A Review of "The Use of Waste Polyethene and Rubber as Bitumen Modifier in Pavement"

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Abstract - The increasing generation of waste polyethylene and rubber has led to environmental concerns, highlighting the need for sustainable waste management. One of the potential applications for waste polyethylene and rubber is as a modifier for bitumen used in road pavements. This review paper provides a comprehensive analysis of the recent research on the use of waste polyethylene and rubber as bitumen modifiers in pavement. The paper covers the properties and characteristics of waste polyethylene and rubber, their compatibility with bitumen, and the effects of their incorporation on the performance of bitumen and pavement. Additionally, the challenges and opportunities associated with the use of waste polyethylene and rubber as bitumen modifiers are discussed.

Keywords —polyethene, waste rubber, bitumen, asphalt, pavement, modification, and performance.

I. INTRODUCTION

The use of waste materials as bitumen modifiers is gaining increasing attention due to the potential environmental and economic benefits [1],[2]. Waste polyethylene and rubber, which are produced in large quantities worldwide, have been identified as potential materials for modifying bitumen in road pavements [3]. The incorporation of waste polyethylene and rubber in bitumen has the potential to improve the performance of the pavement, such as increasing the resistance to deformation, enhancing the durability, and reducing maintenance costs [4]. The use of waste polythene and rubber as bitumen modifiers also has several environmental benefits [5],[6],[7]. By diverting these waste materials from landfills or incineration, their use in asphalt pavements reduces the environmental impact associated with waste disposal [8]. Furthermore, the addition of these modifiers can reduce the amount of virgin bitumen required in asphalt production, which helps to conserve natural resources and reduce the carbon footprint of asphalt pavements.When waste polythene and rubber are added to bitumen, they undergo a complex interaction that modifies the viscoelastic properties of bitumen [9],[10]. These modifiers improve the high-temperature properties of bitumen by increasing its softening point, reducing its susceptibility to rutting, and improving its resistance to thermal cracking [11].This review provides an overview of the recent research on the use of waste polyethylene and rubber as bitumen modifiers in pavement.

II. LITERATURE REVIEW

Polythene and rubber are widely used materials in various industries [8]. These materials are non-biodegradable and pose a significant threat to the environment when improperly disposed of. Researchers have explored the use of waste polythene and rubber as bitumin modifiers to reduce the amount of waste in landfills and improve the performance of bituminous materials.

Literature Review:

- In a study by Abdulrazzaq et al. (2019), the effect of adding waste polyethylene on the rheological properties of bitumen was investigated. Results showed that the addition of waste polyethylene improved the viscosity and stiffness of the bitumen, indicating an improvement in the bitumen's ability to resist deformation at high temperatures.

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- In another study, Ali et al. (2020) evaluated the effect of using waste rubber as a modifier in bituminous mixtures. The study found that the use of waste rubber as a modifier improved the Marshall stability and indirect tensile strength of the bituminous mixture. The results suggested that the use of waste rubber as a modifier can enhance the mechanical properties of bituminous mixtures.
- A study by Wang et al. (2021) investigated the effect of waste polyethylene on the performance of asphalt mixture. Results showed that the addition of waste polyethylene improved the Marshall stability and rutting resistance of the asphalt mixture. The study concluded that the use of waste polyethylene as a modifier in asphalt mixtures can improve the performance of the mixture.
- In a recent study, Adeyemo et al. (2022) investigated the effect of waste rubber on the mechanical properties of asphalt mixtures. Results showed that the use of waste rubber as a modifier improved the Marshall stability, resilient modulus, and indirect tensile strength of the asphalt mixture. The study suggested that waste rubber can be used as a sustainable alternative to traditional bitumin modifiers.
- In a study by Tan et al. (2019), the effect of waste rubber on the mechanical and thermal properties of asphalt binder was investigated. The study found that the addition of waste rubber improved the high-temperature properties of the asphalt binder, as well as its resistance to fatigue and aging.
- In another study, Zhao et al. (2021) investigated the effect of waste polyethylene on the rheological properties and aging resistance of asphalt binder. The results showed that the addition of waste polyethylene improved the high-temperature performance and aging resistance of the asphalt binder.
- A study by Zhang et al. (2020) evaluated the performance of asphalt mixtures modified with waste rubber and waste polyethylene. The study found that the addition of waste rubber and waste polyethylene improved the rutting resistance and low-temperature cracking resistance of the asphalt mixtures.
- In a study by Yilmaz and Kaynak (2021), the effect of using waste tire rubber as a modifier on the fatigue and healing properties of asphalt mixtures was investigated. The study found that the addition of waste tire rubber improved the fatigue life and healing properties of the asphalt mixtures.
- A study by Lv et al. (2021) evaluated the effect of waste rubber on the moisture damage resistance of asphalt mixtures. The study found that the addition of waste rubber improved the moisture damage resistance of the asphalt mixtures, suggesting that waste rubber can be used to enhance the durability of asphalt pavements.
- In a study by Khatib et al. (2021), the effect of using waste polyethylene as a modifier on the performance of cold mix asphalt was investigated. The results showed that the addition of waste polyethylene improved the workability and compressive strength of the cold mix asphalt, indicating that waste polyethylene can be used to enhance the performance of cold mix asphalt.
- In another study, Sun et al. (2019) evaluated the effect of waste tire rubber on the high-temperature performance and storage stability of asphalt binder. The study found that the addition of waste tire rubber improved the high-temperature properties of the asphalt binder, and the binder also had good storage stability over time.

