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"Study on Optimizing the Plastic Content in the Innovative Plast-Bit Roads''

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ABSTRACT

In recent times, the proliferation of plastic waste in both municipal and industrial sectors has escalated dueto population growth, development activities, and changing lifestyles. The non-biodegradable nature of plastic waste presents a significant challenge for its disposal in India. To address this issue and contribute to environmental management, researchers have focused on utilizing plastic waste in bitumen road construction. The primary objective of this study is to enhance the properties of bitumen by incorporating a certain percentage of plastic waste into hot bitumen. The addition of plastic waste leads to improvements in penetration value, softening point, and viscosity of bitumen. Consequently, it can be inferred that plastic waste enhances the performance of bitumen in road construction.The increasing production of disposable plastic has become a pressing concern in numerous countries. Non-biodegradability poses a significant problem in managing these solid wastes. One potential solution to this crisis and the need for waste plastic management is the utilization of waste plastic as a secondary material in construction projects. This approach not only helps mitigate the excessive production of waste plastic but also improves the structural characteristics of constructions, particularly their resistance to cracking. This research aims to explore the effects of incorporating plastic in road pavement. Specifically, the study focuses on employing waste plastic, such as Low Density Polyethylene (LDP), as a modifier in preparing samples for testing the properties of modified bitumen. Additionally, the research aims to analyze the impact of waste plastic- modified.

Keywords: Non-biodegradable plastic, Bitumen, Low Density Polyethylene (LDP, Plastic-modified.

1. INTRODUCTION

Roadways are essential for facilitating the safe, efficient, and rapid movement of large volumes of passengers and goods throughout the year. Constructed on land, they play a vital role in a country's economic, social, and cultural development, and the extent of a nation's transportation network is often indicative of its growth and status. However, constructing new roads requires substantial funding, making it crucial to explore cost-effective and sustainable construction methods by leveraging new technologies. One such approach involves incorporating plastic materials into bituminous mixtures. Bitumen, a black viscous substance derived from petroleum distillation or purification, is a key component in road construction. Plastic, composed of one or more high molecular weight organic polymers, is solid in its finished state and can be molded by flow. It is highly durable and degrades slowly, which creates significant environmental challenges when it becomes waste. As a result, researchers across various fields are continually seeking effective reuse options for different forms of plastic.

In India, plastic-content bituminous roads, which utilize waste plastic in the wearing course, have gained considerable popularity. The Indian Road Congress has issued specifications under IRC SP: 98-2013 to guide the construction of plastic roads, encouraging numerous agencies to adopt this sustainable practice. The Ministry of Road Transport and Highways has also launched initiatives to promote the extensive use of waste plastic in road construction. Currently, more than 100,000 kilometers of roads in India have been built using waste plastic, and the practice continues to expand across various regions.

The objective of this study is to determine the optimal plastic content in PLAST-BIT roads and to evaluate key properties such as ductility, penetration, softening point, and flash point values of PLAST-BIT pavement with varying plastic contents of 0%, 2%, 4%, 6%, and 8%. Additionally, the study aims to analyze potential adverse environmental effects of PLAST-BIT roads and propose appropriate remedies.

The hypothesis proposes that waste plastic materials, such as polythene and carry bags, when liquefied at specific temperatures, can enhance the properties of bitumen by acting as a binder or by blending effectively with it. This enhancement has the potential to improve the durability of bituminous roads while contributing to sustainable waste

management. The significance of the study lies in the understanding that incorporating plastic waste into bitumen can substantially improve the strength, fatigue life, and overall performance of bituminous mixtures, thereby increasing pavement longevity and supporting the development of environmentally friendly road infrastructure.

