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Plastic Road A Sustainable Innovation in Civil Engineering

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Abstract: *The increasing generation of plastic waste and the deterioration of conventional road pavements have become major environmental and infrastructural challenges worldwide. This study investigates the utilization of waste plastic materials in bituminous road construction as a sustainable alternative to traditional pavement materials. Waste plastics such as polyethylene (PE), polypropylene (PP), and polystyrene (PS) are processed, shredded, and incorporated into bitumen using dry and wet mixing techniques. The incorporation of plastic waste enhances the mechanical properties of asphalt mixtures, including impact resistance, abrasion resistance, water resistance, and durability. Experimental evaluations such as Aggregate Impact Value (AIV), Los Angeles Abrasion Value (LAAV), Binding Test, Moisture Absorption Test, and Soundness Test demonstrate superior performance of plastic-coated aggregates compared to conventional aggregates. The findings indicate that plastic roads offer an effective solution for plastic waste management while improving pavement performance, reducing maintenance costs, and promoting sustainable infrastructure development.*

Keywords: Plastic Roads, Waste Plastic, Bitumen Modification, Sustainable Pavement, Road Construction, Recycling

I. INTRODUCTION

Plastic waste has become one of the most serious environmental challenges of the twenty-first century due to its non-biodegradable nature and rapidly increasing consumption worldwide. Global plastic production has exceeded 400 million tonnes annually, and a significant portion of this waste is disposed of in landfills, water bodies, and open environments, causing severe ecological damage and public health concerns. [1].

At the same time, the transportation sector requires durable and cost-effective road infrastructure capable of withstanding increasing traffic loads and varying climatic conditions. Conventional bituminous pavements often suffer from distresses such as rutting, cracking, potholes, stripping, and fatigue failure, resulting in frequent maintenance and rehabilitation requirements. [2].

One promising approach is the incorporation of waste plastic into bituminous road construction. Waste plastics such as polyethylene (PE), polypropylene (PP), and polystyrene (PS) can be processed and blended with aggregates or bitumen to produce plastic-modified asphalt mixtures. These modified mixtures exhibit improved mechanical properties, enhanced bonding characteristics, and greater resistance to moisture damage compared to conventional asphalt pavements [3].

The concept of plastic roads was pioneered in India by Prof. Rajagopalan Vasudevan, whose research demonstrated that shredded plastic waste can effectively coat heated aggregates and improve the performance of bituminous mixes. Since then, numerous studies have confirmed that plastic-modified pavements possess higher Marshall Stability, better abrasion resistance, and increased durability under traffic loading conditions [4].

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Fig 1: Plastic Road in Jamshedpur

The use of plastic waste in road construction provides dual benefits by addressing environmental pollution and enhancing pavement performance. Plastic-coated aggregates reduce water absorption, improve adhesion between aggregate and bitumen, and increase resistance to deformation caused by heavy traffic and temperature fluctuations. These characteristics contribute to longer pavement life and reduced maintenance costs [5].

Several experimental investigations have reported significant improvements in engineering properties when waste plastic is incorporated into asphalt mixtures. Studies indicate that plastic-modified roads demonstrate superior resistance to rutting, fatigue cracking, and moisture susceptibility while maintaining structural integrity under adverse weather conditions. Such improvements make plastic roads particularly suitable for regions experiencing heavy rainfall and high traffic intensity [6].

Furthermore, plastic road technology supports the principles of sustainable development and circular economy by converting waste materials into valuable construction resources. The reduction in bitumen consumption and the utilization of non-recyclable plastic waste contribute to resource conservation and lower greenhouse gas emissions associated with conventional road construction practices [7].

Therefore, the present study focuses on evaluating the potential of plastic roads as a sustainable innovation in civil engineering. [8].

II. PROBLEM STATEMENT

The rapid increase in plastic consumption has resulted in the generation of enormous quantities of plastic waste, creating serious environmental and waste management challenges. Since plastics are non-biodegradable, they accumulate in landfills, drainage systems, rivers, and oceans, causing pollution and ecological damage. Traditional disposal methods such as open burning and landfilling are not sustainable and may lead to harmful environmental effects.

