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## **Use of plastic waste in bituminous road construction**

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### **Abstract**

Plastic waste is one of the resources of which a major part of solid waste that is available in bulk and is disposed of without properly treating it. There has been an epidemic growth in the plastic waste disposal by the municipality especially in urban areas that decline the beauty of the land. Plastic is found to be one of the most effectively unite bitumen mixes used in the pavements. The main objective to use of waste plastic is to reduce plastic waste and improve the durability and sustainability of road infrastructure. It can also make the roads more resistant to wear and tear. In this paper it is recommended/presented to use the plastic waste materials in the road construction. 6% plastic waste with 60/70 grade of bitumen modification showed maximum stability in Marshall Stability test which represent high loading capacity of road due to increased brittleness of the road.

**Keywords:** Bitumen, PVC, Marshall stability

### **Introduction**

In India, the issue of waste plastic has become a pressing environmental problem due to the vast quantities of non-biodegradable plastics being generated and improperly disposed of. With a rapidly growing population and increasing urbanization, there has been a significant rise in the production and consumption of plastic goods, leading to massive amounts of plastic waste clogging landfills, waterways, and public spaces. The lack of effective waste management infrastructure exacerbates this issue, resulting in harmful environmental impacts such as soil contamination, water pollution, and harm to wildlife. Furthermore, burning plastic waste releases toxic chemicals into the atmosphere, contributing to air pollution and posing health risks to nearby communities. Addressing the problem of waste plastic in India requires comprehensive policies for reducing plastic usage, improving recycling and waste management systems, and promoting sustainable alternatives to non-biodegradable plastics. Polymer modified bitumen (PMB) is a type of bituminous binder utilized in the construction of flexible roads to enhance their performance. By adding polymers such as styrene-butadiene-styrene (SBS) or atactic polypropylene (APP) to bitumen, PMB exhibits improved flexibility, elastic recovery, fatigue resistance, and temperature susceptibility compared to traditional bitumen. This modification results in a more durable road surface that can better withstand heavy traffic loads and adverse weather conditions, reducing rutting and cracking over time. The enhanced properties of PMB also allow for thinner pavement layers, reducing material consumption and construction costs while maintaining high performance levels. Overall, the incorporation of polymer modified bitumen in flexible road construction leads to longer-lasting infrastructure with superior mechanical properties and improved overall performance.

### **Literature review**

We have studied various literatures related to plastic, polymer modified bitumen, flexible road performance and etc. Some important literatures are as followings:

V. S. Punith and A. Veeraragavan (2007) [22] are described that viability of using reclaimed polyethylene (PE) derived from low-density PE carry bags collected from domestic waste as an additive in asphalt concrete mixtures. Different ratios of PE (2.5, 5.0, 7.5, and 10% by weight of asphalt) were blended with (80/100)-paving grade asphalt. The dynamic creep test indirect tensile test, resilient modulus test, and Hamburg wheel track tests were carried out on asphalt concrete mixtures blended with PE. The rutting potential and temperature susceptibility can be reduced by the inclusion of PE in the asphalt mixture. A PE content of 5% by weight of asphalt is recommended for the improvement of the performance of asphalt concrete mixtures similar to that investigated in this study.

Milad A. *et al.*, (2020) [23] described that using waste materials in road construction is of great interest as their utilization may contribute to reducing the problems of hazard and pollution and conserve natural resources. Thus, there is an urgent need to find a sustainable method for

using waste materials as a substitute in the standard asphalt binders. There are several concerns about the physical and chemical properties and mechanical performance of asphalt pavements incorporated with waste material in the effort to reduce permanent deformation of the road surface.



Fig 1: Various form of Plastic

Kurmadasu Chandramouli *et al.* (2016) "Plastic waste: its use in the construction of roads" reported that asphalt concrete using polyethylene modified binders were more resistant to permanent deformation at elevated temperature and found improvement in stripping characteristics of the crumb rubber modified mix as compared to unmodified asphalt mix.

After going through all the referred research papers, I found that the use of waste plastic in making of road and flexible pavement shall open up the solution for the disposing issues regarding the waste plastic. The coating of plastic may lessen the soaking of moisture, porosity and improves the correctness. The aggregate bitumen mix coated with the polymer forms a better material for use in the flexible pavement. Thus, the using of plastic waste for the flexible pavement is the best method for disposing of the waste plastic.