2. LITERATURE REVIEW

The research conducted by suggests that using a blend of polymer and bitumen as a binder in road construction offers advantages over using plain bitumen alone. The polymer bitumen blend exhibits an increased softening point and reduced penetration value, while maintaining suitable ductility. These properties enable the blend to withstand higher temperatures and heavier loads during road usage. The addition of plastic coatings to the aggregate and bitumen mix further enhances the material for flexible pavement construction. The coating helps reduce porosity, minimizes moisture absorption, and improves the overall soundness of the pavement. As a result, the mix demonstrates higher Marshall Stability values and a suitable Marshall Coefficient, which are important factors in assessing the quality and performance of flexible pavements. Therefore, utilizing waste plastics in the construction of flexible pavements is considered one of the most effective methods for achieving easy implementation, pollution prevention, and other benefits.

Utilization of Plastic waste in Bitumen Mixes for Flexible Pavement by Dr S.L Hake, Dr.R.M.Damgir (2017). In the present research work created procedures to utilize plastic waste for development motivation behind adaptable asphalts will be survey. In regular Street making process bitumen is utilized as folio. Such bitumen can be adjusted with squander plastic pieces and bitumen blend is made which can be utilized as a best layer of adaptable asphalt. The plastics from PET jugs to be utilized in blends for examine work. The measurements of plastic of 5 %, 7.5%, 10 %, 12.5% and 15 % utilized as substitution of bitumen.

Use of Plastic Waste in Bituminous Pavement by R.Manju; Sathya S; Sheema (2016).The waste plastic used are poly-ethylene, poly-styrene, poly- propylene. The waste plastic is shredded & coated over aggregate & mixed with hot bitumen and resulted mix is used for pavement construction. This will not only strengthen the pavement and also increases its durability. The titanium-di- oxide is used as a smoke absorbent material, which will absorb the smoke from the vehicles. This innovative technology will be boon for Indian hot-humid climate. It's economical and eco-friendly. In this paper, we have discussed about the soil properties to be considered in design of pavement, pavement design, process of construction flexible and plastic-smoke absorbent pavement.

Plastic Roads: A Recent Advancement in Waste Management by Anzar Hamid, Huda Shafiq (2010).Plastics are the non-biodegradable materials and so a means to degrade our environment. Plastic wastes have proved to be a source of health hazard as it is toxic in nature. Plastic waste is a big nuisance in today's world. So, this plastic waste should be reused to eliminate the threat to the surroundings. One such reuse can be in the construction of flexible pavements. Plastic coated aggregates have proved to offer better resistance to abrasion and wear and tear. Moreover the bond between these plastic coated aggregates and the bitumen is also very strong due to increased contact area between plastic (polymers) and bitumen. Such roads show better performance and have increased life spans.

Case Study on Plastic Roads by P. Guruswamy Goud, M. Rajasekhar, N. Vijayakumar , K Snehalatha , B. Bhanu (2018). Plastic roads are made entirely of plastic or of composites of plastic with other materials. Plastic roads are different from standard roads in the respect that standard roads are made from asphalt concrete, which consists of mineral aggregates and asphalt. Plastics increase the melting point of the bitumen. The use of this plastic in road construction is an innovative technology which not only strengthens the road but also increases the road life. The analysis in this paper reveals that Durability, strength and cost.

Using waste plastics in road construction by Manu Sasidharan, Dr Mehran Eskandari Torbaghan & Dr Michael Burrow (2017. The idea of using waste plastics in road construction is relatively new. Laboratory tests have shown positive results when a small amount (5-10% by weight) of plastic is incorporated in bituminous mixes (asphalt), resulting in improved pavement stability, strength, and durability. However, international field experience using plastics in actual road construction is quite limited. In this review, we found examples of waste plastics being used in road construction in a few case studies in India, UK, Netherlands, Ghana, Ethiopia and South Africa. While roads constructed using waste plastics have shown good longevity and pavement performance to date, the first roads constructed using this technology are only about ten years old, so long-term outcomes are not yet clear. This review did not find any evidence discussing the maintenance of roads constructed using waste plastics.