III. OBJECTIVES

- The primary sustainable objective is to tackle the global issue of plastic waste.
- Waste Management: To provide a productive and large-scale use for non-recyclable or low-value waste plastics, diverting them from landfills and oceans.
- Resource Conservation: To reduce the consumption of virgin materials, specifically by partially replacing the bitumen (a petroleum-derived product) used in traditional asphalt mixes, thus conserving natural resources.
- Emission Reduction: To mitigate greenhouse gas (GHG) emissions associated with plastic disposal methods like incineration and by reducing the energy required for the production and use of bitumen.

IV. LITERATURE SURVEY

Paper 1

Title: Plastic Bituminous Roads: A Sustainable Technology for Better Handling Distresses

Authors: Arjita Biswas and Sandeep Potnis

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Summary:

This paper discusses the use of waste plastic materials in bituminous road construction as a sustainable solution for plastic waste management. The authors analyzed the performance of plastic-modified asphalt mixtures and found that the addition of waste plastic improves road strength, flexibility, and resistance to deformation. The study reported enhanced Marshall Stability values and reduced moisture susceptibility compared to conventional pavements. The research concluded that plastic roads can effectively minimize environmental pollution while extending pavement service life and reducing maintenance costs.

Paper 2

Title: Exploring the Potential of Waste Plastic-Modified Asphalt

Authors: Jasim Nisar, Mohammad Shafi Mir, and Vivek

Summary:

The study investigates the engineering properties of asphalt mixtures modified with waste plastic materials such as polyethylene and polypropylene. Experimental results showed significant improvements in rutting resistance, durability, and load-bearing capacity. The researchers observed that plastic-coated aggregates exhibited lower water absorption and better adhesion with bitumen. The paper highlighted that plastic-modified asphalt can provide a cost-effective and environmentally friendly alternative to conventional road construction materials**.**

Paper 3

Title: Optimizing Bituminous Pavement Construction with Waste Plastic Materials

Authors: M. Lalitha Pallavi, M. Balaji, and P. Venkatesh

Summary:

This research focuses on the optimization of bituminous pavement performance through the incorporation of waste plastic. Laboratory tests including Marshall Stability, abrasion resistance, and moisture susceptibility were conducted. The results demonstrated that plastic-modified mixes possess superior mechanical properties and increased resistance to weathering effects. The authors concluded that waste plastic utilization not only improves pavement quality but also contributes to sustainable waste management practices.

Paper 4

Title: Plastic Based Road: An Innovative Approach for Sustainable Pavement Construction

Authors: Gautam Mewada, Ankit Sharma, Rahul Verma, and Team

Summary:

This paper presents an overview of plastic road technology and its practical implementation in road construction projects. The study examined both dry and wet processes of plastic incorporation and evaluated their impact on pavement performance. Results indicated improved aggregate binding, higher resistance to abrasion, and reduced formation of potholes. The authors emphasized that plastic roads offer economic benefits, environmental sustainability, and longer pavement life, making them a promising solution for modern transportation infrastructure.

V. WORKING OF SYSTEM

1. Plastic material

Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, polyaddition, and crosslinking. There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene (PTFE In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process.

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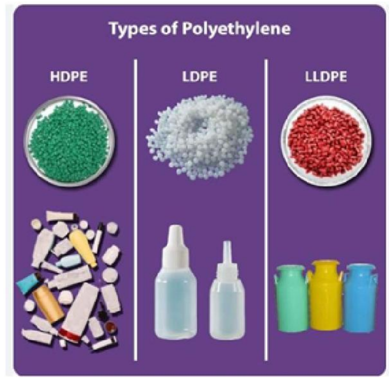

Fig 2: Polyethylene materials

2. Polypropylene

This plastic may be available in the form of carry bags or solid plastic it's depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

Polypropylene (PP) is a versatile, lightweight thermoplastic polymer known for high heat resistance, chemical durability, and an excellent strength-to-weight ratio. It is widely used for rigid and flexible packaging, automotive parts, textiles, and medical devices


Fig 3: Polypropylene materials

3. Basic process

Waste plastic is ground and made into powder; 3 to 4 % plastic is mixed with the bitumen. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Use of shredded plastic waste acts as a strong "binding agent" for tar making the asphalt last long. By mixing plastic with bitumen the ability of the bitumen to withstand high temperature increases.

