



Utilization Of Polymer Modified Bitumen In Surface Coating

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ABSTRACT: Plastic is a toxic & persistent material. It is generally found to be nearly 5% in Municipal Solid Wastes (MSW) which is a major environmental threat. Nowadays, plastics are used in our day-to-day life for enormous purposes viz. carry bags in various shops, plastic sheet materials for making roofs of temporary kutchas and hutments, packaging materials in LDPE & HDPE manufacturing industries, in drinking water supply and sanitary appurtenances, in electrical appliances, in manufacturing of various electronic appliances etc. The outcome of Life Cycle Assessment (LCA) of these plastic materials is not satisfactory. Generally people dispose off these plastic materials and plastic products after their usage on open ground as surface impoundment in lieu of their reuse, recycle and reduction in volume which has become a prominent ecological & environmental problem. Waste plastic bags & waste plastic materials interrupt the infiltration and percolation of rain water through soil pores and in turn diminishes the ground water recharge in aquifers. Nowadays we have tonnes of plastic solid wastes in our surroundings. There are so many institutes which after consistent researches have come to a conclusion that waste plastics can be used in modifying roads. If we use plastics in road construction, we can reduce the cost of road construction and pollution index of environment to an appreciable extent. We can use plastics as binder with bitumen. It may give better finishability, stability, binding property, resistance to water and durability.

KeyWords: Toxic, Persistent, Lifecycle Assessment, Aquifers, Municipal Solid Waste (MSW)

I. INTRODUCTION

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'Plastic'. Plastic is a boon for humans. As it has cheap cost, easy to transport, can be used for different purposes. For packaging purposes mainly we use jute bags, paper bags, cloth bags which are heavy and not. The agricultural sector is one of the most important components of Indian Economy. Agriculture continues to be a mainstay of life for majority of the population. Which contributes around 17.5 per cent (Economic survey 2015-16) of the GVA; About 68.84% people are living in rural areas (Census 2011) and are still dependent on Agriculture. About 43% of India's geographical area is used for agricultural activity and employs 50 per cent of the workforce in the country. Therefore the responsibility of providing infrastructure is with the state which aims at rapid growth of agricultural production for attaining developmental goals such as attaining food security, promoting industrial development, relieving unemployment, and poverty alleviation etc. The agricultural sector in our country has prospered over the years because of government's constant thrust on increasing agricultural production. Still the benefits are not percolating down to the farming community. Indian agriculture is characterized by lack of proper infrastructure facilities. Economical for transport. So for overcoming it we prefer plastic bags or carry bags. In a survey it was found that a plastic can last more than 4000 years. It was good to know that the life of plastic is more than any other packaging material. Plastics are versatile packing materials and commonly used by man but they become a problem to the environment.

Consumption, Generation & Classification of plastic waste in India After using them mostly used plastic products are bags, cups, films and foams, made up of polyethylene, polypropylene or polystyrene. India's consumption of plastics will grow 15 million tonnes by 2015* and is set to be the third largest consumer of plastics in the world. In our country we use so many plastics in our daily use. The data we look above was a comparison of consumption of plastic in the world and in India. India generates 5.6 million metric tons of plastic waste annually, with Delhi generating the most of at the municipality level at 689.5 metric tons every day, according to a



PLASTIC SCENARIO

Plastic Common Man's Friend
Energy Saving
Superior Priority
Convenient To Carry
Energy For Transportation Cost is less

report from the Central Pollution Control Board (CPCB). CPCB submitted the report to the Indian Supreme Court, which said, "We are sitting on a plastic time bomb."

Table 3: Year Wise Plastic Consumption

S.No.	Year	Consumption (Tonnes)
1	1996	61000
2	2001	400000
3	2006	700000
4	2011	135000
5	2013	174000

According to our Municipal Waste Management Plastic comes under solid waste. So by our solid waste management the solid waste dump in an open area where it decompose.

Solid Waste Found In India

- Biodegradable
- Rags
- Glass
- Inerts
- Others
- Plastic
- Metals
- Paper

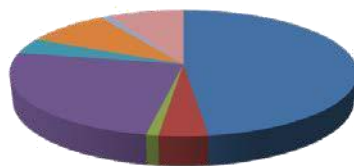


Figure 1: Pie Chart Showing Municipal Solid Waste in India

The littered plastics, a non biodegradable material, get mixed with domestic waste and make the disposal of municipal solid waste difficult But as we see plastic does not decompose easily, it take thousands of years. Disposal of plastic results in unnecessary Land Filling & Incineration



Figure 2: Waste Plastic Open Dumping



Figure 3: Plastic Burning in open dumping



Plastic waste somehow reduced by recycling but it does not reduce it in large manner. For reducing plastics people also burn it. But they don't know that on burning plastic dioxin gas released which is in toxic nature. So, burning Of Plastic is not a better idea for decomposing and reducing it. By some industries plastics were recycling according to their use which is good for environment. For example: The cloth industry which crush plastics into small pieces and make cloths by it. They have their own technique which is good for our ecological system. Nowadays we can use plastic in road construction purpose. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Shredded plastic waste acts as a strong —binding agent for tar making the asphalt last long. Processes for manufacturing bitumen mix road using plastic waste. The experimentation at several institutes indicated that the waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time.

