

UTILISATION OF PLASTIC WASTE MATERIAL AS ROAD CONSTRUCTION MATERIAL

Prafull Pandey¹, Atul Kumar Tiwari²,

¹M.Tech (CE) Scholar, Institute of Technology & Management, Lucknow

²Assistant Professor, School of Management Sciences, Lucknow
Uttar Pradesh, India

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 kutcha houses 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 interrupts the infiltration and percolation of rain water through soil pores and in turn diminishes the ground water recharge in aquifers. Nowadays we have tones 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 finish-ability, stability, binding property, resistance to water and durability.

Index Terms— 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 boon for humans. As it has cheap cost, easy to transport, can be use for different purpose. For Packaging purpose mainly we use jute bags, paper bags, cloth bags which is heavy and not economical for transport. So for overcoming it we prefer plastic bags or carry bags.

In a Survey it was found that a plastic can be long lasting more than 4000 years. It was good to know that life of plastic is more than any other packaging material.

Plastics, are versatile packing materials and commonly used by man but they become problem to the environment.

Table 1: Plastic Scenario

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

Consumption, Generation & Classification of plastic waste in India

After using them mostly used plastics products are bags, cups, films and foams, made up of polyethylene, polypropylene or polystyrene. India 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 plastic in our daily use.

Table 2: Plastic Waste Consumption

S.No.	Description	World	India
1	Per Capita Per Year Consumption Of Plastic (kg)	24-28	12-16
2	Recycling (%)	25	60
3	Plastic In Solid Waste (%)	7	9

The data we look above was a comparison of consumption of plastic in World and in India.

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.

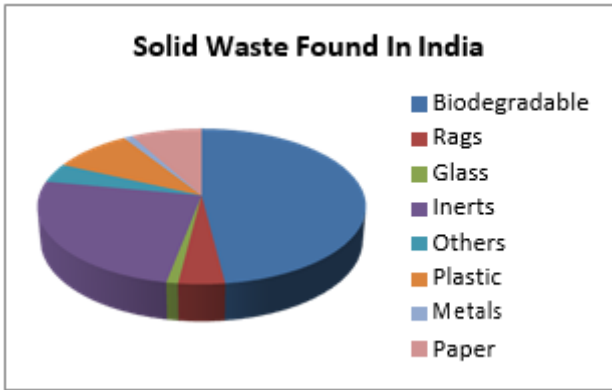


Figure 1: Pie Chart Showing Municipal Solid Waste in India

The littered plastics, a non-biodegradable material, get mixed with domestic waste and make the disposal of municipal solid waste difficult.



Figure 2: Waste Plastic Open Dumping

But as we see plastic does not decompose easily, it take thousands of years. Disposal of plastic results in unnecessary Land Filling & Incineration.

Burning Of Plastic Releases Toxic Gases like CO, CO₂, Dioxin & Ash (Oxides).

Burning of Plastic is also responsible for :

- Global Warming
- Air Pollution
- Monsoon Failure



Figure 3: Plastic Burning in open dumping

India generates 5.6 million metric tons of plastic waste annually, with Delhi generating the most of at municipality at 689.5 metric tons every day, according to a 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."

- 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.

There are two main processes namely:

1. DRY PROCESS
2. WET PROCESS

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.

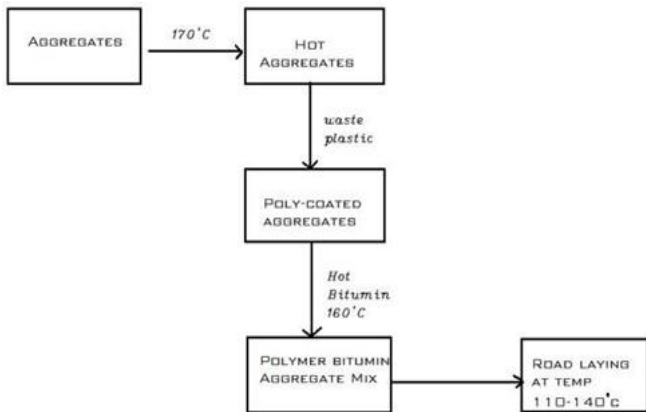


Figure 4: Flow Chart for Process of Mixing and Placing

- 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.

