Use of Plastic Waste in Flexible Pavements

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Abstract

As global concerns about environmental sustainability increase, there is an urgent need to find new solutions for plastic waste management. This research paper investigates the feasibility and effectiveness of incorporating plastic waste into the construction site as an alternative to traditional materials. Through a detailed review of existing information, experimental studies, and field trials, this study investigates the artificial intelligence, durability, and impact of plastic-modified asphalt mixture. Important parameters such as plastic type, quantity and processing methods are evaluated to optimize the performance of the coating while minimizing damage to the environment.

Keywords -: Plastic waste management, bituminous roads, durability.

1. Introduction

Plastic waste has become a major environmental problem worldwide, with large amounts of plastic waste accumulating in landfills, oceans and ecosystems. The damage caused by plastic pollution to biodiversity, human health and the environment has led to an urgent need for new solutions to reduce its impact. Among these solutions, the integration of plastic waste into the construction of basic facilities is considered a promising way to build sustainable infrastructure. The road network provides the necessary connectivity. However, traditional paving materials rely heavily on natural resources such as aggregate and asphalt, leading to resource depletion and environmental degradation through extraction, processing and transportation.

By reusing plastic waste as a replacement or addition to paving materials, this method not only replaces plastic in landfills and oceans, but also improves the performance and durability of flexible pavements. It is versatile. By diverting plastic from landfills, this approach will reduce the burden on landfills and reduce the risk of plastic contamination of soil and water ecosystems. In addition, the use of plastic in paving materials can reduce the ecological footprint of road construction by reducing the use of virgin materials, including aggregate and asphalt. Research and development studies have demonstrated the potential of using different forms

of plastic, such as recycled plastic bags, bottles and films, in asphalt mix solutions

2. LITERATURE REVIEW

The use of plastic waste in construction of flexible pavement would enable us to deal with a major problem of disposing plastic waste. Many researches and analyzations' have been done in the area of use of plastic waste in construction of flexible pavement.

1. "Use of plastic waste in flexible pavement green highway"
[1]Mr. Chabi Lal Singh, Mr. Prashant Singh, Mr. Abishek Kumar, Mr. Sushant Singh, Mr. Rajeev Rajput, 2020

This paper deals with the topics of use of plastic waste in design mix for construction of flexible pavement green highway.

2. "Use of plastic waste in construction in construction of flexible pavement: A creative waste management idea"
[2]Amit Tyagi, Apoorva Agarwal 2016

The amount of plastic waste is escalating due to population increase. disposal is hazardous and that is why it has become a serious problem. Because of increasing traffic intensity, the load bearing capacity had to be parallel to these problems and they can be solved by using plastic waste in flexible pavement.

3. "Use of plastic waste in bitumen mixes for flexible pavements."
[3]Dr. S. L. Hake, Dr. R. M. Damgir, P R Awsarmal,May,2019

In the present research work, some procedures are applied to utilize plastic waste for development of the bitumen flexible pavements. In regular street making process, bitumen can be adjusted with squander plastic pieces and bitumen blend is made which can be utilized as best layer of adaptable asphalt.

3. OBJECTIVES

The main objectives of using waste plastic in the construction process of flexible pavement are:

1. Use of waste plastic present in our environment will help in reducing bituminous content from the asphalt mix.
2. To efficiently use the several properties of plastic such as heat resistibility, durability, bonding properties, etc. to enhance the standard and quality of flexible pavement.
3. To find out the right percentage of plastic waste which can be used to overrule the bituminous content from mix.
4. Use of waste plastic which is present in our environment abundantly will make the waste management better and help in disposing of waste plastic.
5. By use of waste plastic, the cost of construction of bituminous flexible pavement by replacing some amount of bitumen from asphalt mix.

4. METHODOLOGY

The materials involved in the design mix for the construction process of flexible pavement are:

1. Bitumen - Bitumen acts as the binder which keeps all the materials together in the mix. Different grades of bitumen are used based on the strength,

environment and other factors.

Figure.1 Melted Bitumen

2. Aggregate – Coarse aggregates are used to give solidness to the mix and fine aggregates are used to fill the voids and gaps in the pavement.

3. Filler- Filler materials are frequently included to make strides the workability and they offer assistance to fill voids, upgrade solidness, and decrease black-top cover drain-down.

4. Plastic waste- Plastic squander, such as reused PET or HDPE, can be included within the black-top blend to upgrade certain properties or give natural benefits. Plastic squander can move forward asphalt solidness, decrease rutting, and advance maintainability by reusing squander materials.

The process of preparing a mix design with plastic waste for flexible pavements involves these following steps:

1. Collection of waste plastic: Waste plastic is collected from home, nearby areas, workplace or study place etc.

Figure 2. Colleting waste plastic

2. Cleaning and Shredding of Waste Plastic:

The collected waste plastic is the further cleaned or washed with water if necessary. The plastic waste is then shredded or cut into very small, thin pieces which can be easily used in the mix.

Figure 3. Cutting of waste plastic

3. Mixing of shredded waste plastic:

The mixing of plastic can be done in two methods which are dry and wet method according to the requirement.

