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Laying of Bitumen Roads by Partial Replacement of Plastic

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Abstract:
Because plastic waste is non-biodegradable and poses a health risk, environmental engineers are now very concerned about how to dispose of it. One of the most used binding materials for road pavement nowadays is bitumen. Bitumen is primarily utilized as a binding material because of its superior binding qualities, waterproofing capabilities, and affordability when compared to alternative binders. It is well known, meanwhile, that it experiences a variety of distresses and struggles in hostile environments. Bitumen is typically mixed with several types of modifiers, like polymers and crumb rubber, to address these drawbacks. Because these modifiers are expensive and difficult to get, research is instead concentrating on waste plastic and polypropylene. Bitumen's stability, capacity, and water resistance are all increased when waste plastic is combined with it. In field conditions, the Marshal stability test is thought to be stimulating. After adding scrap plastic, the mix's flow and stability improve.

Keywords: Recycling waste, Sieved aggregates, Shredded Plastic, Bitumen, Carbon footprints

I. INTRODUCTION

Laying roads with partial replacement of plastic instead of bitumen involves incorporating shredded or granulated plastic waste into the bitumen mix used for road construction. This innovative approach aims to enhance road durability, reduce plastic waste, and potentially improve the roads resistance to wear and tear. The process involves melting plastic waste and blending it with bitumen to create a more resilient and eco- friendly road surface. By using recycled plastic, this revolutionary technique makes roadways more resilient and long-lasting than their conventional counterparts. With encouraging outcomes, the technology has been adopted in a number of nations across the world. What precisely are plastic roads, then? Recycled plastic materials, such as bags, containers, water bottles, and other non-biodegradable plastic products, are used to make plastic highways. The road is formed by mixing recycled plastic components with bitumen and asphalt, which are subsequently heated and melted.

Compared to conventional roads, this building style offers a number of advantages.

II.OBJECTIVES

There are 3 objectives in our project:

1.Bituminous roads and pavements gain strength and improved characteristics when plastic trash is used in them.

2.It would also benefit India as a way to handle the disposal of plastic and other road and pavement flaws, such as potholes, ruts, corrugation, etc.

3.The objectives of using partial replacement of plastic in road construction instead of bitumen include reducing environmental impact by recycling plastic waste, enhancing road durability, improving resistance to wear and tear, and potentially lowering maintenance costs.

III. NEED OF USING PLASTIC IN ROAD CONSTRUCTION

1. Recycling waste: Incorporating plastic waste into roads helps in managing and refusing non-biodegradable plastic materials that would otherwise contribute to environmental pollution.

2. Enhanced Durability: Plastic-modified roads tend to be more durable and resistant to damage from weather conditions, heavy traffic, wear and tear.

3. Reduced maintenance: Because plastic roads are stronger and more resilient to cracks and potholes, they may require less maintenance.

4. Environmental Benefits: Utilizing plastic in road construction reduces the demand for virgin materials like bitumen, thus conserving natural resources.
5. Cost-Efficiency: In some cases, using plastic in roads may result in cost savings due to the longer lifespan of the road and reduced maintenance requirements

IV. ENVIRONMENTAL BENFITS OF USING PLASTIC IN ROAD CONSTRUCTION

Plastic waste management: It provides a way to recycle and reuse plastic waste that might otherwise end up in landfills or the environment, reducing its negative impact.
Natural resource conservation: By replacing some bitumen with plastic, bitumen and other natural resources can be preserved and reliance on them is lessened.
Reduced Environmental pollution: Incorporating plastic in roads reduces the chances of plastic waste entering ecosystems, decreasing the potential harm to wildlife and marine life.

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Energy savings: The use of plastic in roads may reduce the energy required to produce and transport traditional road construction materials, thereby reducing the overall carbon footprint of road construction.

Since the building of plastic roads can create jobs and boost economic growth, this can be a great source of money for low-income communities.

V. PROCEDURE FOLLOWED TO LAYING OF ROAD IN MAJOR PROJECT

1. SITE PREPARATION

.

Site is allotted by our civil engineering department at our college as per our design required dimensions

CLEANING OF SITE

Site that is allotted to our project batch is cleaned by using broomsticks, axe, digging bar etc. The first step is to remove all the dust particles from site. The site is cleared and removed ostraca's that are in the site like plants, stones and trash.

DIMENSIONS USED

*Size of the wall 10.8 x 10.8 feet.
*Height of the wall is 1.3 feet.
*Width of the wall is 0.9 feet (12 cm).

DEIMENSIONS FOR PROFILE

*Excavation dimensions: 3.5 x 3 feet in size, 1 feet depth.
*Height of the profile is 2.9 feet (90 cm from top of the wall)
*Height of the wall bellow the profile is 1.3 feet.

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2.FOUNDATION PREPARATION

EXCAVATION FOR FOUNDATION

Marking of digging area is done by using lime powder. After the marking , dimensions are cross checked . Once after coming into clarity that marking is done as per the planning . The site is digged up to the 1 feet depth , 11 X 11 feet in size for a wall foundation using materials digging bar or crow bar , basket , grape hoe , measuring tape and pegs etc .

Figure 1: Foundation work

3 WALL CONSTRUCTION

For wall construction bricks are brought from store of size 10 x 10 cm . Mortar is prepared by using 1: 1.5 ratio . water is add 20% of the cement + sand weight . Generally it varies from 17% to 30 % of the weight. Mortar is mixed manually by our project members

Figure 2: Wall Construction

4 REFILLING AND COMPACTION OF SOIL

Soil is refilled in the empty area (inside the wall) by the tractor. soil is imported from outside and refilled layer by layer . For every layer proper compaction is done , to remove voids in the soil .

