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# A Review on Design of Flexible Pavement Using Waste Plastic

**Rohit Raj[1], Ritesh Kumar Yadav[2], Km Esha Jaishwal[3], Dr. Shiv Kumar[4]**

[1,2,3] UG Students, B. Tech (Civil Engineering),

[4]Professor and Head Civil Engineering,

Greater Noida Institute of Technology, Greater Noida

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**KEYWORDS**

*Flexible pavement, plastic waste, Roads, Marshel Stability, Aggregates, plastic* modified bitumen.

**ABSTRACT:** The extensive use of plastic wrappers for items like betel nuts, chocolates, chips, handbags, and cold drink bottles presents significant environmental and economic challenges. The production and disposal of these wrappers consume substantial energy and resources, contributing to environmental harm. While industries favor plastic for its lightweight, inexpensive, and sturdy qualities, a potential shift to alternative materials like paper and wood may worsen environmental issues. Polyethylene, Polystyrene, and Polypropylene, the main components of plastic, resist easy decomposition in the environment. This study emphasizes the importance of utilizing plastic in construction processes, particularly through the heating and coating of plastics on aggregates at 160˚C, minimizing air gaps and enhancing stability. Proper disposal of non-biodegradable plastic remains challenging due to insufficient landfills. Research suggests that incorporating waste plastics into road construction materials results in stronger, more damage-resistant, and cost-effective roads. In India, roads adhere to specific guidelines with bituminous concrete layers over a granular base, utilizing Bitumen Grade VG-30 and specific aggregate sizes. The addition of polymers to road materials offers advantages such as increased longevity, damage resistance, cost-effectiveness, reduced maintenance, effective insulation, and diminished noise pollution, contributing to a more sustainable construction approach. [1][2].

## 1. Introduction

The increasing problem of plastic waste disposal in India has raised serious environmental and health issues, posing threats to both humans and wildlife. The pervasive use of plastic in daily life has led to a surplus of waste, necessitating innovative solutions. Traditional disposal methods like landfilling and incineration not only fail to address the environmental consequences but worsen the problem.

In response, the idea of using plastic waste in road construction has emerged as a promising alternative. Laboratory tests have shown positive results by incorporating 5 to 10% plastic in bituminous mixes, enhancing pavement stability, strength, and durability. Plastic, categorized into thermoses and thermoplastics, with the former known for its high durability, proves to be well-suited for construction applications.

The impact of plastic waste extends beyond local concerns, contributing significantly to global issues such as greenhouse gas emissions climate change. India has taken proactive measures by promoting the use of waste plastic in constructing National Highways and Rural roads within urban areas with populations exceeding 50,000. Guidelines from the Indian Road Congress and the National Rural Road Development Agency endorse the incorporation of waste plastic in hot bituminous mixes for road construction, reflecting a commitment to sustainable practices.

Examining the broader context of lightweight materials, including polymer matrix composite, reveals a growing market driven by the need for energy conservation. The market's significant growth, from $133.1 billion in 2014 to an anticipated $189.076 billion by 2022, underscores the importance of these materials in contemporary energy-efficient solutions.

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However, the widespread use of plastics in these materials adds to the overarching challenge of plastic waste management. Exploring the intricacies of plastic waste issues, such as the detrimental effects of plasticizers, landfill concerns, and ocean pollution, this literature review aims to provide a comprehensive understanding of the complex landscape surrounding plastic waste and the imperative for sustainable interventions in its management.[3][4]

**LITERATURE REVIEW**

1. *Yash Menaria and Rupal Sankhla (2015)* conducted a study that efficiently utilizes waste plastic in road construction, determining an optimum 8% plastic addition for the required strength. Experimental results showed enhanced mix binding, improved bitumen properties, and the feasibility of constructing plastic roads even in high-temperature areas (50˚C). The eco-friendly approach repurposes waste plastic, reducing construction costs, and potentially enhancing road durability and stability, leading to future maintenance cost savings. This study provides valuable insights into sustainable waste plastic utilization, presenting a multifaceted solution to environmental and economic challenges related to plastic waste disposal.[1]