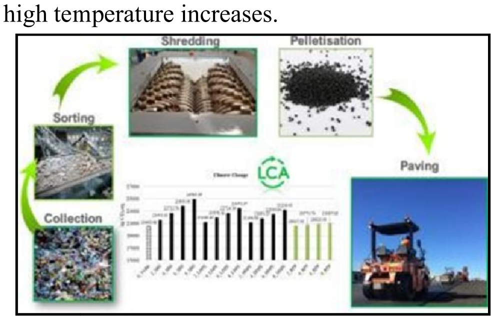

Fig 4: Basic process of plastic road

4. Plastic roads

Plastic use in road construction is not new. It is already in use as PVC or HDPE pipe mat crossings built by cabling together PVC (polyvinyl chloride) or HDPE (high-density polyethylene) pipes to form plastic mats. The plastic roads include transition mats to ease the passage of tyres up to and down from the crossing. Both options help protect wetland haul roads from rutting by distributing the load across the surface

Fig 5: Plastic road in construction

5. Plain bituminous mix

Bitumen is a black, oily, viscous material that is a naturally-occurring organic by product of decomposed organic materials. Also known as asphalt or tar, bitumen was mixed with other materials throughout prehistory and throughout the world for use as a sealant, adhesive, building mortar, incense, and decorative application on pots, buildings, or human skin.

Fig 6: Plain bitumen mix

VI. SYSTEM DESIGN

a) Plastic waste scenario

The use of plastic materials such as carry bags, cups, etc. is constantly increasing. The consumption of plastics has increased from 4000 tons/annum to 4 million tons/annum and it is expected to rise 8 million tons/annum during the year 2010. Nearly 50 to 60% of the total plastics are consumed for packing.

India generates approximately 9.3 to 9.4 million tonnes of plastic waste annually, accounting for roughly a fifth of global plastic emissions. Driven by rapid urbanization and the packaging industry, this breaks down to a per capita consumption of about 11 kg per year

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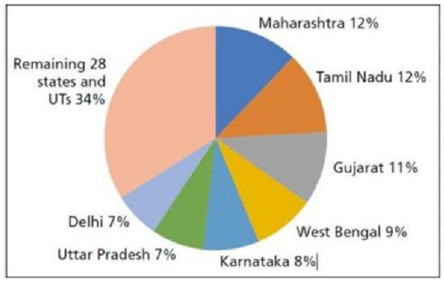

Fig 7: Plastic waste scenario

b) Waste plastic shredding

Shredding is the process of cutting the plastic into small sizes between 2.36mm to 4.75mm with the help of the plastic shredding machine viz. Agglomerater and Scrap Grinder. In Agglomerater, thin films of poly-ethylene and polypropylene carry bags are shredded and in Scrap Grinder a solid plastic material are shredded i.e. plastic bottles, drip lines, electric cable lines etc

Fig 8: Waste plastic shredding

c) Agglomerator

For shredding of poly-ethylene "Agglomerator" is used. In this process a thin plastic waste carry bags cut in small pieces with the help of fix and rotator blades this whole process required 20-25 minutes for shredding.

An agglomerator machine (or densifier) is an industrial device that physically transforms loose, lightweight, and powdery materials—most notably plastic films, foams, and fibers—into dense, free-flowing chips or granules. It is a vital primary step in recycling processes, preparing scrap material to be easily fed into an extruder hopper.

Fig 9:Agglomerator shredding machine

d) Preparation of plastic-waste coated aggregate

The aggregate are heated to around 1700C; the plastic waste shredded to the size varying between

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2.36mm and 4.75mm. This shredded plastic waste is added over hot aggregate with constant mixing to give a uniform distribution. The plastic get softened and coated over the aggregate. The hot plastic waste coated aggregates are mixed with hot bitumen 60/70 or 80/100 grade (1600C).

