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ENHANCING RESISTANCE TO PENETRATION IN BITUMEN THROUGH INCORPORATION OF WASTE PLASTIC

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Abstract
Asphalt pavement play a crucial role in modern transportation infrastructure and the durability of these pavements is crucial for long term performance. The disposal of plastic waste poses a significant environmental challenge, prompting the exploration of sustainable methods to integrate waste plastic into construction material. This research focuses on improving the resistance to penetration of bituminous materials by incorporating waste plastic additives. Results demonstrates that the addition of waste plastic significantly enhances the resistance to penetration of bitumen. The outcomes contribute to the ongoing efforts in developing environmentally friendly construction materials for applications in infrastructure development. This research also explores the thermal stability and aging behaviour of the plastic modified bitumen to assess its long-term performance under different environmental conditions.

Keywords: Plastic, bitumen, pavement, penetration.

Introduction

The study evaluates the feasibility of waste plastic added bitumen for asphalt pavement applications, considering the implications for pavement durability, rutting resistance, and fatigue performance. The findings contribute to the development of sustainable and eco-friendly asphalt materials, addressing both the environmental challenges associated with plastic waste and the need for enhanced pavement performance. Experimental investigations involve the preparation of bitumen samples with varying concentrations of waste plastic derived from post-consumer packaging materials. The resistance to penetration is evaluated through standard penetration tests, measuring the depth of penetration of a standard needle into the modified bitumen at controlled temperature and loading conditions.
This research provides valuable insights into the optimization of waste plastic modified bitumen formulations, offering a potential solution for the sustainable management of plastic waste while improving the engineering properties of bituminous binders.

Aim and objectives of the research

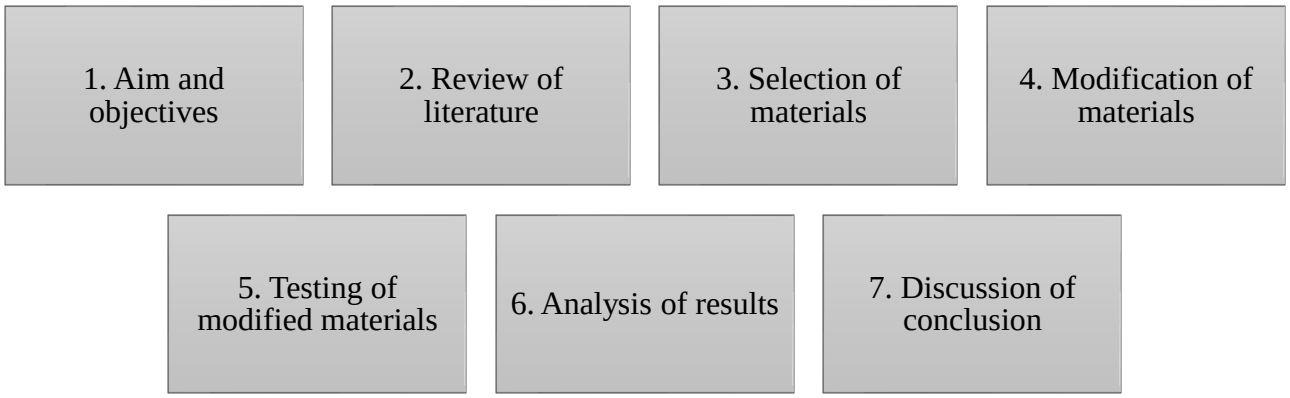
The primary aim of this study is to investigate and enhance the resistance to penetration of bitumen by incorporating waste plastic additives. The research aims to contribute to the development of sustainable and environmentally friendly practices in the construction industry by repurposing waste plastic for improving the performance of bitumen. The objectives are as follows:

1. Investigate different types of waste plastic materials obtained from post-consumer packaging.
2. Develop bitumen samples with varying concentrations and types of waste plastic additives.
3. Optimize the formulation parameters to achieve improved resistance to penetration while maintaining other essential properties of the bitumen binder.
4. Conduct standardized penetration tests to quantify the resistance of the waste plastic modified bitumen to penetration.
5. Compare the results with conventional bitumen to assess the effectiveness of waste plastic in enhancing the penetration resistance.
6. Provide insights and recommendations for the sustainable incorporation of waste plastic in bituminous binders.
7. Contribute to the ongoing efforts in developing eco-friendly construction materials for infrastructure applications.

