

Plastic-Bitumen Roads

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Abstract— Plastic waste is a major environmental and public health problem at Jamshedpur. Plastic shopping or carrier bags are one of the main sources of plastic waste. Plastic bags of all sizes and colors dot the city's landscape due to the problems of misuse, overuse and littering. Besides this visual pollution, plastic bag wastes contribute to blockage of drains and gutters, are a threat to aquatic life when they find their way to water bodies, and can cause livestock deaths when the livestock consume them. Furthermore, when filled with rainwater, plastic bags become breeding grounds for mosquitoes, which cause malaria. Burning of these chlorine-containing substances releases toxic heavy metals and emits noxious gasses like dioxins and furans. They are the most toxic and poisonous substances on earth and can cause a variety of health problems including damage to the reproductive and immune system, respiratory difficulties and cancer. Land filling of plastics into properly designed disposal sites takes up valuable room in the site for a non-toxic, non-leachable, non-decomposable material. Whether plastic is a menace or not depends how we use it and how we dispose of it minimizing the impacts on the environment. We are collecting the threat (waste plastics) from the source, segregating the waste and shredding the same into 2-4mm size and mixing the shredded plastic to make a coating over the aggregates used for road construction providing the road a tremendous strength at no extra cost. Plastic gets coated over stone and the hot plastic coated stone is mixed with bitumen (tar) and the mix is used for road laying.

Key words: Bitumen (Tar), Plastic-Bitumen Roads

I. INTRODUCTION

Preparation of the mix- The aggregate mix, used for flexible road construction is first coated with molten plastics waste and this plastic coated aggregate is used as raw material. (The plastic used was disposed carry bags, films, cups, and etc. with a maximum thickness of 60 microns). To the hot plastics coated aggregate (165^oc), bitumen (160^oc) is added and mixed and used for road construction. The Bitumen Was Not Blended With Plastics Waste.

Properties of the plastics waste coated aggregate-bitumen mix:

- 1) Even after 96 hrs, there is no stripping of bitumen layer showing the resistance towards stripping and pot hole formation.
- 2) Marshall Stability Value increases depending upon the percentage of plastics used for coating from 1265Kg to approx.2500 kg thus increasing the strength of the road. The field trials are still on.
- 3) Extraction of bitumen from the above mix is very slow compared to non-plastic-Bitumen mix showing the increased strength of binding of bitumen
- 4) Plastics coated aggregate has low percentage of voids, hence less oxidations of bitumen and less raveling and rutting.

- Plastic coated aggregate – bitumen mix have very low moisture absorption and hence no stripping or pothole formation
- The percentage of bitumen needed to form an effective mix can be reduced from 5% to 4.5% thus a saving of bitumen, not less than 10% is also possible.
- Plastics coated aggregate, when soaked in water for 72 hours, there is no stripping. The aggregate gains non-wetting property with respect to water.
- Plastic coated aggregate, when mixed with hot bitumen, they mix well and the blend can be used for road construction. Coated plastics waste helps to increase both blending property and binding property.

II. METHODOLOGY & PROCESS

The roads can be constructed with plastic wastes (8%) in conjunction with bitumen (92%). This process has 2 way benefits – Reusability of hazardous plastic, which could have otherwise clogged drains, caused flooding, choked animals that eat them. Burying plastic forever into roads is the safest. Polymer-Modified Bitumen is in use since long. It is approved in the Indian Roads Congress' Special Publication 53 guidelines, 1999. Reduced penetration and ductility, a higher softening point, less rutting and cold cracking. Marshall Stability value is initially 25% better, later 200-300% better than unmodified roads. Test samples show 260% improved resistance to water-soaking, hence ideal for sub-grade. 100% improvement in fatigue life of roads. Greatly reduced road cracking after 1 year on Bangalore-Mysore Rd vs. unmodified road.

- Step 1: Plastic waste made out of PE, PP and PS cut into a size between 2.36mm and 4.75mm using shredding machine.
- Step 2: Similarly, the bitumen is to be heated to a maximum of 170^oC to have good binding and to prevent weak bonding. (Monitoring the temperature is very important)
- Step 3: At the mixing chamber the shredded plastic waste is to be added to the hot aggregate. It gets coated uniformly over the aggregate within 30 Sec, giving an oily look Plastic coated aggregate is obtained.
- Step 4: Hot bitumen is then added over the plastic coated aggregate and the resulting mix is used for road construction. The road laying temperature is between 110^oC to 120^oC. The roller used is 8-ton capacity

