

Ecofriendly Approach towards Waste Plastic: A Review

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Abstract—Plastics are user friendly but not eco-friendly as they are non-biodegradable, generally it is disposed by way of land filling or incineration of materials, which are hazardous. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics, by using them in road laying. Today the availability of the waste plastics is enormous, as the plastic materials have become part and parcel of daily life. They either get mixed with Municipal Solid Waste and or thrown over land area. Their present disposal is either by land filling or by incineration. Both the processes are not Ecofriendly. Under this circumstance, an alternate use for the waste plastics is also the need of the hour. Plastics are organic in nature and Bitumen is also a mixture of organic compounds. Hence the mixture of the two is possible. Many researchers have done work on utilization of waste plastic so it would be helpful to have a Review of work done so far as per past research. Waste plastics (carry bags, etc.) on heating soften around 130-140 degree C. Moreover the softened plastics have a binding property. Hence, the molten plastics materials can be used as a binder and or they can be mixed with binder like bitumen to enhance their binding property. This may be a good modifier for the bitumen, used for road construction.

1. INTRODUCTION

Plastics, a versatile material and a friend to common man become a problem to the environment after its use. Disposal of a variety of plastic & rubber wastes in an eco-friendly way is the thrust area of today's research. (3)

Practical experience over the last four decades have shown that the modification of the bituminous binder with polymer additives offers several benefits in asphalt concrete and has been tested in a number of countries around the World. The use of polythene materials for pure water sachet in the country has received a great boost due to its abundant supply and high resistance to insects, fungi, animals, as well as molds, mildew, rot and many chemicals. However the disposal of the waste polythene materials in large quantities has been a problem all over the country. The performance of the road pavement is strongly influenced by the properties of the bituminous binder as bitumen is the continuous phase and the only deformable component. (4)

The use of plastic bottles, containers and packing strips is increasing day by day and disposal is a big problem. Since these products are non-bio –degradable, these are likely to remain in the environment for many years creating environmental problems and health hazards. (5)

Disposal of plastic waste, particularly plastic bags are a menace and has become a serious problem, especially in urban areas, in terms of its misuse its dumping in the dustbins, clogging of drains, reduced soil fertility and aesthetic problems etc. (5).

India consumption of Plastics will grow 15 million tons by 2015 and is set to be the third largest consumer of plastics in the world. Around 55% is being used for packing. They are mostly dropped and left to litter the environment, after the contents have been consumed. Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. (1)

Looking forward the scenario of present life style a complete ban on the use of waste plastic cannot be put, although the waste plastic taking the face of a devil for the present and the future generation. But the use of waste plastics in road construction is gaining importance these days because plastic roads perform better than ordinary ones and the plastic waste considered to be a pollution menace, can find its use. (6)

From practical experience of last 4 decades is proven that the modification of the asphalt binder with polymer additives, offers several benefits. These include enhanced fatigue resistance, improved thermal stress cracking, decrease in temperature susceptibility and reduction of rutting. (7)

Post construction pavement performance studies are to be done for these waste materials for construction of low volume roads with two-fold benefits: (a) it will help clear valuable land of huge dumps of wastes; (b) it will also help to preserve the natural reserves of aggregates, thus protecting the environment. (2)

2. REVIEW OF PREVIOUS WORK DONE

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.

In the construction of asphalt pavement, hot bitumen is coated over hot stone aggregate mixed, laid and rolled. Bitumen acts as a binder. Yet when water is stagnated over road, it penetrates and results in potholes, a defective spot on the pavement. The use of anti-stripping agents is having limited use only and the process also increases the cost of road construction. Use of plastic (virgin as well as waste) to modify the bitumen.

Cost Bitumen Approx.: Rs. 35,000/ton and Waste Plastic:

Rs. 12000/ton

Savings of bitumen = 1 ton

Use of Plastics waste – (11, 25, 000) carry bags (1.125 ton)

Bitumen needed– 10125kg

Plastics waste needed – 1125 kg.

Three kilograms of bitumen were saved and three kilograms of waste plastics were used. The cost of bitumen is much higher than that of plastics and this process also helps to save the natural resources. There is no maintenance cost for a minimum period of five years. Hence the process is cheap and ecofriendly. (1)

Table 1: Comparison between plain bitumen and modified bitumen.

Sr. No.	Test Conducted	Test results			
		Plain bitumen		Modified bitumen (10% plastic replaced)	
1	Penetration test	68mm		58mm	
2	Ductility Test	83mm		52mm	
3	Flash Point	235°C		260°C	
4	Fire Point	251°C		295°C	
5	Softening Point	Temp.in°C	Time in sec	Temp.in°C	Time in sec
		53	334	64	550
6	Stripping Value	0.4%		0.0%	

The polymer bitumen blend is a better binder compared to plain bitumen. The blend has increased Softening Point and decreased Penetration Value with a suitable ductility. When used for road construction it can withstand higher temperature. Hence it is suitable for tropical regions. It has decreased Penetration Value. Hence its load carrying capacity is increased. The blend with aggregate has no Stripping Value.