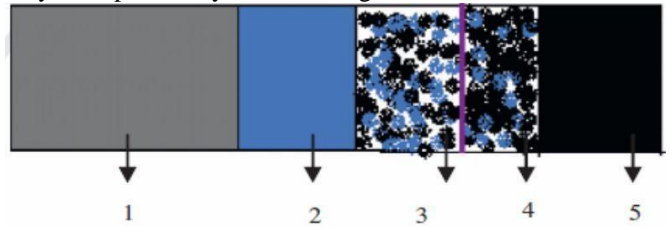


Figure 6: Plastic Waste Coated Aggregate Bitumen Mix Interaction Model

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.

II. LITERATURE REVIEW

The concept of using plastic in flexible pavement has been done sine several years ago in India. The concept of utilization of waste plastic in construction of flexible road pavement has been done since 2000 in India.

The properties of this modified bitumen were compared to that of ordinary bitumen. It was noted that penetration and ductility values of modified bitumen was decreasing with the increase in proportion of the plastic additive, up to 12 % by Weight. 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.

The coating of plastics reduces the porosity, absorption of moisture and improves soundness. Use of plastic bags in road help in many ways like Easy disposal of waste, better road and prevention of pollution and so on.

The results indicated that there was an improvement in strength properties when compared to a conventional mix. Therefore, the life of pavement surfacing using the waste plastic is expected to increase substantially in comparison to the use of conventional bituminous mix.

Hence the use of waste plastics for flexible pavement is one of the best methods for easy disposal of waste plastics. This technology not only strengthened the road construction but also increased the road life.

III. PROPOSED WORK

The varying proportions of waste plastic materials and bitumen's are to be used as binder in the preparation of metal

road and a comprehensive study is to be done with regard to compressive strength of the metal road as well as abrasion resistance of the aggregates used in the preparation of the road. Since the road prepared from waste plastic materials and bitumen's is not susceptible to water stagnation, hence a precise and intensive study is proposed to be done by providing irregular surface having micro and macro cavities on the surface of the road.

IV. EXPECTED RESULT

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

% of Plastics	Moisture Absorption	Soundness	Voids	Aggregate 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 Above value shows that the Plastic Coated Aggregate shows improved quality which is responsible for the better performance of the road.

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:

- i. Develop a technology, which is eco-friendly.
- ii. Generate jobs for rag pickers.
- iii. Avoid disposal of plastics waste by incineration and land filling.
- iv. Use higher percentage of plastics waste.
- v. Reduce the need of bitumen by around 10%.
- vi. The problems like bleeding are reduce in hot temperature region.
- vii. Avoid the use of anti-stripping agents.
- viii. It shows that with the increase of waste plastic in bitumen increases the properties of aggregate and bitumen.

REFERENCES

- [1] Verma S.S. (I.C.J.), (2008), "Roads from plastic waste".
- [2] Sundaram & Roja, (2008), "The use of recycled material in highway construction".
- [3] Sundaram & Roja, (2008), "The use of recycled material in highway construction".
- [4] Justo C.E.G. and A. veeraragavan, (2002)
- [5] Mohd. Intiyaz (2002), "Adhesion Characteristics Study on Waste Plastics Modified Bitumen"
- [6] Anzar Hamid Mir Student, Bachelor of Civil Engineering, IUST Awantipora, Srinagar (J&K), INDIA "Use of Plastic Waste in Pavement Construction: An Example of Creative Waste management"
- [7] Vinoth.N "Use Of Plastic Wastes In Road Construction" Central Institute Of Plastics Enginnering & Technology (CIPET) ; Dept. of chemicals and petrochemicals, Ministry of chemicals and fertilizers, Government Of India
- [8] Miss Aproova ,use of plastic waste in flexible pavements, international journal of innovative research in engineering and management
- [9] Sherwood, P. T. (1995). "Alternative materials in road construction. "Thomas Telford Publications, London, 1995
- [10] Tara Sen, Umesh Mishra, "Usage of Industrial Waste Products in Village Road Construction," International Journal of Environmental Science and Development, Vol. 1, No. 2, June 2010

- [11] Vasudevan R., utilization of waste plastics for flexible pavement, Indian High Ways (Indian Road Congress), Vol.34, No.7. (July 2006).
- [12] Wes Heidenreich, "Recycled plastic in highway construction and maintenance." State Research report #525, July 1997.