Fig 10: Shredding machine blade

Dry process

First the plastic waste is collected, segregated and stored. The segregation is done because certain kinds of plastic like polyvinyl chloride (PVC) and flux sheets cannot be used due to safety concerns. The next step involves the cleaning of the plastic. This is necessary because most of the plastic waste collected has been used for packaging (55% in India) and hence is likely to contain residual substances such as little bits of food which must be removed. After this the plastic goes through the process of shredding which reduces it to the correct thickness

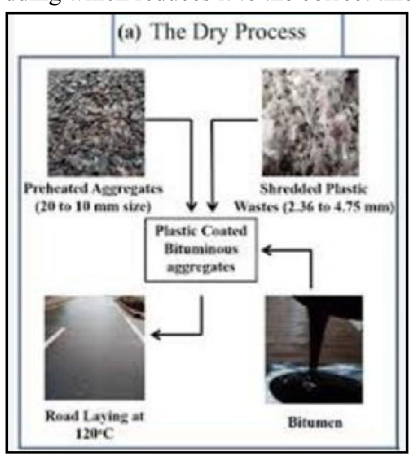

Fig 11: Dry process plastic road

VII. RESULTS

Aggregate impact value

The Aggregate Impact Value (AIV) test measures the resistance of aggregates to sudden shock or impact. In plastic roads, the test is conducted on both conventional aggregates and plastic-coated aggregates to evaluate whether the plastic coating improves impact resistance.

To determine the Aggregate Impact Value (AIV) of aggregates used in road construction and assess the effect of plastic coating on aggregate toughness.

The test measures the percentage of fine material produced when aggregates are subjected to a specified number of blows from a standard hammer.

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Lower AIV → Stronger aggregate with higher resistance to impact. Higher AIV → Weaker aggregate with lower resistance to impact.

Plastic-coated aggregates generally show a lower AIV, indicating improved toughness.

Apparatus Required

Aggregate Impact Testing Machine Cylindrical measure

Tamping rod IS sieves:

12.5 mm sieve

10 mm sieve

2.36 mm sieve Weighing balance Oven

Tray

Fig 12: System Model

Los Angeles abrasion value

Los Angeles Abrasion Value Test for Plastic Road Aggregates

The Los Angeles (LA) Abrasion Test is used to determine the resistance of aggregates to wear, abrasion, impact, and grinding action. In plastic road construction, the test is performed on plastic-coated aggregates and compared with conventional aggregates to evaluate the improvement in durability.

To determine the Los Angeles Abrasion Value (LAAV) of aggregates used in plastic roads and assess their resistance to abrasion and wear caused by traffic.

Aggregates are placed in a rotating steel drum along with steel balls (abrasive charge). As the drum rotates, the aggregates undergo impact and abrasion. The percentage of material worn away is calculated

Binding test

A binding test on plastic roads generally refers to checking the adhesion (bonding strength) between bitumen and aggregates when plastic waste is used in road construction. It is important because plastic-modified bitumen roads depend on how well the plastic-coated bitumen binds with stones (aggregates) under moisture and traffic conditions.

The binding test evaluates How strongly the bitumen (with or without plastic coating) sticks to the road aggregates

Whether water can weaken or remove this bond (called stripping)

In plastic roads, shredded plastic is mixed with hot aggregates or bitumen, so good binding ensures a durable road surface.

To determine the coating and stripping value of bitumen on aggregates in presence of water

IX. FUTURE SCOPE

Plastic road technology has significant potential for future development as a sustainable solution for both waste management and road infrastructure improvement. With the increasing generation of plastic waste across the world, the utilization of waste plastics in road construction can be expanded on a larger scale to reduce environmental pollution and dependence on conventional construction materials.

Future research can focus on optimizing the percentage and type of plastic used in bituminous mixtures to achieve maximum pavement performance under different climatic and traffic conditions

X. CONCLUSION

TPlastic roads represent one of the most promising sustainable innovations in civil engineering. By utilizing waste plastic in road construction, two major challenges are addressed simultaneously: plastic waste management and durable road infrastructure development.

The technology enhances pavement strength, improves resistance to moisture, reduces maintenance costs, and promotes environmental sustainability. Although further research is required regarding long-term environmental impacts, the overall benefits strongly support the adoption of plastic roads as a viable solution for future infrastructure development.