### Objective

The broad objectives of this study are as under:

- Utilize waste plastic in flexible road construction.
- Plastic waste management.
- Increase performance of polymer modified bituminous all-weather roads.

### Methodology and Design

To study the effect of mixing plastic waste in bituminous mixes, the following methodology was adopted.

Four phases are involved to modify virgin bitumen with waste plastic which are as under.

**Segregation:** Plastic waste collected from various sources is

separated from other wastes.



Fig 2: Segregation

The process of shredding plastic involves feeding plastic materials into a machine that breaks them down into smaller, uniform pieces. This is typically done to facilitate the recycling process, as shredded plastic is easier to transport and sort. Shredding also helps to reduce the volume of plastic waste, making it more manageable for storage and disposal. Additionally, shredding can help protect sensitive information on items such as credit cards or documents by destroying them beyond recognition. Professional shredding services use industrial-grade equipment that ensures thorough and precise shredding of plastics, leading to higher efficiency and better outcomes in the recycling industry.

**Cleaning:** Plastic waste is cleaned and dried.





Fig 3: Cleaning

**Shredding:** Plastics will be shredded or cut into small pieces.



Fig 4: Shredding of plastic

**Wet Mixing with bitumen**

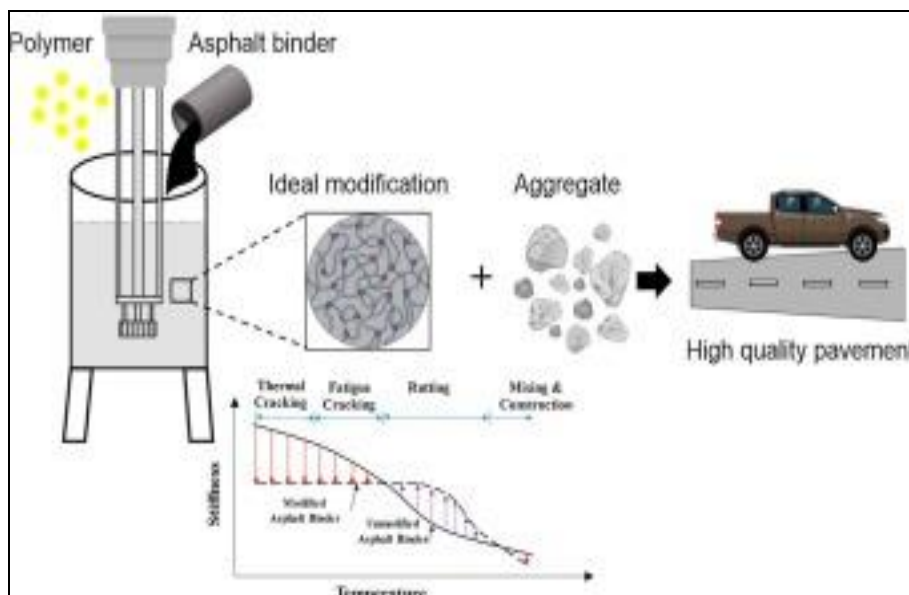


Fig 5: Polymer Modification

The plastic waste like carry bags, Polyethene etc. was collected and shredded to size passing through 2.36 mm sieve and retained on 600-micron sieve. The shredded plastic waste was mixed in the hot aggregates. Normal mix specimens were prepared with bitumen contents of 4.5%, 5%, 5.5% and 6%. The Optimum Bitumen Content (OBC) was found out using Marshall test. Plastic modified mix specimens with plastic contents of 6%, 8%, 10%, 12% and 14% by weight of bitumen were prepared through dry process by adding plastic to heated aggregates. Marshall Test was conducted on plastic modified mix specimens to study different parameters. Processing of plastic waste and their use in road construction.

### Conclusion

**The following point wise conclusions are drawn from this research are as under**

So, turns out mixing plastic with bitumen for roads isn't just some crazy idea - it actually works pretty damn well. When you think about it, plastic is already super durable, so adding it to bitumen just kicks things up a notch in terms of strength and longevity. Plus, using recycled plastic helps reduce waste and is way eco-friendlier than straight-up throwing it in a landfill. The end results? Roads that last longer, can withstand heavier traffic loads, and are even more resistant to wear and tear. Seems like a no-brainer to me! So yeah, next time you're cruising down the highway, take a second to appreciate the merit of plastic-infused roads - they're paving the way for a greener future one mile at a time.

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