

A Review on use of Plastic in Bituminous Roads/Pavements

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Abstract: The waste generated from plastic and its disposal is a major threat to our environment, resulting in pollution and global warming. The use of plastic waste in bituminous roads/pavements enhances its properties and also its strength. In addition it will be boon for India as a solution to manage plastic disposal and various defects in roads/pavements viz., ruts, potholes corrugation, etc. The plastic waste used are polythene, poly-styrene, and poly-propylene. The waste plastic is shredded & coated over aggregate & mixed with hot bitumen and resulted mix is used for road/pavement construction. This will not only strengthen the pavement but also increases its durability. This innovative technology will also be suitable for Indian hot-humid climate. It is eco-friendly as well as economical. In this paper, we have discussed the method of using plastic waste in construction of roads and how it is better than the ordinary roads.

Key words: Plastic waste, bituminous roads, pollution, global-warming

INTRODUCTION:

Plastic have become an integral part in our daily life and so the millions of tons amount of plastic waste is generated annually today. Due to its low cost, easy manufacturing and impervious to water, plastics are used in an excessive and manufacturing wide range of products. Also due to fast growth of industries and vast population has resulted in creation of various varieties of polythene material. Also, basic sectors like agriculture to packing, automobile, electronics, electrical, building construction, communication sectors has been practically transform by the use of plastics. Plastic waste, if not recycled gets mixed with Municipal Waste or get thrown over land area. There are two methods of municipal waste disposal, land filled or incinerated. And both the methods are not eco-friendly. Incineration leads to air pollution whereas dumping the waste in open areas causes contamination of water bodies and soils.

As stated above, plastic disposal is one of the major problems for developing countries like India, at a same time India needs a large network of roads for its smooth economic and social development. Scarcity of bitumen needs a deep thinking to ensure fast road construction. Hence, this new technology of using plastic waste in construction of roads not only increases the road life also retain good environment to live.

Prof. R. Vasudevan, Department of Chemistry, Thiagarajar College of Engineering, Madurai, has introduced a

revolutionary solution for plastic waste problems and he is also known as the Plastic Man of India. In the year 2002 Prof. R. Vasudevan and his team has conducted a plastic tar road inside their institute, which has remained intact till date. From then on, the technology has been going places. Indian Roads Congress and Central Pollution Control Board are also using the same technique.

Waste Plastic (Polymer) Type	Source
Low density Polyethylene (LDPE)	Carrier bags, bin liners, packaging films and squeezable detergent bottles, etc.
High density Polyethylene (HDPE)	Bottles of pharmaceutical, milk, disinfectants, fruit juice, shampoo, etc.
Polypropylene (PP)	Bottle caps, medicine bottles, chips pack, microwave trays for ready-made meals, etc.
Polystyrene (PS)	Disposal cups, cutlery, packaging foam lids, etc.
Polyvinyl Chlorine (PVC)	Water bottles, sanitary pipes, ATM/credit cards, various toys, electrical fitting materials, plastic furniture, various stationery products, etc.

LITERATURE REVIEW:

Dr. R. Vasudevan: He states that the polymer bitumen blend is better binder compared to plain bitumen. Blend has increased softening point and decreased penetration value with a suitable ductility. When it is used for road construction it can withstand higher temperature and load. The coating of plastics reduces the porosity, Absorption of moisture and improves soundness. The polymer coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods for easy and prevention of pollution and so on.

Athira R Prasad et al (2015): He proves that the bitumen which is conventional material used in the road construction can be partially replaced by the waste plastic and rubber. They added rubber and PET in 3%, 4.5%, 6%, 7.5% and 8% in bitumen and found that the optimum content was obtained at 6%. Thus according to their study the use of plastic in 6% by weight of bitumen improves the pavement stability. And

they found the use of PET bottle is best. Therefore the disposal of rubber and PET is best in the road construction.

Anurag V. Tiwari et al (2015): As plastics has non-biodegradable characteristics and Are also harmful to human health therefore disposal of waste plastic is of great concern to the environmental engineers. The roads in India are mostly flexible type and made of bituminous concrete. As bitumen is been extracted from naturally occurring crude oil therefore has its limitation on the availability therefore there is the need of an alternative material. Their papers compose of literature and processes for use of waste plastic in the construction of roads. And also aims to reduce the environmental pollution created by plastic in economic way by using the plastic waste in the construction of road.

Bright Aforlaeta et al (2015): According to them by adding waste plastic the property of bitumen has increased. With two per cent of polymer composition with AC-10 bitumen can give AVC-20 bitumen properties which will finally help in improving the marshal stability design life strength and other desirable property. The asphalt pavement shows saving in usage of bitumen as consumption of waste plastic increases. The disposal of waste plastic in the bituminous pavement construction is therefore a permanent solution and hence which establish the safe and healthy environment.