2. *Brajesh Mishra (2016)* explores recycled polymer modifiers in asphalt mix, analysing Marshall Mix design to determine the Optimum Bitumen Content (OBC). Evaluating varying waste plastic percentages reveals it as an effective modifier, reducing porosity, enhancing mix binding, and achieving an OBC of 5% with an Optimum Plastic Content (OPC) of 9%. Comparative analyses show improved Marshall stability and tensile strength at a 9% plastic waste incorporation in both wet and dry blends. Emphasizing economic viability, the study highlights the suitability of plastic waste-modified mixes for flexible pavement construction, offering durability and cost-effectiveness with minimal maintenance.[2]

3. *V. Rushendrareddy, T. Surendra, and B. Rahul (2017)* researched bituminous plastic's impact on-road performance. The approach enhances bitumen, waste plastic, and aggregate binding, reducing voids and preventing moisture absorption. Results indicate decreased rutting, ravelling, and pothole formation, ensuring road durability under heavy traffic. Bitumen, a critical binder, requires proper proportioning for a strong, durable mix. Bitumen grade 80/100 and specific fine aggregates are utilized. Plastic waste incorporation enhances pavement strength and durability. Testing methods assess the effectiveness of waste plastic in bituminous mixes.[5]

4. *Raghvendra Bajpai, Maaz Allah Khan, Osama Bin Sami, Pramod Kumar Yadav, and Pawan Kumar Srivastava (2017)* conducted research on how plastic coating on aggregates enhances road performance by improving bitumen binding, increasing the bonding area with polymers, and reducing voids. This prevents moisture absorption and bitumen oxidation, resulting in reduced rutting, ravelling, and pothole formation. Tests show improved Aggregate Impact Value, reduced Crushing Value, increased Specific Gravity, lower Stripping Value, minimal Water Absorption, and enhanced Los Angeles Abrasion Value for plastic-coated aggregates. These findings affirm the effectiveness of plastic coating in bituminous construction, providing tougher, more durable, and abrasion-resistant aggregate with minimal water absorption.[6]

5. *Nitin Dutt Sharma and Anupam Sharma's (2019)* research highlights a positive correlation between increased waste plastic in bitumen and enhanced properties of both aggregate and bitumen. The use of waste plastic in flexible pavements outperforms conventional methods, with an optimal utilization of up to 10% determined through Marshal Stability tests. This method minimizes plastic waste disposal, employing an eco-friendly approach. Polymer coating on aggregate surfaces improves pavement quality. The study aims to thoroughly analyze the effective utilization of waste plastic in flexible pavement construction, replacing a portion of the bitumen content, with a focus on detailed process examination and successful application.[7]

6. *S. Naveen Bheempal and B. Vinayaka (2019)* conducted a study that investigates the impact of polypropylene, used as a modifier at 8% by the weight of bitumen, on pavement performance. The research explores the mixing of polypropylene with bitumen at different proportions and evaluates pavement performance. The optimum binder content for the conventional mix (0% polypropylene) was determined as 5.25%, falling within the specified range of Minimum 5.4% for bituminous concrete Grade-II as per MORTH13 specifications. Additionally, the study determines the Optimum Binder Content (OBC) for various percentages of polypropylene waste (4%, 6%,

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8%, 10%) by varying the bitumen percentage. Laboratory tests, including the preparation of Indirect Tensile Strength (ITS) specimens, were conducted for each OBC, and the maximum ITS values and Toughness and Abrasion Resistance (TSR) were determined.[8]

7. *Rajneesh Kumar and Maaz Allah Khan (2020)* studied the optimal percentage of plastic waste for replacing bitumen in flexible pavements. The research highlights the use of plastic-coated aggregates to improve bitumen binding, increase polymer bonding, and reduce voids. This process prevents moisture absorption and bitumen oxidation, resulting in reduced rutting, ravelling, and pothole formation. Comprehensive testing, including Aggregate Impact Value, Crushing Value, Specific Gravity, Stripping Value, and Water Absorption, demonstrates the effectiveness of coated aggregates in bituminous construction, emphasizing increased toughness, reduced crushing value, higher specific gravity, and minimal water absorption compared to plain aggregates.[9]