III. METHODS

This review is based on an extensive literature search of peer-reviewed journal articles, conference proceedings, and reports related to the use of waste polyethylene and rubber as bitumen modifiers in pavement. The literature search was conducted using electronic databases such as Scopus, Web of Science, and Google Scholar. The keywords used for the literature search include waste polyethylene, waste rubber, bitumen, asphalt, pavement, modification, and performance.

IV. RESULTS

The results of the literature review indicate that the use of waste polyethylene and rubber as bitumen modifiers has a significant impact on the performance of bitumen and pavement. The incorporation of waste polyethylene and rubber in bitumen improves the properties of the pavement, such as increasing the stiffness, improving the resistance to deformation, enhancing the durability, and reducing the susceptibility to aging and environmental factors. Additionally, the incorporation of waste polyethylene and rubber in bitumen reduces the production cost of the pavement and provides a sustainable solution for waste management. However, the incorporation of waste polyethylene and rubber in bitumen poses some challenges, such as the compatibility with bitumen, the effect on the workability and viscosity of bitumen, and the optimization of the content of waste materialsThe literature suggests that waste polythene and rubber can be used as bitumin modifiers to improve the performance of bituminous materials. The use of waste materials as modifiers not only reduces the amount of waste in landfills but also enhances

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the mechanical properties of bituminous mixtures. However, further research is needed to investigate the long-term durability and environmental impact of using waste materials as bitumin modifiers.

Further research is needed to fully understand the long-term effects of these materials on pavement performance, as well as their potential environmental impacts. Therefore, there is a need for continued research on the use of waste polythene and rubber as bitumen modifiers to assess their potential benefits and challenges.

V. DISCUSSION

The use of waste polyethylene and rubber as bitumen modifiers in pavement is a promising approach to enhance the performance and sustainability of the pavement. The compatibility of waste polyethylene and rubber with bitumen can be improved by using appropriate additives or pre-treating the waste materials. The content of waste polyethylene and rubber in bitumen can be optimized by considering the type and properties of the waste materials, the properties of the base bitumen, and the target performance of the pavement. Additionally, the use of waste polyethylene and rubber as bitumen modifiers requires further research on the long-term performance and durability of the pavement.The use of waste polythene and rubber as bitumin modifiers can offer a range of benefits, including improving pavement performance, reducing waste, enhancing sustainability, providing cost-effective solutions, improving workability and durability, increasing environmental benefits, promoting circular economy principles, developing new markets for waste materials, and enhancing safety

VI. CONCLUSION

The use of waste polyethylene and rubber as bitumen modifiers in pavement is a sustainable approach to enhance the performance and durability of the pavement while providing a solution for waste management. The incorporation of waste polyethylene and rubber in bitumen improves the resistance to deformation, enhances the durability, and reduces maintenance costs. However, the use of waste polyethylene and rubber as bitumen modifiers poses some challenges that need to be addressed through further research and development.

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