So it can resist the effect of water. The Marshall Stability Value is high. The bitumen required could be reduced depending upon the % of polymer added.

The use of plastic bottles, containers and packing strips is increasing day by day and disposal is a big problem. Since these products are non-biodegradable, these are likely to remain in the environment for many years creating environmental problems and health hazards. It has been discussed in detail as to how the municipal solid waste can be handled and used successfully in the construction of roads thus mitigating the environmental problems and economise the cost of construction of roads within the country.

Plastic bag fibers were used as a modifier in this study. The waste plastic bags were shredded into fibers of size 20mm x 3mm. The density, melting point and tensile strength of the fibers were 0.468 g/cc, 1680°C. And 210 MPa respectively. Different percentages of modifier (waste plastic fibers) added to 60/70 and 80/100 grades of bitumen affected the physical properties of the binder in terms of penetration, softening point, ductility and Specific Gravity. (5)

The quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in life style which leading widespread littering on the landscape. Thus disposal of waste plastic is a menace and become a serious problem globally due to their non-biodegradability and unaesthetic view. Since these are not disposed scientifically & possibility to create ground and water pollution. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics for particular road mix. (7)

A material that contains one or more organic polymers of large molecular weight, solid in its finish state and at some state while manufacturing or processing into finished articles, can be shaped by its flow is termed as plastics. The plastic constitutes two major categories of plastics, Thermoplastics and Thermoset plastics. The thermoplastics, constitutes 80% and thermoset constitutes approximately 20% of total postconsumer plastics waste generated. The following table describes the average municipal solid waste production from 0.21 to 0.50 Kg per capita per day in India. (7)

Table 2: Plastic consumption in India

Year	Consumption (Tones)
1996	61000
2001	400000
2006	700000
2011	13500000

Table 3: Plastic waste consumption

Description	World	India
Per capita per year consumption of plastic (Kg)	24-28	12-16
Recycling %	24-25	60
Plastic in solid waste (%)	7	9

3. WHY WASTE PLASTIC? AS A BINDER AND MODIFIER

- Soften at around 130°C.
- No gas evolution in the temperature range of 130-180°C.
- Have a binding property hence used as a binder.
- Can also be mixed with binder like bitumen to enhance their binding property. (7)

Every year, around 500 billion plastic bags are used worldwide. Over one million bags are being haphazardly disposed every minute and they are damaging our environment. Yet, precious little has been done to recycle, re-use and disposal of non-biodegradable plastic waste. Plastic bags are difficult and costly to recycle and therefore mostly end up on landfill sites where they take around 300 years to photo degrade. As a result, several state governments including Delhi had put a ban on the use of plastic bags.

Marshall Stability test: The Marshall Mix design is conducted on mixes with and without waste plastics to arrive at the optimum binder content. The samples are prepared using conventional 60/70-grade bitumen and the volumetric studies were conducted on the mixes. It is observed that the mix with waste plastics had lesser density as compared to conventional bituminous mix; this is because of the low specific gravity of waste plastics. The Marshall stability of the mix with addition of 8 % plastics is 1.5 times higher than the mix without plastics in one of the case study.

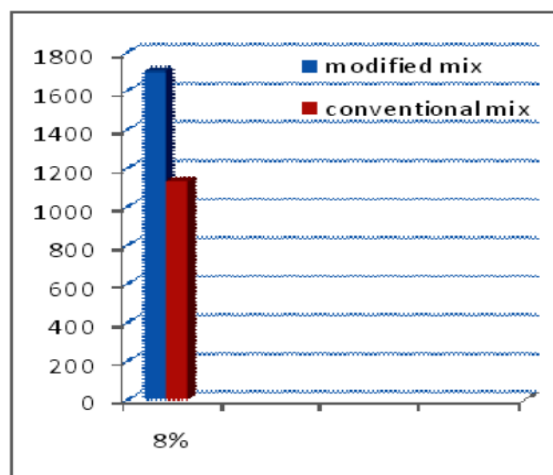


Fig. 1: Marshall Stability Test result

4. DISCUSSION

It can be seen from various contributions made in above-mentioned paragraphs that, many researchers have identified the issues related with disposal of waste plastic. One the way found out to dispose waste plastic without any hazardous effect on environment is by adding it to the binder content of

road. The major benefits are as follows; the stability or strength, softening point, stripping value, penetration value etc. have been enhanced. And as per NHAI Indian road network of 33 lakh Km.is second largest in the world and consists of:

Expressways 200 Km	1.	200
National Highways 92851.07 Km	1.	92,851.07
State Highways 131899 Km	2.	1,31,899
Major District Roads 467763 Km	3.	4,67,763
Rural and Other Roads 2650000 Km	4.	26,50,000
Total Length 33Lakhs km (approx.)		

So we can have a good scope for utilizing waste plastic

5. CONCLUSION

Various researchers mostly at developed countries including India are facing the issue of disposal of waste plastic. In India such works have limited scope so far. Having found out a solution to the issue there is a scope of study. It would be helpful to have review of the work done in developed countries and apply the results to improvise Indian road construction and maintenance practice. The study will also create many research avenues in the road construction industry in light of preserving natural resources.

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