REFERENCES

1) R. Vasudevan, S. K. Nigam, R. Velkennedy, A. Ramalinga Chandra Sekar, and B. Sundarakannan, "Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers," Proceedings of the International Conference on Sustainable Solid Waste Management, Chennai, India, 2007.
2) A. Biswas and S. Potnis, "Plastic Bituminous Roads: A Sustainable Technology for Better Handling Distresses," International Journal of Engineering Research and Technology, vol. 11, no. 5, pp. 452–458, 2022.
3) J. Nisar, M. S. Mir, and Vivek, "Exploring the Potential of Waste Plastic-Modified Asphalt for Sustainable Road Construction," Journal of Sustainable Infrastructure, vol. 8, no. 3, pp. 145–154, 2024.
4) M. L. Pallavi, M. Balaji, and P. Venkatesh, "Optimizing Bituminous Pavement Construction with Waste Plastic Materials," International Journal of Civil Engineering Research, vol. 15, no. 2, pp. 67–75, 2024.
5) G. Mewada, A. Sharma, R. Verma, and S. Patel, "Plastic Based Road: An Innovative Approach for Sustainable Pavement Construction," International Research Journal of Engineering and Technology, vol. 11, no. 4, pp. 1123–1129, 2024.
6) K. Kalauni, S. Singh, and P. Kumar, "A Comprehensive Review of Recycling and Reusing Methods for Plastic, vol. 9, no. 1, pp. 25–39, 2025.
7) S. Chavan, "Use of Plastic Waste in Flexible Pavements," International Journal of Application or Innovation in Engineering and Management, vol. 2, no. 4, pp. 540–552, 2013.
8) S. K. Sharma and P. K. Jain, "Utilization of Waste Plastic in Construction of Flexible Pavement," International Journal of Engineering Sciences and Research Technology, vol. 6, no. 7, pp. 321–327, 2017.
9) B. H. Kumar and K. V. Prasad, "Performance Evaluation of Plastic Modified Bituminous Mixes," International Journal of Pavement Engineering, vol. 14, no. 6, pp. 510–518, 2018.
10) A. Gupta and R. Gupta, "Sustainable Road Construction Using Waste Plastic Materials," Journal of Materials in Civil Engineering, vol. 31, no. 4, pp. 1–10, 2019.
11) S. Rajasekaran, "Reuse of Waste Plastics in Bituminous Road Construction," Indian Highways Journal, vol. 45, no. 8, pp. 35–42, 2017.
12) M. A. Islam, M. Rahman, and M. A. Hossain, "Mechanical Properties of Plastic Modified Asphalt Mixes," Construction and Building Materials, vol. 234, pp. 117–126, 2020.
13) P. Senthil Kumar and K. Chandrasekar, "Experimental Investigation on Plastic Waste Modified Bitumen," International Journal of Advanced Engineering Research and Science, vol. 5, no. 10, pp. 80–87, 2018.
14) S. S. Verma, "Roads from Plastic Waste," The Indian Concrete Journal, vol. 82, no. 5, pp. 43–46, 2008.
15) A. Ahmadinia, M. Zargar, M. R. Karim, M. Abdelaziz, and E. Ahmadinia, "Performance Evaluation of Utilization of Waste Polyethylene Terephthalate in Stone Mastic Asphalt," Construction and Building Materials, vol. 36, pp. 984–989, 2012.

16) M. N. Rahman and M. A. Wahhab, "Effects of Recycled Plastic on Asphalt Mixtures,", vol. 14, no. 2, pp. 156–165, 2021.
17) P. Appiah, V. Berko-Boateng, and T. A. Tagbor, "Use of Waste Plastic Materials for Road Construction in Ghana," Case Studies in Construction Materials, vol. 6, pp. 1–7, 2017.
18) M. N. Hossain and M. A. Islam, "Waste Plastic Modified Asphalt for Sustainable Pavements,", vol. 10, no. 3, pp. 267–278, 2023.
19) IRC: SP:98, "Guidelines for the Use of Waste Plastic in Hot Bituminous Mixes (, New Delhi, India, 2013.
20) Ministry of Road Transport and Highways (MoRTH), "Specifications for Road and Bridge Works," 5th Revision, Government of India, New Delhi, 2013.