8. *S. S. Barmade, Mustafa Jarman, R. L. Raut, S. N. Sonawane (2022)* proposed an innovative solution to the increasing plastic waste problem. Combining plastic with bitumen and gravel enhances road performance, reducing voids and moisture absorption through polymer-coated aggregates. The plastic pavement, more durable than flexible pavement, withstands heavy traffic. This approach reduces bitumen concentration by 10%, improving road strength. The technology, utilizing specific polymers, raises the bitumen's melting point. The waste plastic-bitumen mix exhibits superior Marshall Stability values, making it an environmentally friendly and effective material for road construction. The study suggests an optimal plastic usage of 10% to 15% of bitumen based on the Marshall Stability test, contributing to eco-friendly waste disposal.[10]

9. *P. Vijaya Lakshmi Kanthi, Ch. Rohitha, K. Rakesh, D. Hema, V. Hemanth, B. Jayaram (2023)* conducted a study to enhance pavement strength and extend the lifespan and policymakers, guiding efforts to create a more sustainable and resilient infrastructure.

## CONCLUSION

Using waste plastic in flexible pavement design is a crucial step in tackling the global plastic waste issue. The different types of plastics, like polyethylene and polypropylene, can improve pavement stability and durability. Studies show that incorporating waste plastic leads to better performance in areas like strength, load-bearing capacity, and resistance to environmental factors compared to traditional pavements. This not only benefits the environment by reducing plastic in landfills but also offers potential cost savings in construction. However, challenges like standardization, long-term performance, and public perceptions need attention. Continued research and development are essential for refining methods and ensuring successful implementation of waste plastic in real-world infrastructure projects. This review serves as a valuable resource for researchers, engineers, and policymakers, guiding efforts to create a more sustainable and resilient infrastructure.

## REFERENCES

[1] Yash Menaria and Rupal Sankhla *"Use of Waste Plastic in Flexible Pavements-Green Roads", Open Journal of Civil Engineering, 2015, 5, 299-311.*

[2] Brajesh Mishra, *"Use of Plastic Waste in Bituminous Mixes of Flexible Pavements by Wet and Dry Methods: A Comparative Study", International Journal Of Modern Engineering Research (IJMER), ISSN No:1001-2400,* 2016.

[3] Prashant Singh, Abhishek Kumar, Shushant Singh and Rajeev Rajput *"Use of Plastic Waste in Flexible Pavement-Green Highway", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 9 Issue 09, September-2020.*

[4] Ayesha Noor and Muhammad Atiq Ur Rehman, *"A mini-review on the use of plastic waste as a modifier of the bituminous mix for flexible pavement", Cleaner Materials* (ISSN: 2772-3976), 2022.

[5] V. Rushendrareddy, T. Surendra, and B. Rahul, "USE OF WASTE PLASTIC IN FLEXIBLE PAVEMENTS", International Journal of Civil Engineering and Technology (IJCIET), ISSN Print: 0976-6308 and ISSN Online: 0976-6316, Volume 8, Issue 5, May 2017.

[6] Raghvendra Bajpai, Maaz Allah Khan, Osama Bin Sami, Pramod Kumar Yadav, and Pawan Kumar Srivastava, "*Construction of Flexible Pavements using Plastic Waste Along with Bitumen'', IJSRD - International Journal for Scientific Research & Development, ISSN (online): 2321-0613, Vol. 5, Issue 09, 2017.*

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 2730-2733 | ISSN:2251-6727

[7] Nitin Dutt Sharma and Anupam Sharma, "Utilization of Waste Plastic in Flexible Pavement", International Journal of Science and Research (IJSR), ISSN: 2319-7064, Volume 8 Issue 5, May 2019.

[8] S. Naveen Bheempal and B. Vinayaka, "Use of Waste Plastic in Flexible Pavement Construction", S-JPSET : Vol. 10, Issue Supplementary, ISSN : 2229-7111 (Print) and ISSN : 2454-5767 (Online), November 2019.

[9] Rajneesh Kumar and Maaz Allah Khan, "Use of Plastic Waste Along with Bitumen in Construction of Flexible Pavements", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 9 Issue 03, March-2020.

[10] S. S. Barmade, Mustafa Jarman, R. L. Raut, S. N. Sonawane, "Utilization of Waste Plastic in Flexible Pavement", International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653, Volume 10 Issue VI June 2022.

[11] P. Vijaya Lakshmi Kanthi, Ch. Rohitha, K. Rakesh, D. Hema, V. Hemanth, B. Jayaram, "*UTILIZATION OF WASTE PLASTIC IN FLEXIBLE PAVEMENTS*", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 10 Issue: 03 | Mar 2023.