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Construction of Plastic Roads Can Reduce Plastic Wastes and Increase the Durability of Roads

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Abstract

Plastic roads are made of using polymer plastics with the regular mix of bitumen, sand, and stone. These increase strength, flexibility, and durability of the roads and the project becomes cost effective. These are built through the mixing plastic wastes with bitumen that are usually put into landfill and incinerated that usually pollute the environment with high risk. Plastics are the non-biodegradable materials that are threats to environment and human health due to their toxic nature. Plastic roads increase life spans, and make the construction economical and solve the environmental problem at the same time. These roads also reduce bitumen requirements by about 10%, improve road performance, prevent the need for anti-stripping agents, and prevent plastic waste from being disposed of through land filling and incinerator. The use of plastic wastes in road construction is increasing that will reduce environmental impact worldwide. This study tries to explore the use of waste plastics into pavements by considering both infrastructure needs and environmental concerns.

Keywords: bitumen, plastic waste, road construction, environmental pollution

1. Introduction

Plastic has revolutionized various sectors due to its durability, flexibility, and cost effectiveness, and has become an integral part of modern life (Mohajan, 2025d). But it is not eco-friendly and non-biodegradable. The plastic wastes are ending up in landfills, oceans, and natural habitats that pose grave threats to ecosystems, wildlife, and human health for non-biodegradable nature (Tayde et al., 2024; Mohajan, 2015). The plastic wastes are collected through washing, then shredded to a uniform size, and melted at 165°C; and then blended with hot aggregates and bitumen, and then used for the construction of plastic roads. These roads have hollow space that allows ease of wiring, connecting pipes, etc. This construction process is an environmental friendly way of disposing plastic wastes (Appiah et al., 2017).

Plastic roads are more durable than traditional asphalt roads that provide a potential solution for managing plastic waste and improving road infrastructure (Patel et al., 2014; Mohajan, 2025a). Actually, the plastic roads are not made entirely of recycled plastic, but instead mixed with asphalt for an ideal consistency to keep the road safe for motorists that helps it last longer, cost less, and avoid cracking; the plastic waste is melted and mixed with bitumen in a particular ratio (Poweth et al., 2013). These consist of modular, hollow, and prefabricated road elements made from consumer waste plastics (Mohajan, 2020). These are first developed by Indian Chemist Rajagopalan Vasudevan, the Plastic Man of India, in 2001 (Thiagarajan, 2018). The most common plastics used in making plastic roads are polyethylene terephthalate (PET), polypropylene (PP), low density polyethene (LDPE), and high density polyethene (HDPE). These plastics are available in the form of carry bags, water bottles, milk packets, glasses, cups, and other plastic debris (Conlon, 2021; Mohajan, 2025d).

2. Literature Review

A literature review is a comprehensive overview of existing research and scholarly works on a specific topic. It discusses published information in a particular subject area within a certain time period (George et al., 2023). It involves summarizing, analyzing, and synthesizing different sources to provide a cohesive understanding of the current state of knowledge (Baglione, 2012). A good literature review has a proper research question, a proper theoretical framework, and a chosen research methodology (Galvan, 2015). Akshar Patel and his coauthors have discussed the suitability of plastic waste materials for road construction. In their study they have wanted a safe and prolific disposal of plastic wastes, quarry dust, and tyre. The results of their tests indicated that plastic alone is not suitable for pavement subgrade. They have realized that when quarry dust is added along with soil plastic mix, it maintains the California Bearing Ratio (CBR) value within the required range (Patel et al., 2018). Ahmed Trimbakwala has shown that the plastic wastes can be used in road construction and the field tests withstood the stress. He has observed that the durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. This technology not only strengthened the road construction but also increases the road life as well as helps to improve the environment and also creating a source of income (Trimbakwala, 2017).

Moorey B. Dalen and his coworkers seek to incorporate up to 30% weight-by-weight low density polyethylene (LDPE) and polyethylene terephthalate (PET) plastic wastes of total binder required for the asphalt design into bitumen for road pavement that help to secure an environment friendly way of plastic wastes disposal, improve soil compost for agriculture, reduce the demand of bitumen, reduce the cost of road construction, and create job opportunities (Dalen et al., 2017). Aditya Raut and his coauthors have indicated that plastics are user friendly but not eco-friendly as they are non-biodegradable. They have observed that the plastic waste modifies bitumen mix and shows better binding property, stability, density, and more resistant to water. They have stressed that this technique for road construction proves eco-friendly, economical, and use of plastic gives strength in the sub-base course of the pavement (Raut et al., 2016).

Josu´e Cardoso and his coauthors have realized that disposal of plastic waste has become a great challenge for the current generation due to the large-scale production and non-degradable properties of plastics. They have investigated that plastic waste has the potential to be incorporated into asphalt mixtures and help mitigate the environmental problem related to its disposal (Cardoso et al., 2023). Akhilesh Yadav and Ruchi Chandrakar have shown that the use of plastic wastes in pavement construction is an effective disposal of plastic wastes and at the same time it increases the strength and durability of the roads that provides the environmental, economic and safety issue. They have noticed that plastic increases the melting point of the bitumen and makes the road flexible during winters resulting in its long life. Consequently, the brittleness of the roads overcomes and elastic nature of them enhances, and also creates a source of income (Yadav & Chandrakar, 2017).