The dry method involves the addition of processed waste plastic with hot aggregates. The shredded waste plastic should preferably be 2-3mm for better spread and coating of plastic on hot aggregate that are heated upto 170C. The shredded waste plastic melts to form a coating of plastic on the surface of aggregate. The bitumen is also heated upto 160C and then plastic is coated over aggregate and is mixed with bitumen and used for road construction.

The wet method involves the shredding of waste plastic into the powder form which is then mixed with the mix of bitumen and aggregate.

5. RESULT AND DISCUSSION

We have conducted several laboratory and field tests which have enable us to determine the differences in the properties of ordinary bitumen mix and plastic modified bitumen mix. The tests we have performed and their results are given below:

1. Determination of penetration value of bitumen.

The test results obtained from penetration value test of bitumen with and without plastic content for different percentages of waste plastic mixed with bitumen are:
I. Without plastic content, the penetration value obtained in three attempts are 40 seconds, 38 seconds and 37 seconds.
II. With 6 percent plastic present in bitumen, the penetration value obtained in three attempts are 59 seconds, 63 seconds and 61 seconds.
III. With 8 percent plastic present in bitumen, the penetration value obtained in three attempts are 76 seconds, 74 seconds and 75 seconds.

2. Determination of ductility of bitumen.

The test results obtained from penetration value test of bitumen with and without plastic content for different percentages of waste plastic mixed with bitumen are:
I. Without plastic content the ductility value obtained is 83 cm.
II. With 5 percent plastic present in bitumen the ductility value obtained is 68 cm.
III. With 10 percent plastic present in bitumen, the ductility value obtained is 57 cm.
This experiment shows that ductility is decreasing with addition of plastic. This maybe

due to better interlocking of particles in the mix due to plastic.

3. Determination of penetration value of bitumen.

The test results obtained from penetration value test of bitumen with and without plastic content for different percentages of waste plastic mixed with bitumen are:
I. Without plastic content, the penetration value obtained in three attempts are 8.5mm, 8.7mm and 8.6mm.
II. With 6 percent plastic present in bitumen, the penetration value obtained in three attempts are 6.4mm, 6.3mm and 6.35mm.
III. With 8 percent plastic present in bitumen, the penetration value obtained in three attempts are 6.3mm, 6.1mm and 6.2mm.

4. Determination of viscosity value of bitumen sample.

The test results obtained from penetration value test of bitumen with and without plastic content for different percentages of waste plastic mixed with bitumen are:
I. Without plastic content, the penetration value obtained in three attempts are 40 seconds, 38 seconds and 37 seconds.
II. With 6 percent plastic present in bitumen, the penetration value obtained in three attempts are 59 seconds, 63 seconds and 61 seconds.
III. With 8 percent plastic present in bitumen, the penetration value obtained in three attempts are 76 seconds, 74 seconds and 75 seconds.

6. CONCLUSION

Utilizing waste plastic in flexible pavement offers several benefits, including:

1. By incorporating waste plastic into flexible pavement, we can mitigate the environmental impact of plastic waste.

2. The addition of waste plastic can enhance the properties of asphalt mixtures, such as increased flexibility, durability, and resistance to rutting and cracking. This can lead to longer pavement service life and reduced maintenance costs.

3. Using waste plastic as a modifier in pavement construction can potentially lower material costs, as well as reduce the need for virgin polymers or other additives. This contributes to more economical pavement solutions.

4. Incorporating waste plastic into pavement materials can reduce the consumption of fossil fuels typically used in asphalt production, thereby conserving energy and lowering greenhouse gas emissions.

In conclusion, integrating waste plastic into flexible pavement offers a sustainable and cost-effective solution that improves pavement performance while addressing environmental concerns associated with plastic waste disposal.

7. REFERENCES

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8. SCOPE OF FUTURE WORKS

The future holds exciting potential for further advancements in utilizing plastic waste in flexible pavement. Some areas for future exploration include:

1. Optimization of plastic types and blends: Investigating the effects of different types of plastic waste and their blends on pavement performance can lead to the development of optimal mixtures that offer the best combination of durability, flexibility, and other desirable properties.

2. Enhanced testing and standards: Developing standardized testing protocols specifically tailored to assess the performance of plastic-modified pavements will be crucial for ensuring consistency and reliability in pavement design and construction.

3. Long-term performance monitoring: Conducting comprehensive field studies to monitor the long-term performance of plastic-modified pavements under real-world conditions will provide valuable insights into their durability, maintenance requirements, and environmental impact over time.

4. Innovative processing techniques: Exploring innovative processing techniques, such as microwave or chemical treatments, to enhance the compatibility and effectiveness of waste plastic modifiers in asphalt mixtures can further improve pavement performance and sustainability.

5. Integration with other sustainable materials: Investigating synergies between waste plastic and other sustainable materials, such as reclaimed asphalt pavement (RAP), recycled tire rubber, or bio-based additives, can lead to the development of even more environmentally friendly and high-performance pavement solutions.

By addressing these research areas and collaborating across disciplines, the future of using plastic waste in flexible pavement holds great promise for advancing sustainable infrastructure practices and mitigating the environmental impact of plastic pollution.