Mahesh M Barad (2015): Proves that modified bitumen by polymer shows good properties as compare to normal bitumen. But if we add more per cent of plastic in bitumen the blend gets separates on cooling. And which finally affect the properties of bitumen. In the dry process the aggregate are coated with plastic. The aggregate coated with plastic shows the improved binding properties as due to increased area of contact between bitumen and polymer.

S.Rajasekaran et al (2013): Proves that by coating the aggregate with the polymer has many advantages and which ultimately helps in improving the flexible pavement quality not only it improve the pavement quality but also improve the aggregate quality. This technology also helps in the disposal of waste plastic obtained from the domestic and industrial packing materials. The dry process is more valuable as it dispose the 80 % of waste polymer in eco-friendly way. And use of polymer reduces the equivalent bitumen quantity and therefore reducing the construction cost of road.

Sasane Neha .B et al (2015): Proves that the addition of plastic is the innovative technology which strengthen the road construction and also increases the life of road. As the plastic content increase the property of bitumen and aggregate also increases compared to conventional flexible pavement the flexible pavement with the added plastic has good results. According to marshal stability test the optimum use of plastic is up to 10%.

MATERIALS, SPECIFICATION AND PROCEDURE:

In plastic roads (composites of plastic with other materials) construction generally following materials are used-
Aggregates- of size 20mm, 10mm and stone dust / lime as filler.

b. Bitumen- for binder different grades of bitumen 60/70 or 80/100 can be opted.

Plastic Waste- collected from various garbage dumps in the shredded form is used (PVC is not used because of the high toxicity).

A. Plastic Waste Specifications

Following types of plastic wastes can be used in rural road construction-, films of

Hard foams polystyrene (PS) and Soft foams polypropylene (PP) and polyethylene (PE) of any thickness. Films of polystyrene (PS), polypropylene (PP and polyethylene (PE) up to 60micron thickness.

Laminated plastics (metal coated also) up to 60micron thickness.

B. Process of Road Construction Using Plastic Waste

The basic process for road construction using plastic waste includes following steps-

Plastic Waste Collection: In first step, various plastic wastes as characterized in above specifications are collected from various sources.

Segregation: Other wastes are separated out from the plastic waste collected from various garbage dumps in above first step.

Cleaning and drying: the separated waste is cleaned properly and dried.

Shredding: After segregation and cleaning-drying step the waste collected is broken and is graded into a size of 2.36 mm to 4.75 mm IS sieve with the help of a shredding machine.

Heating Process: Before transferring to the mixing chamber the aggregate mix is heated to 165°C to 170°C and for preventing weak bonding the bitumen is heated up to the temperature of 160°C.

Surface Coating: At the mixing chamber, the shredded plastic waste gets coated uniformly over the surface of the aggregates and shows an oily look within approximately one minute of time.

Construction: The aggregates after mixing with the combined mixture of the plastic waste and the bitumen are used for laying the road between the temperatures of 110°C to 120°C.

C. Method of Mixing

Dry process is preferred for isolated works. According to the recommendations of CRRI and Dr. Vasudevan the percentage of shredded plastic waste should be 8%, and 10% respectively. However, 8% can be adopted as the optimum plastic waste content for blending the bitumen for use in plastic road construction.

Dry Process: First the plastic waste is collected, segregated and stored. The segregation is done because certain kinds of plastic like polyvinyl chloride (PVC) and flux sheets cannot be used due to safety concerns. The next step involves the cleaning of the plastic. This is necessary because most of the plastic waste collected has been used for packaging (55% in India) and hence is likely to contain residual substances such as little bits of food which must be removed. After this the plastic goes through the process of shredding which reduces it to the correct thickness, 2-4 mm. The aggregates heated to around 160°C-170°C and then the plastic is added and after 30-40s a uniform coating is observed. This coating gives it an oily look. The bitumen is then added and the mixture is thoroughly mixed before laying. The bitumen is added at a

temperature of around 155°C-163°C. This temperature is carefully regulated to make sure that the binding is strong. Wet Process: In this process, the waste plastic is directly mixed with the hot bitumen at 160°C and this mixture is then mixed using a mechanical stirrer. This mixture also contains additional stabilisers and requires proper cooling. It is not popular because it requires huge investments, larger plants and more equipment than the Dry process.

DISCUSSION:

A well-constructed plastic road will result in following advantages:

- Strength and performance of the road increases.
- Reduces the bitumen requirement by around 10% resulting in reduction of overall cost.
- No stripping and no potholes.
- The maintenance expenditures reduces to almost nil.
- Generates employment for rag pickers.
- The road life sustainably increases.
- Helps in disposal of plastic waste. Hence minimizing the pollution.