Upcycling Plastic Waste for Rural Road Construction in India: An Alternative Solution to Technical Challenge by Andri Heriawan (2012).One of the innovative ways by which the Government of India is addressing the challenges of rural road development is the use of plastic waste as an alternative material for road construction. Under the Pradhan Mantri Gram Sadhak Yojana (PMGSY), or the Prime Minister's Rural Road Program, several implementing state-level agencies have utilized plastic waste as alternative road construction materials in various ways, even though still on a pilot basis. It is expected that India will not only reduce the amount of plastic waste that goes to its landfills or

incinerators, but also benefit from more efficient rural road development. Due to the expected increase in road construction and its impact on the environment, the requirement for more sustainable and low-maintenance road infrastructures has become very importan.

Plastic Waste Road Construction in Madhya Pradesh by Riya Goyal (2013),Plastic or polythene bags, these non-biodegradable toxic items have been playing a major role in degrading our environment, especially our oceans. But now there might be a solution to tackle this mounting problem, using plastics to build roads. The idea is to create roads that are durable and also to get rid of potholes. Given the current plastic crisis, the aim of this case study is to make sure that plastic waste does not reach the landfills or water bodies and to ensure that the 3 R's – Reduce, Reuse and Recycle are implanted effectively. The plastic mixed with bitumen and aggregates is used for the better performance of the roads.

A Review on Studies and Research on Use of Plastic Waste by Sunil J. Kulkarni (2020).Sustainable development is important aspect of modern development. The minimization of waste is key to many environmental problems. Many investigations are nowadays focused on use of waste material for various applications. Such wastes are being used for ethanol, starch, acetic acid and manufacturing of other chemical. The problem of plastic waste can be minimized by reuse of plastic. Waste plastic can be used for synthesis of products like ethanol. The use of plastic for road construction is widely investigated area. The strength of the roads constructed with plastic mixed bitumen was found to be more than that constructed with usual material.

3. METHODOLOGY

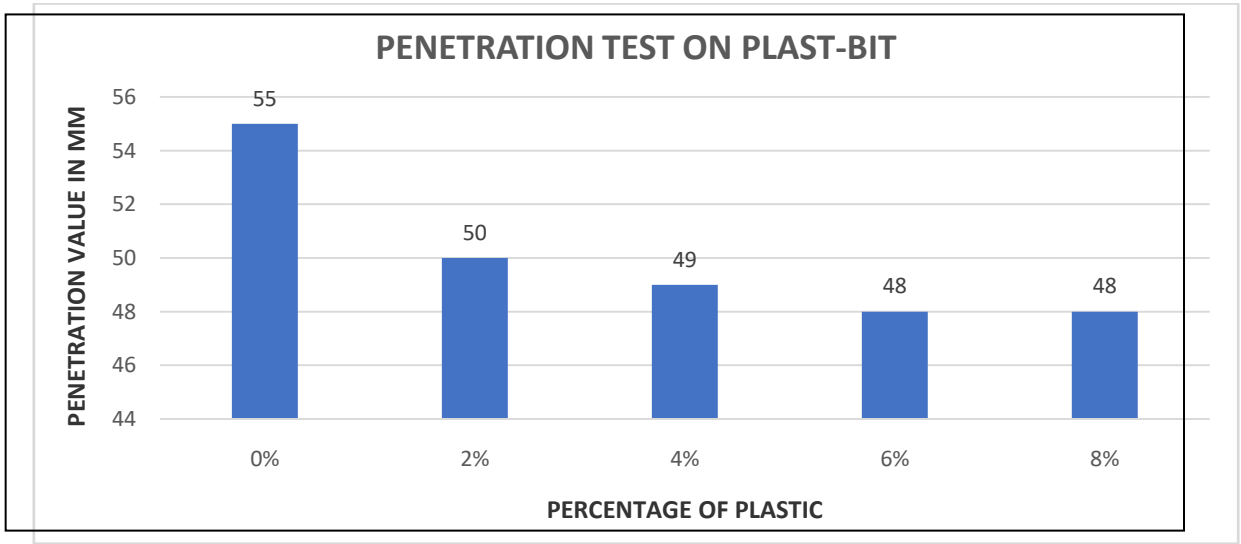
The study begins with identifying the most suitable type of plastic for use in plastic pavement, considering factors such as availability, compatibility with bitumen, melting temperature, and environmental impact. Commonly used plastics include polyethylene (PE), polypropylene (PP), and polystyrene (PS), which are generally sourced from waste materials and processed into shredded form. After selecting the appropriate plastic type, various research papers related to plastic pavement technology are reviewed to understand previous findings and methodologies. Based on the literature review, different percentages of plastic 0%, 2%, 4%, 6%, and 8% are selected to be blended with bitumen in order to evaluate their performance and determine the most effective proportion.

