

An Integrated Approach for Rural Road Development in India

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Abstract: India has a road network of over 5,472,144 kilometers (3,400,233 mi) as on 31 March 2015, the second largest road network in the world. The plastic wastes can be used in road construction and the field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. 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. Waste plastic is ground and made into powder; 3 to 4 % plastic is mixed with the bitumen. The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. The use of the innovative technology not only strengthened the road construction but also increased the road life as well as will help to improve the environment and also creating a source of income.

Keywords: HDPE (high-density poly-ethylene), Dry process

1. Introduction

Plastic waste is a huge threat to the environment. In 2005, after monsoon rains flooded Mumbai, plastic bags were blamed for clogging the underground drainage system and intensifying the effect of the floods. In areas frequented by tourists, like Goa, heavy consumption of bottled water has resulted in trash on beaches, creating eyesores and endangering marine life. Even India's cows, considered sacred, have not been spared. After 3,000 cows died in Lucknow in 2000, the city investigated and found plastic bags in their stomachs. Apparently the bags had been ingested as the animals grazed at dump sites. With more than 35 tons of plastic waste generated by every Indian state, each day India is confronted with the big question of how to get rid of this non-biodegradable menace.

2. Need of study

Disposal of waste plastic is a major problem.

- It is non-biodegradable.
- It mainly consists of low-density polyethylene.
- To find its utility in bituminous mixes for road construction.
- Burning of these waste plastic bags causes environmental pollution.

- Laboratory performance studies were conducted on bituminous mixes.
- Studies proved that waste plastic enhances the property of the mix.
- Improvement in properties of bituminous mix provides the solution for disposal in a useful way.

3. Plastic as an additive for bituminous materials

Plastic used 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. Recent studies in this direction have shown some hope in terms of using plastic-waste in road construction i.e., Plastic roads.

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. Use of shredded plastic waste acts as a strong "binding agent" for tar making the asphalt last long. 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. Normally, blending takes place when temperature reaches 45.5°C but when plastic is mixed, it remains stable even at 55°C. The vigorous tests at 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 BC mix, of the order of two to three times higher value in comparison with the untreated or ordinary bitumen. Another important observation was that the bituminous mixes prepared using the treated binder could withstand adverse soaking conditions under water for longer duration.

A. Salient features of the polymer-waste-bitumen mix road

- Road strength is twice stronger than normal roads;
- Resistance towards water stagnation i.e. no potholes

are formed;

- Less bleeding during summer;
- Burning of plastics waste could be avoided
- It doesn't involve any extra machinery;
- It doesn't increase cost of road construction; and
- It helps to reduce the consumption of bituminous mix vis-à-vis reduce cost.

Table 1

Comparison between Normal Bituminous Road and Plastic Road

S. No.	Properties	Plastic Road	Normal Bituminous Road
1.	Marshall Stability Value	More	Less
2.	Rutting	Less	More
3.	Softening Point	Less	More
4.	Seepage Of Water	No	Yes
5.	Stripping (Pot Holes)	No	More
6.	Durability Of Road	Better	Good
7.	Tensile Strength	High	Less
8.	Penetration Value	More	Less
9.	Binding Property	Better	Good

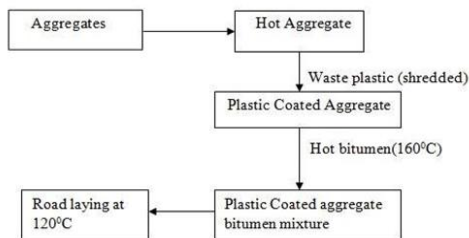


Fig. 1. Process block diagram

Step 5:-
• The plastics waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The roller used is 8-ton capacity.



• Step 6:- The road laying temperature is between 110°C to 120 °c. And the rollers are used have capacity 8- ton generally.



Fig. 2. Construction of plastic roads

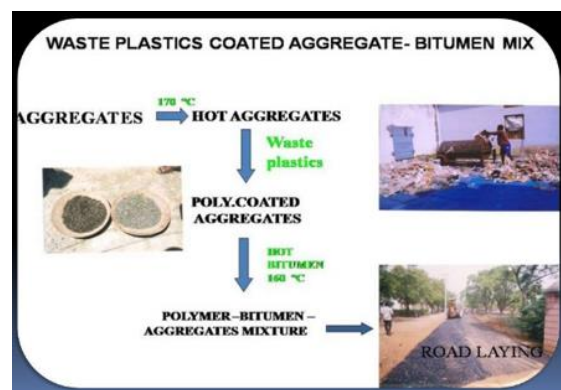


Fig. 3. Over all process

Step 1:- Plastics waste (bags ,cups , bottles) made out of PE,PP and PS cut into a size between 2.36mm and 4.75mm using shredding machine.



Step 2:- The aggregate mix is heated to 165°c (as per the HRS specification) and transferred to mixing chamber. Amount of plastic to be added is @8% of bitumen.



STEP 3:-

- Similarly the bitumen is to be heated up to a maximum of 160 °c (HRS Specification) to have good binding and to prevent weak bonding. (Monitoring the temperature is very important).



- Step 4:- At the mixing chamber, the shredded plastics waste is to be added. It get coated uniformly over the aggregate within 30 to 60 seconds, giving an oily look.



4. Conclusion

Polymer Modified Bitumen is used due to its better performance. In the modified process (dry process) plastics waste is coated over aggregate. This helps to have better binding of bitumen with the plastic-waste coated aggregate due to increased bonding and increased area of contact between polymer and bitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reduced rutting, raveling, and there is no pothole formation. The road can withstand heavy traffic and show better durability. The use of the innovative technology will not only strengthen the road construction but will also increase the road life as well as help to improve the environment and will also create a source of income.

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