Akshay A. Tayde and his coworkers have tried to explore the potential of incorporating waste plastic into pavements as a means of addressing both infrastructure needs and environmental concerns that enhance pavement performance, durability, and resistance to temperature variations and moisture infiltration, particularly in regions with hot and humid climates (Tayde et al., 2024). Gaurav Gadekar and his coworkers have explored the concept of upcycling plastic waste for road construction as a sustainable solution to address the environmental challenges posed by plastic waste accumulation, such as discarded bottles and packaging. They have examined the technical feasibility, environmental impact, and economic viability of incorporating plastic waste into asphalt mixtures and other road construction applications; providing valuable insights for policymakers, engineers, and environmentalists interested in promoting sustainable waste management practices (Gadekar et al., 2023).

3. Research Methodology of the Study

Research is a scientific inquiry aims at learning new facts, testing ideas, etc. that is the systematic collection, analysis, and interpretation of data to generate new knowledge and answers certain question or solve a problem (Franklin, 2012). It is a tool for building knowledge and facilitating learning that provides the latest information, new ideas, curiosity, ethical principle, etc. (Mahalakshmi et al., 2023). It is divided into two types, such as quantitative and qualitative research (Mohajan, 2025e). Quantitative research is the main methodology of the natural sciences that uses precise numerical measurements (Berg, 2009). On the other hand, qualitative research is more characteristic of the social sciences that aim more at an in-depth understanding of the meaning of the studied phenomena (Kothari, 2004). Methodology is the study of research methods. It refers either to a method, to the field of inquiry studying methods, or to philosophical discussions (Howell, 2012). Research methodology is the detailed procedure used to identify, select, process, and analyze information about a topic. It helps readers to understand the basic concepts and the application of results directly to real life business, industry and research organizations (Dubey & Kothari, 2022).

4. Objective of the Study

Traditional road construction materials, such as virgin asphalt causes environmental degradation and resource

depletion. But, if a portion of waste plastics is used in road construction with asphalt that enhance the properties of bituminous mixes, and the whole process becomes more sustainable and environment friendly (Tayde et al., 2024; Mohajan, 2021c). The use of this innovative technology is strengthen the road construction and increases the road life as well as helps to the utilization of waste plastic material. The growth of local recycling industries can generate employment opportunities in the society (Vasudevan, 2006). Main objective of this article is to study the utilization of plastic waste with bituminous mixes for the road construction (Mohajan, 2018). Other minor objectives of the study are as follows:

- to highlight on the features of plastic roads, and
- to discuss on advantages of plastic roads.

5. Features of Plastic Roads

After adding plastic with bitumen improves viscosity, stability, binding property, penetration value, water resistance, and softening point of the bitumen, and reduces the construction cost of road pavement about 8% (Gadekar et al., 2023; Mohajan, 2025b). Bitumen is a naturally occurring, oily, viscous substance, and black in color that is produced when organic molecules break down. The strength of plastic roads is twice than normal roads and no potholes are formed (Hyder & Altaf, 2024; Mohajan, 2021a). These do not involve any extra machinery, and do not increase cost of road construction. These are of better quality and do not require maintenance in the first five years (Mohajan, 2025g). These are less bleeding during summer, and dumping in landfill and incineration of plastics waste could be avoided when these wastes are used in road construction (Trimbakwala, 2017).

6. Advantages of Plastic Roads

Plastic roads have hollow spaces that allow ease of wiring, connecting pipes, etc. These are built from waste plastic that is usually dumped into landfill and sometimes incinerated, which pollute the environment emitting gaseous pollutants (Chirag et al., 2012; Mohajan, 2021b). Use of plastic with asphalt saves on cost and consumption of bitumen decreases and plastic waste decreases, and improves the quality and durability of roads (Awwad & Shbeeb, 2007). These are better resistance to water and water stagnation, and no effect of UV radiation. These can avoid the use of anti-stripping agents, industrial involvement, and disposal of plastics waste by incineration and land filling (Gadekar et al., 2023).

After the addition of plastic with asphalt the viscosity of the mixture is reduced that allows a lower working temperature, which lowers volatile organic compound (VOC) and carbon monoxide (CO) emissions. The plastic roads do not absorb water; have better flexibility that results in less rutting and less need for repair, road surfaces remain smooth, absorb sound better, and need lower maintenance (Khimta & Arora, 2017). Strength of the road increases and increased binding and better bonding of the bitumen mix and can reduce the need of bitumen by about 10%. Since the plastic roads are water resistant, have better binding property, higher softening point and can withstand high temperatures and higher loads. Rainwater does not seep through these roads because of the plastic in the tar and these results in fewer repairs (Rajasekaran et al., 2013; Mohajan, 2025c).

7. Conclusions

The plastic roads not only allow for the construction of more durable and cost-effective roads, but also give a sustainable solution to the plastic waste problem, and consequently the resources are utilized efficiently, and waste is minimized. More people are needed for the collection, sorting, and cleaning of the plastic wastes, and therefore, job opportunities are created during plastic road construction. Use of plastic waste with bitumen and stone can reduce bitumen by about 10%, increase strength and performance of road, avoid use of anti-stripping agent, avoid disposal of plastic waste by incineration and land filling, and develop ecofriendly technology. The plastics in the road can break down into micro-plastics and can mix with the soil and water, and can pollute the environment.

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