III. CHARACTERISTICS OF THE PROCESS

- Easy process without any new machinery
- Simple process without any industry involvement
- In situ process
- Use of lesser percentage of bitumen and thus savings on bitumen resource
- Use of plastics waste for a safe and eco-friendly process

- Both Mini Hot Mix Plant and Central Mixing Plant can be used
- Only aggregate is polymer coated and bitumen is not modified
- Use 60/70 and 80/90 bitumen is possible
- No evolution of any toxic gases like dioxin
- Fly ash can also be used to give a better performance

IV. EASY DISPOSAL OF WASTE PLASTICS

- Plastics waste like carry bags, disposal cups, thermo Coles and polyethylene and polypropylene foams can be used.(1ton ~10 lakhs carry bags)
- There is no need of segregation.
- No need for much cleaning
- Multi layer films can also be used.
- No special machinery is required.
- The machinery available for road construction can be used without any extra modification.
- No external industry is involved.
- No granulation or blending is needed.
- Land filling and incineration process can be avoided.
- Burning of plastics can be avoided
- Nearly 7500 tons of Co2 emission due to burning was saved so for
- Carbon Credit have been achieved

V. HIGH QUALITY OF PLASTICS TAR ROAD

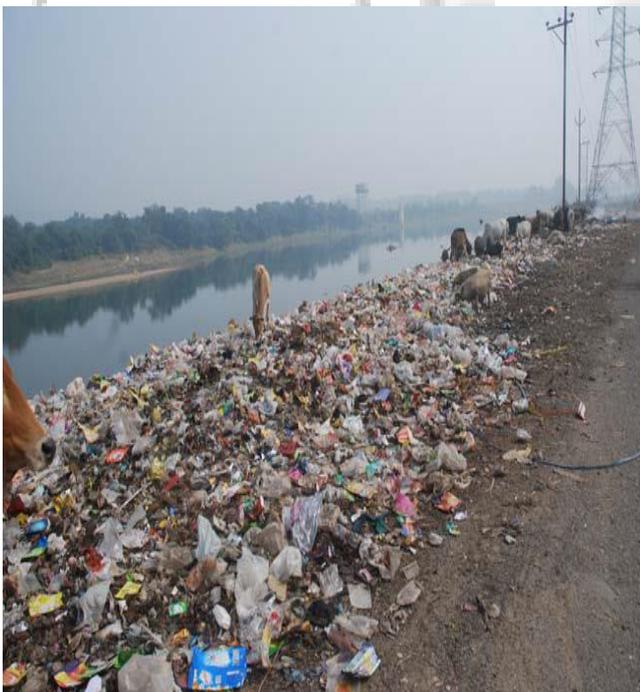


Fig. 1: Plastic Menace in the Swarnrekha river side, Jamshedpur

- Strength of the road increased by 100% (Increased Marshall Stability Value)
- Better resistance towards rain water and water stagnation
- No stripping and have no potholes.
- Increased binding and better bonding of the mix.
- Increased load withstanding property (Withstanding increased load transport)

- Consumption of bitumen decreases by not less than 10%
- Reduction in pores in aggregate and hence less rutting and raveling.
- Better soundness property.
- Maintenance cost of the road is almost nil.
- The Road life period is doubled
- No leaching of plastics.
- No effect of radiation like UV.



Fig. 2: Plastic Tar road, CH area road no.1

VI. ENVIRONMENTAL BENEFIT

- 1) The waste plastic is used only for the lamination of stone aggregate. There is no evolution of any gas during the process. There is no air or land pollution.
- 2) There is no evolution of CO₂ (only melting of plastics)
- 3) If 1Km of single lane plastic tar road laid, 1 tone of plastics is used and this helps to avoid the evolution of 3 tones of CO₂, which may otherwise result due to burning of plastics. Nearly 8 Km road has been laid till toady and this has prevented the evolution of 24 tones of CO₂.
- 4) This road withstands heavy rain and water stagnation.
- 5) No pot holes have formed till date.

VII. TOTAL INVESTMENT

There is no additional investment. Actually there is a reduction in the cost and saving of bitumen. There is no maintenance expenditure for five years.

VIII. RETURNS

- 1) Clean environment, free from plastic waste.
- 2) Better road without any deformation due to rain or traffic load)

- 3) Saving natural resource.
- 4) Use of plastic waste effectively.
- 5) Eco-friendly way for the use of waste plastics.

IX. CONCLUSION

The process of using low end waste plastic to construct roads has been included in Plastic Waste Management & Handling rule amended on 4th Feb'2011'. It indicates that it has been a proven technology to take care of Mother Earth this way. We are mixing shredded waste plastic for laying all the present and future roads of Jamshedpur.

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