II. LITERATURE SURVEY

Dr. P. K. Jain, (2012) carried out use of plastic waste in bituminous road construction. It is found that shredded plastic waste of the size 2-8 mm may be incorporated conveniently in bituminous mixes used for road constructions. The optimum dose is 0.40.5 % by weight of bituminous mix and 6-8% by weight of bitumen. Plastic waste may also be used for up gradations of fly ash for its use as fine aggregate and filler in bituminous road construction.

Sangita, Tabrez Alam Khan, Sabina, D.K. Sharma (2011) carried out study of the effect of waste polymer (nitrile rubber and polyethylene in 1:4 ratio) modifier (WPM) on various mechanical properties such as Marshall stability, flow, Marshall quotient (stability to flow ratio), resilient modulus and permanent deformation potential of bituminous concrete overlays has been evaluated.

P Sreejith (2010) carried out Polymer modified bitumen is emerging as one of the important construction of flexible pavements. The polymer modified bitumen show better properties for road construction and plastics waste can find its use in this process and this can help solving problem of pollution. The studies on the thermal behaviour and binding property of molten plastics promoted a study on the preparation of plastic waste-bitumen blend and its properties to find the suitability of the blend for road construction.

Pada Sabtu (2010) compared properties of the modified bitumen were compared with ordinary bitumen. It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive, up to 12 % by weight. The softening point of the modified bitumen increased with the addition of plastic additive, up to 8.0 % by weight. Studies were carried out on Bituminous mixes using 60/70 grade bitumen having average Marshall Stability Value (MSV) of 1300 kg at optimum bitumen content of 5.0 % by weight of the mix. Mohammad T. Awwad and Sheeb Lina. (2007) worked out polyethylene as one sort of polymers used to investigate the potential prospects to enhance asphalt mixture properties. The objectives also include determining the best type of polyethylene to be used and its proportion. Two types of polyethylene were added to coat the aggregate High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE). The results indicated that grinded HDPE polyethylene modifier provides better engineering properties. The recommended proportion of the modifier is 12% by the weight of bitumen content. It is found to increase the stability, reduce the density and slightly increase the air voids and the voids of mineral aggregate.

S.K. Nigam, R. Velkennedy, A. Ramalinga Chandra Sekar, B. Sundarakannan (2006) The authors' applied innovative techniques to use the waste plastics and the tyre waste for the construction of flexible pavement, for making pathway blocks, and for making laminated roofing sheets. The major polymers namely polyethylene, polypropylene, polystyrene show adhesion property in their molten state.

Prof.C.E.G. Justo States that addition of 8.0 % by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.4 % bitumen by weight of the mix or about 9.6 kg bitumen per cubic meter (m³) of BC mix. Modified Bitumen improves the stability or strength, life and other desirable properties of bituminous concrete mix. Dr. R. Vasudevan states that the polymer bitumen blend is a better binder compared to plain bitumen. Blend has increased Softening point and decreased Penetration value with a suitable ductility. When it 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 disposal of waste plastics. Use of plastic bags in road help in many ways like Easy disposal of waste, better road and prevention of pollution and so on. V.S. Punith, (2001), Some encouraging results were reported in this study that there is possibility to improve the performance of bituminous mixes of road pavements. Waste plastics (polythene carry bags, etc.) on heating soften at around 130°C. Thermo gravimetric analysis has shown that there is no gas evolution in the temperature range of 130-180°C. Softened plastics have a binding property. Hence, it can be used as a binder for road construction.



III.METHODOLOGY

There are two main processes namely:

1. DRY PROCESS
2. WET PROCESS
- 3.

DRY PROCESS: In Dry process waste plastics are used as coating materials by softening the plastic and not by burning. For a flexible pavement hot stone aggregate (170°C) is mixed with hot bitumen (160°C) and the mix is used for road laying. The aggregate when coated with plastics improved its quality with respect to voids, soundness and moisture absorption and decreases porosity and thus the performance of the pavement is increased.

WET PROCESS: Plastic waste is ground and made into powder 6 to 8%. Plastic is added to the bitumen at 160°C. The process did not yield a homogenous mix with prominent separated solid deposits of mix therefore wet process was not adopted and another waste material (crumb rubber) has been adopted to add to it.

For mixing the plastic in the aggregate as well as bitumen following temperatures should be maintained.