Subsequently, a series of laboratory tests are conducted on the plastic-modified bitumen to assess its engineering properties. These tests include the ductility test to measure the elongation capacity of the binder, the penetration test to determine hardness, the softening point test to evaluate temperature susceptibility, and the flash and fire point tests to assess safety at high temperatures. The results obtained from these tests are carefully recorded and compared with standard specifications to determine whether the modified bitumen meets the required performance criteria. Graphical representations are then prepared to clearly compare the standard values with the experimental results for each percentage of plastic content. Based on the analysis of these comparisons, the results are discussed in detail, leading to a conclusion regarding the optimum percentage of plastic to be used in plastic pavement for improved performance and durability.

4. RESULT AND DISCUSSION

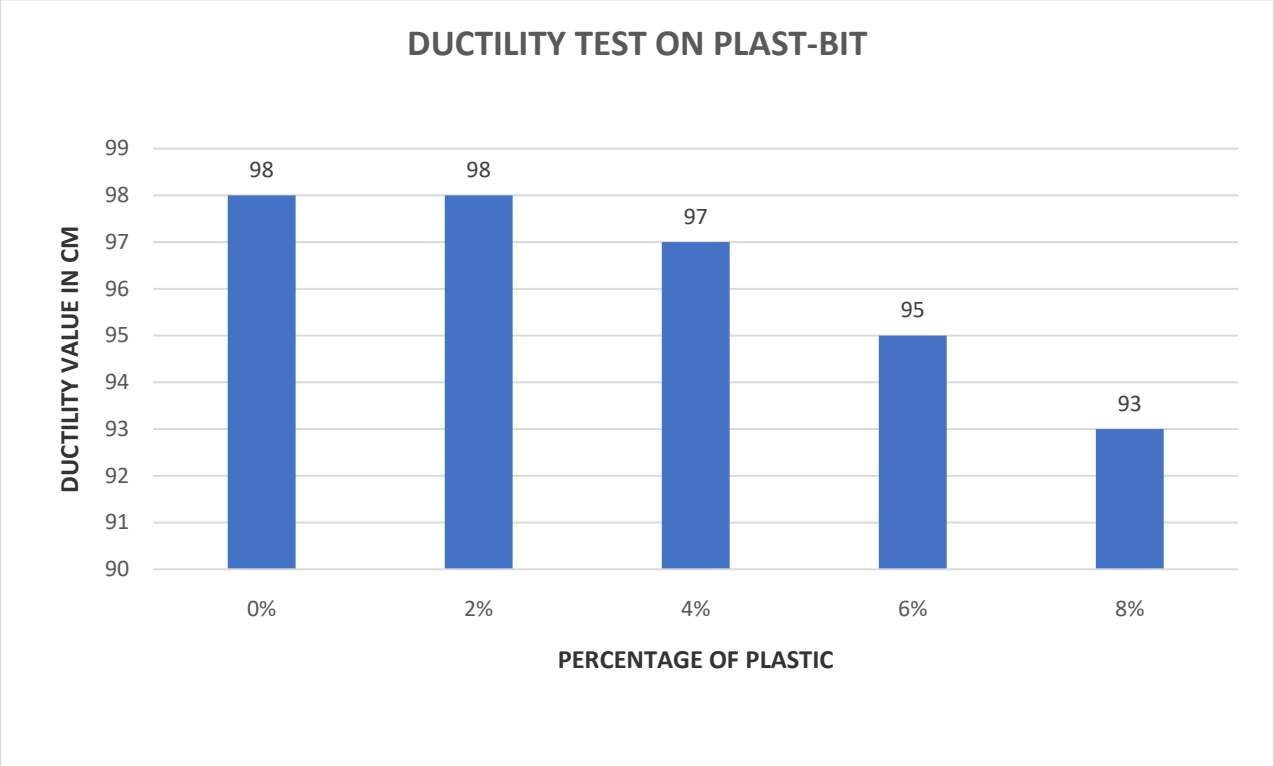
4.1 Laboratory test results