Some disadvantages of plastic roads:

- Cleaning Process: Toxic present in the co-mingled plastic wastes would start leaching.
- During the road laying process: The presence of chlorine will definitely release HCL gas.
- After the road laying: Once the road has been laid, its components, are no inert. The first rain may cause leaching problem. As the plastic, will merely form a sticky layer. Once the road is started to be used will cause their release of fine polymer particles.

Difference between Plastic road and Ordinary road:

Properties	Plastic Road	Ordinary Road
Marshall Stability Value	More	Less
Binding Property	Better	Good
Softening Point	Less	More
Penetration value	More	Less
Tensile Strength	High	Less
Rutting	Less	More
Stripping(Pot Holes)	No	More
Seepage of water	No	Yes
Durability of the roads	Better	Good

CONCLUSION:

1. There is marginal increase in the cost because of the mixing requirements for shredded plastic waste and the bitumen but this get overcome by large amount of the total mix volume resulting in less bitumen requirement.
2. Lots of problems at a global level can be solved by utilizing non-biodegradable waste material like plastic in road construction.
3. There is overall increase in road life by opting these technologies in the pavement construction.
4. Properties of bitumen get enhanced with the addition of plastic waste. The resulting mix shows good result when compared to standard results.

5. Because of the plastic, rain water will not seep through. Hence there is lesser maintenance requirements.
6. Binding property also get improved by making use of these technologies.
7. There is increase in the resistance to stripping for plastic waste coated aggregates followed by bitumen.
8. Most of the properties for the plastic-coated aggregates keep on improving up to 7% plastic waste content. Thereafter on farther increase in the plastic waste content, the values slightly start coming back moving towards the negative side.

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REFERENCES:

- [1] Indian Roads Congress IRC: 37-2012 - Guidelines for the design of flexible pavements-August 2012.
- [2] R. Vasudevan, (2011) "A technique to dispose waste plastics in an eco-friendly way-Application in construction of flexible pavements" Construction and Building Materials, Vol. 28 Department of Chemistry, Thiagarajar College of Engineering, Madurai, Tamil Nadu, India, pp 311-320.
- [3] Miss Apurva J Chavan - Use of plastic waste in flexible Pavements - ISSN 2319 - 4847, Volume 2, Issue 4, April 2013
- [4] S.S.Verma - Roads from plastic waste - The Indian Concrete Journal - November 2008
- [5] Vinoth.N - Use of plastic wastes in road construction - Central Institutes of Plastic Engineering and technology
- [6] 6. Aravind K. Das Animesh, (2007), "Pavement design with central plant hot-mix recycled asphalt mixes", Construction and Building Materials, Vol. 21, Dept. of Civil Engg., Indian Institute of Technology, Kanpur,India, pp 928-936.
- [7] Dhodapkar A N., (Dec. 2008), "Use of waste plastic in road construction" Indian Highways, Technical paper, journal, P.No.31-32.
- [8] Al-Hadidy A.I., Yi-qiu Tan (2009), "Effect of polyethylene on life of flexible pavements", Construction and Building Materials, Vol. 23
- [9] Rishi Singh Chhabra*, SupriyaMarik - A Review Literature On The Use Of Waste Plastics And Waste Rubber Tyres In Pavement - International Journal Of Core Engineering &Management(IJCEM) Volume 1, Issue 1, April 2014
- [10] Zahra NiloofarKalantar , Mohamed RehanKarim, AbdelazizMahrez - A review of using waste and virgin polymer in pavement - Construction and Building Materials 33 (2012) 55-62
- [11] AmitGawande*, G. Zamare, V.C. Renge, SaurabhTayde, G. Bharsakale - An overview on waste plastic utilization in asphaltting of roads - Journal of Engineering Research and Studies volume 3,2012/01-05
- [12] Shruti Yerkar, Kunal Jagtap, Yogesh Borkar - Use of plastic waste in road construction - International Advanced Research Journal in Science, Engineering and Technology Vol. 4, Special Issue 3 January 2017
- [13] Aditya Bhardwaj, Bal Krishna Keshav, Akuldev Singh - Review paper on Application of Waste Plastic Modifying Bitumen Properties - International Journal of Engineering Research and Application Vol. 7, issue 4, April 2017, pp 79-81
- [14] Paramesh G.A - A Review on Usage of Waste Plastic(Polyethylene) in Construction of Flexible Pavement - International Journal of Advances in Science, Engineering and technology Vol. 6, Issue-1, Feb 2018