Literature review

The performance evaluation of bitumen modified with waste plastic was the focus of the research. Insights into the improved resistance to penetration and mechanical properties of bituminous binders were provided, contributing to sustainable pavement solutions [1]. The modification of bitumen using waste polyethylene was the focus of the research. Enhanced performance in terms of resistance to penetration was indicated by the results, emphasizing the potential of waste polyethylene for improving bituminous properties [2]. The impact of incorporating waste plastic on bituminous mixes was investigated. Improvement in the mechanical properties and resistance to penetration was explored, providing valuable insights for sustainable pavement construction [3]. The utilization of wate plastic in bituminous mixes for sustainable development was explored in the study. The positive influence of waste plastics on resistance to penetration and the overall sustainability of bituminous materials was discussed [4]. The utilization of waste plastic in bituminous pavements was investigated in the study, highlighting the positive effects on penetration resistance. The feasibility of incorporating waste plastic as an environmentally friendly approach in bitumen modification for pavement applications was emphasized [5].

Methodology



Experimental analysis

5.1. Weather conditions – Mostly hot weather throughout the year.

5.2. Materials

Bitumen: Free sample of Penetration grade 40/60 bitumen from hot mix plant.

Plastic: Waste wrappers of packaged food.

Apparatus: Standard penetrometer, water bath (25±1ºC) and thermometer (250 ºC).

5.3. Sampling

1. The bitumen was initially softened at the temperature of 90 ºC for pouring into the container.
2. The melted bitumen was poured in to the container more than the expected penetration.
3. The sample was then allowed to cool down to 25 ºC at room temperature.
4. The sample was placed into the water bath 25 ºC for 1.5 hours in 35 mm deep container.
5. The mould was placed on the standard penetrometer base.
6. The needle was cleaned with benzene to make sure that the needle was free of any unwanted substances on its surface.
7. The needle with 100 gm weight was then placed vertically above the specimen such that the tip of the needle was just above the specimen without making any contact and disturbing the surface of the bitumen.
8. Then the needle was released on the specimen and was allowed to penetrate for 5 seconds. Three determinations were taken.

9. The results were noted.
10. Then the traditional bitumen was modified by replacing the bitumen with melted plastic by 5%, 10% and 15% respectively.
11. Same procedure for the penetration test was carried out for all the samples.

5.4. Testing

The sampling as well as testing of all the specimens was carried out as per IS 1203 – 1978.

Table 1. Test results for traditional bitumen with 0% waste plastic.

Penetration dial reading	1	2	3
Initial reading	0	0	0
Final reading	46	45	47
Average penetration value	46		

Table 2. Test results for bitumen containing 5% waste plastic.

Penetration dial reading	1	2	3
Initial reading	0	0	0
Final reading	43	45	47
Average penetration value	45		

Table 3. Test results for bitumen containing 10% waste plastic.

Penetration dial reading	1	2	3
Initial reading	0	0	0
Final reading	48	46	50
Average penetration value	48		

Table 4. Test results for bitumen containing 15% waste plastic.

Penetration dial reading	1	2	3
Initial reading	0	0	0
Final reading	49	51	50
Average penetration value	50		

Result analysis

1. The penetration value of the traditional bitumen was noted as 46 mm.
2. The penetration value of the bitumen containing 5%, 10% and 15% of plastic was noted as 45 mm, 48 mm, and 50 mm respectively.
3. A rise in the penetration value was observed in the bitumen containing 10% and 15% of waste plastic.
4. The place at which the penetration test was conducted generally has a hot weather throughout the year. Therefore, it was required that the modified bitumen should show similar properties to that of the bitumen generally used in that area, i.e. bitumen of penetration grade 40/60.

5. Bitumen containing 5% of waste plastic showed similar penetration value as the traditional bitumen.

Conclusion

1. It can be concluded that the optimum content of waste plastic can be counted as 5% by the weight of bitumen.
2. This study can have a positive impact on the modification of construction materials and can lead towards sustainability.
3. This study can also pave its path towards conservation of natural resources and exploiting them.
4. This study can also help ongoing researches which have concern with the road construction advancements.

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