1. **Penetration Test**



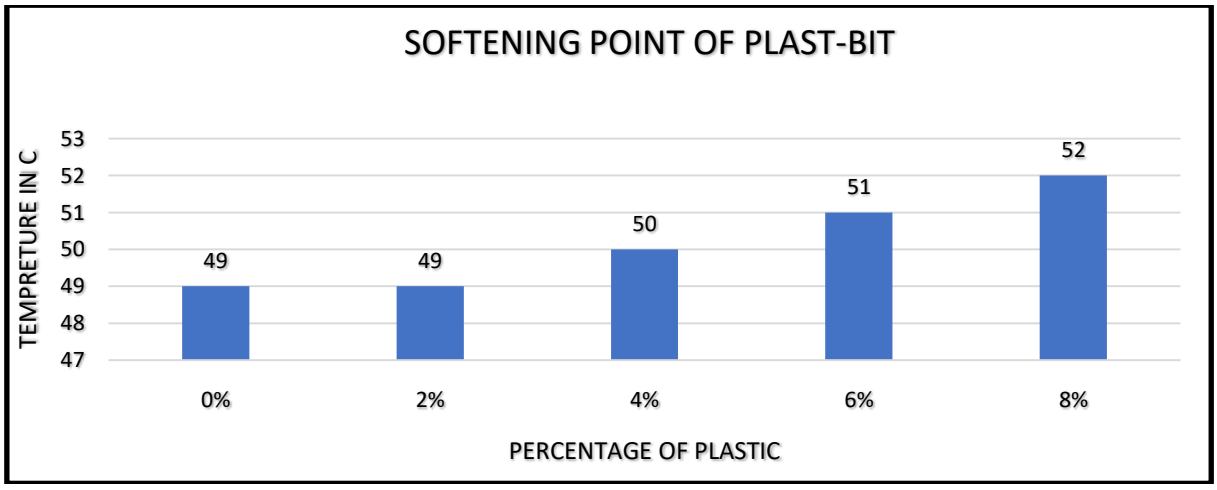
Penetration is the measurement of hardness or of consistency of bitumen. It is the vertical distance penetrated by a point of a standard needle into bitumen material under specific condition of bad, time and temperature. The distance is measured in a 1/10th of mm this test is used for compacting consistency of bituminous material.

2. Ductility Test



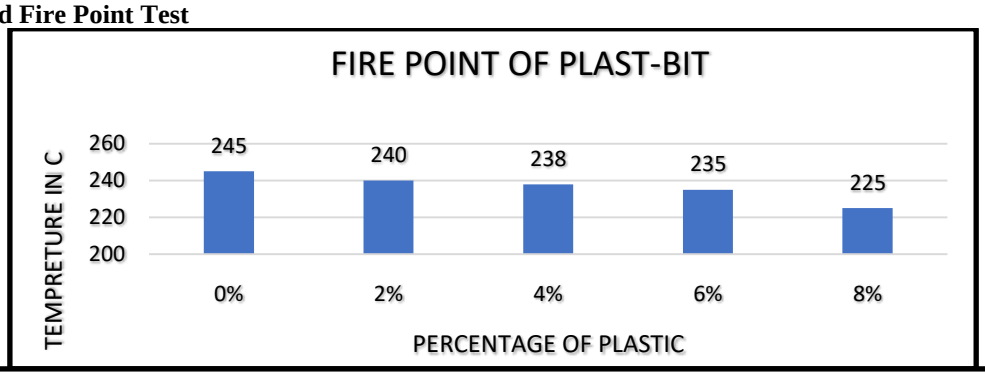
The ductility gives a measure of adhesive property of bitumen and its ability to stretch. In a flexible pavement design it is necessary that the binder should form a thin ductile film around the aggregate, so that physical interlocking of the aggregate is imposed. Binder material having insufficient ductility gets cracked when subjected to repeated traffic loads and provides pervious pavement surface. Ductility of bituminous material is measured by the distance in centimeters to which it will elongate before breaking when two ends of a standard mould of material are pulled apart at a specific temperature.

