentage of plastics.

Marshall Stability

Marshall Stability measures the maximum load sustained by the bituminous material at a loading rate of 50.8 mm/min. Marshall Stability is related to the resistance of bituminous materials to distortion, displacement, rutting and shearing stresses.

Ductility Index Test

The ductility of a bituminous material is measured by the distance in cm to which it will elongate before breaking when a standard briquette specimen of the material is pulled apart at a specified speed and a specified temperature

Dry process

For the flexible pavement, hot stone aggregate (170⁰C) is mixed with hot bitumen (160⁰C) and the mix is used for road laying. The aggregate is chosen on the basis of its strength moisture absorption capacity as per IS coding. The bitumen is chosen on the basis of its binding property, penetration value and viscoelastic property. The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate. [10]

Advantages of Dry Process

- Coating is easy & temperature required is same as road laying temp.
- The coated aggregates show increased strength.
- Cost efficiency is possible.
- No degradation of roads even after 5-6 years after construction.
- Can be practiced in all type of climatic conditions.
- No evolution of any toxic gases as maximum temperature is 180⁰C.

Disadvantages of Dry Process

- The process is applicable to plastic waste material only.

Wet process

In this process 6 to 8 % plastic is mixed with the bitumen. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. By mixing plastic with bitumen the ability of the bitumen to withstand high temperature increases. The plastic waste is melted and mixed with bitumen in a particular ratio. The vigorous tests in the laboratory level proved that the bituminous concrete mixes prepared using the treated bitumen binder fulfilled all the specified Marshall mix design criteria for surface course of road pavement. There was a substantial increase in Marshall Stability value of the mix, of the

order of two to three times higher value and has longer soaking conditions in comparison with the untreated or ordinary bitumen. [11]

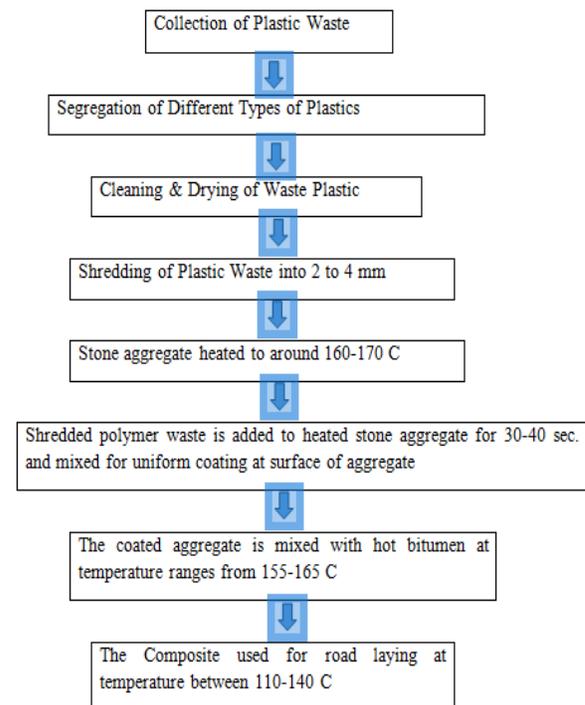
Advantages of Wet Process

- This Process can be utilized for recycling of any type, size, shape of waste material (Plastics, Rubber etc.)

Disadvantages of Wet Process

- Time consuming- more energy for blending.
- Powerful mechanical is required.
- Additional cooling is required as improper addition of bitumen may cause air pockets in roads. [12]

VI. PROCESS FLOW DIAGRAM OF PLASTIC COATED BITUMEN MIX ROAD



VII. OPTIMISTIC PLASTIC: STEP TOWARDS FUTURE

- Laboratory studies were carried out at the Centre for Transportation Engineering of Bangalore University.[13]
- In Tamil Nadu, length of roads around 1000 m in various stretches were constructed using waste plastic as an additive in bituminous mix.
- The performance of the road stretches constructed using waster plastic in Kamataka is also found to be satisfactory [14]

VIII. CONCLUSION

- The use of recycled waste plastic in pavements represents a valuable outlet for such harmful materials.
- The use of modified bitumen with the addition of processed waste plastic helps in substantially improving the stability, strength, fatigue life and other desirable properties of bituminous concrete mix, improving the longevity and pavement performance along with marginal saving in bitumen usage.
- The process is environment friendly. The use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics.
- Thus, these processes are socially highly relevant, giving better infrastructure.

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