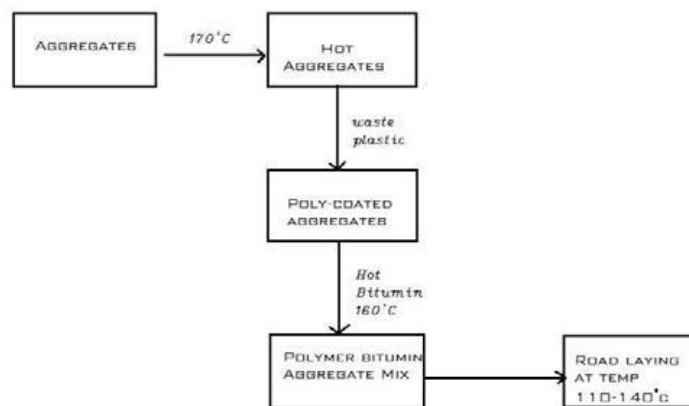


Figure 4: Flow Chart For Process Of Mixing And Placing

We need to go through some process for mixing plastic in asphalt roads. Firstly, we clean the plastic waste. By cleaning we remove all the non plastic things. After that we do shredding of plastics by which all the plastics crushed into very small fine parts, which is easy to mix and use. After the shredding process we mix the bitumen and plastic in mini hot mix plant by which bitumen and plastic bind together. After mixing of bitumen and plastic we add aggregate to the bitumen plastic mix for mixing. In this way we do the process for mixing the plastic to the bitumen as well as aggregate. We can understand the process by looking at the figure 5:



Figure 5: Plastic Tar making process with the help of Pictures

When bitumen was mixed with plastic coated aggregate a portion of bitumen diffuse through the plastic layer and binds with aggregate. Use of higher percentage of plastic waste reduces the need of bitumen by 10%. It also increases the strength and performance of the road. The results of the studies on the extraction of bitumen by dry process showed that the bonding between stone aggregate and bitumen is improved due to the presence of polymers. This may be explained by the following structural models.

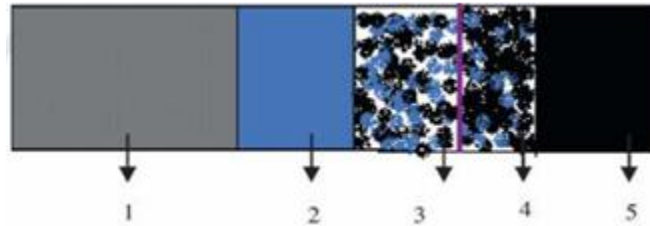


Figure 6: Plastic Waste Coated Aggregate Bitumen Mix

Interaction Model

1. Aggregate
2. Area of Plastics bonded with aggregate (polymer coating)
3. Area of Bitumen–plastics blend (due to diffusion between molten plastics & hot bitumen).
4. Area of Loosely bonded bitumen with dispersed plastics
5. Area of Plain bitumen layer.

This study presents the proper utilization of waste in hot bitumen and aggregate to enhance pavement performance, to protect environment and to provide low cost roads.

IV. DATA ANALYSIS

The results of the studies on the extraction of bitumen (Table) by dry process showed that the bonding between stone aggregate and bitumen is improved due to the presence of polymers. This may be explained by the following structural models.

Table 4: Bitumen Extraction At certain Interval

Plastic Content (% By Weight)	Bitumen Extracted After 5 Min %	Bitumen Extracted after 10 min %	Bitumen Extracted after 15 min %
0	96.0	98.0	99.0
0.5	63.5	88.7	92.3
0.75	63.2	86.7	90.7
1.0	61.3	76.7	83.6

Use of higher percentage of plastic waste reduces the need of bitumen by 10%. It also increases the strength and performance of the road . In compliance with the expected results we can ignore the cavities, unsoundness and water accumulation on the roads and make the roads durable and of higher compressive strength along with abrasion resistant in an affordable and cost-effective manner.

Table 5: Improved Characteristics of Plastic Coated aggregate

Plastics	Absorption			Crushing Test
Nil	4%	5%	4%	26%
1%	1%	Nil	2.2%	21%
2%	1%	Nil	1%	20%
3%	0.5%	Nil	Nil	NA
5%	0.35%	Nil	Nil	NA
10%	0.12%	Nil	Nil	NA

The main problem for plain bitumen road is occur in rainy season. The bitumen aggregate mix not get binding strength due to which pothole form on the roads. So by using plastic this strength will increase and there will be less or may be nil pothole formation. It depends on the ratio of plastic we added to the bitumen and aggregate.



Table 6: Resistance to Stripping

Type Of Aggregate	Time	Stripping %
Plain Bitumen Coated aggregate	24 Hrs	5 %
Polymer Coated Aggregate	72 Hrs	Nil
No Pothole Formation		

V. CONCLUSION

Our studies on the performance of plastic tar road conclusively proves that it is good for heavy traffic due to better binding, increased strength and better surface condition for a prolonged period of exposure to variation in climatic changes. Above all, the process helps to dispose waste plastics usefully and easily.

Following are some points which are drawn from the study:

1. Develop a technology, which is eco-friendly.
2. Generate jobs for rag pickers.
3. Avoid disposal of plastics waste by incineration and land filling.
4. Use higher percentage of plastics waste.
5. Reduce the need of bitumen by around 10%.
6. The problems like bleeding are reduce in hot temperature region.
7. Avoid the use of anti-stripping agents.
8. It shows that with the increase of waste plastic in bitumen increases the properties of aggregate and bitumen.

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