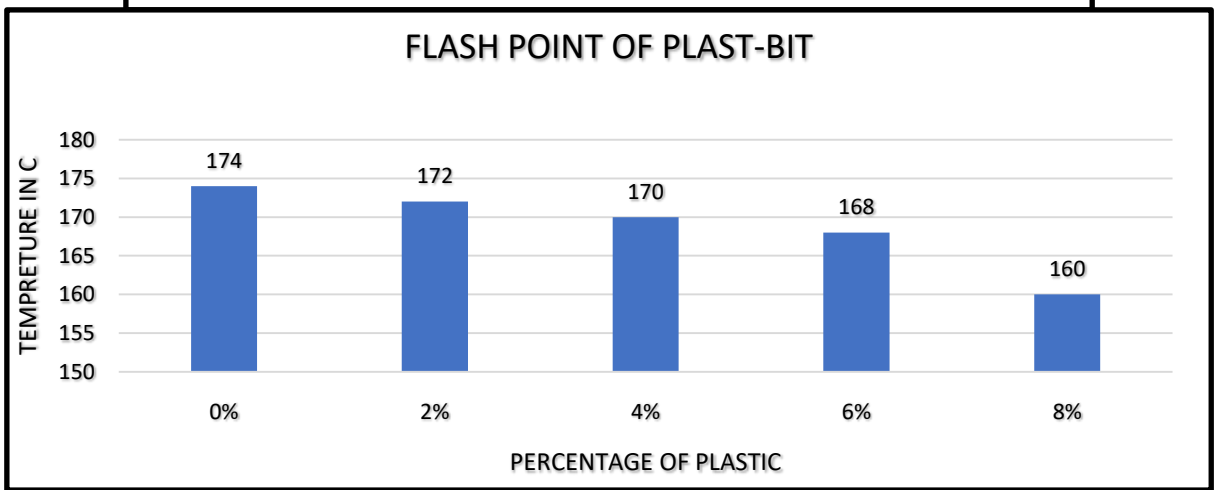
3. Softening Point Test



The softening point of bitumen or tar is the temperature at which the substance attains a particulars degree of softening. As per IS 334-1982, it is the temperature in degree Celsius at which a standard ball passes through a height of 2-5cm, when heated under water or glycerine at specified condition of the test. The binder should have sufficient fluidity before its application in road uses. The determination of softening point helps to know the temperature, up to which a bituminous binder should be heated for various road use applications.

4. Flash and Fire Point Test





The flash point of a material is lowest material at which the application of test film causes vapor from sample material, momentarily catch fire in the form of a flash under specified condition of test. The fire point is lowest temperature at which the application of test flame causes the material to ignite and burn at least for '5' sec. Under specified condition of test. At high temperature bituminous material emits hydrocarbon vapors, which are susceptible to catch fire. therefore the heating of bituminous material can be safely heated.

5. CONCLUSION

From above study or experiment we can conclude that using liquid plastic waste with bitumen will help to improve the strength and performance of road. The use 6% plastic waste is found to be the optimum percentage for modification of bitumen this percentage could make the road able to resist heavy vehicular and hot climate and to reduce the rutting effect. It does not involve any extra machinery as well as it does not increase the cost of road construction.

6. REFERENCES

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