Compaction of soil is the process of mechanically increasing soil density. During the building process, this is an important step. Inadequate execution may cause soil settlement, which could lead to needless maintenance expenses or structural failure.

Figure 3: Refilling and Compaction of soil

5 TYPICAL LAYERS OF A FLEXIBLE PAVEMENT

Multiple layers make up flexible pavements, which are intended to disperse traffic loads and give roadways a long-lasting surface. These layers usually consist of

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Surface course: The topmost layer that has direct touch with traffic is this one. It is composed of asphalt concrete and gives the road longevity, smoothness, and resistance to skids. It is resistant to weathering and damage from traffic.
Below the surface course lies the binder course, which is also composed of asphalt but with a slightly coarser mix. It provides additional strength and durability, enhancing the pavement's ability to bear heavy traffic loads.
This layer serves as the primary load-bearing component and helps in distributing the traffic loads over a wider area. It's typically made of high-quality aggregates and can be constructed using asphalt-treated base, crushed stone, or gravel.
This is the bottom-most layer, consisting of the native soil or prepared earth. It acts as the foundation for the entire pavement structure and should possess good strength and stability to support the overlying layers

PREPARATION OF SUB GRADE
A layer of natural soil that has been prepared to withstand the forces from the layers above is known as the top soil or sub-grade. It is crucial to avoid overstressing the soil subgrade at any point. Near the ideal moisture content, it should be compacted to the desired density. In essence, the underlying ground is the sub-grade layer of a pavement. Another name for it is the "Formation Level," which is the point at which excavation stops and building begins.

PREPARATION OF SUB BASE COURSE
Subbase Course. the stratum that lies between the subgrade and base course. Although its primary purpose is structural support, it can also enhance drainage and reduce the number of particles from the subgrade that seep into the pavement structure.
Sub base is also prepared as the sub grade but sub grade is a existing soil and where sub base is a layer added additionally to support the sub grade.

8PREPARATION OF SURFACE COURSE OR WEARING COURSE
Asphalt concrete, which is a construction aggregate with a bituminous binder, makes up the top layer of flexible pavements. Usually, the base course is laid on the sub base, which is situated on the sub grade, and the wearing course is placed on the binder course.
After 15 seconds of mixing hot bitumen with plastic waste-coated aggregate, the mixture is transported for road construction.
VI MATERIALS USED FOR PREPARATION OF PLASTIC BITUMENIOUS MIX

1. MATERIALS USED IN LAYING OF ROADS
AGGRIGATES
Aggregates can be categorized based on their physical, chemical, and mineral characteristics. Physical characteristics are usually used by the paving industry to characterize performance. The mineral and chemical characteristics of an aggregate directly affect its physical characteristics.
local market will be the source of the aggregates required for the research project.

Figure 4 : Sieved aggregates

WASTE PLASTIC MODIFIERS
By decreasing the air gap between the aggregates and binding them together to prevent bitumen bleeding, modifiers are typically employed to improve the qualities of bituminous concrete mixes. Carry bags and rigid polythene bags are examples of plastic garbage that we employ as a plastic modifier in our study.

Figure 5 : Shredded Plastic

BITUMEN
In bituminous mixes, bitumen serves as a binding agent for the aggregates. In India, flexible pavement is often constructed using bitumen of grades 60/70 or 80/100. Grade 80/100 bitumen, which complies with ASTM criteria, was employed for the study.

PREPARATION OF PLASTIC COATED AGGREGATES
COLLECTION OF PLASTIC

Plastic can be collected from various sources like domestic, commercial & Public Sources.
Segregation: rubbish made of plastic that has been gathered from different sources is kept apart from other rubbish.
Cleaning procedure: Waste made of plastic is cleaned and allowed to dry.
Plastics will be chopped into tiny bits or shredded during the shredding process.

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Procedure for collection: The plastic garbage that is retained on a 2.36 mm IS sieve is gathered.

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COATED AGGREGATES WITH PLASTIC

The aggregates are heated at specified temperature of 130 to 160o C & then Shredded plastic added after some time the plastic is coated to aggregate.

Figure 6: Coated aggregates with plastic

VII. FLASH AND FIRE TEST

Figure 7: Flash and Fire Test

Apparatus:

The Pensky-Martens closed cup tester comes with a testing cup, lid, shutter, stirrer mechanism, and flame exposure device. It also has a thermometer. It is recommended to use a thermometer with a sensitivity of 0.1oC and a set range, often 0oC to 350oC.

RESULT

The bitumen's flash point is 200 0C.
The bitumen's fire point is 250 0C.

VIII. COST ESTIMATION.

Waste plastic is utilized for bitumen modification in the wet process and for coating over aggregates in the dry phase. In India, the collection of waste plastic usually involves a vast network of workers at different stages. Consequently, there is a distinct economy operating there.

As natural resources become less available, upgrading becomes more expensive. The application of this innovative method to road improvement proved beneficial and cost-effective, saving thousands of crores of rupees. Given that road quality and condition are deteriorating daily, there are a ton of opportunities for road upgrades in terms of both cost and quality.

IX. CONCLUSION

Modified Polymer Bitumen is utilized because it performs better.

X. REFERENCES

1.V. S. Punish and A. Veeraraghavan, Laboratory Fatigue Studies on Bituminous Concrete Mixed Utilizing Waster Shredded Plastic Modifier, Proceedings of 21st ARRB Transport Research (ARRB) & 11th Road Engineering Association and Australia Conference, Claims, Australia (2003) pp. 19-23

2.S. S. Varma, Roads from Plastic Waste, The Indian Concrete J. (2008) pp. 43-44

3.R. Vasudevan, Utilization of Waste Plastics for Flexible Pavement, Indian High Ways (Indian Road Congress), 34 (2006) p.

4.N. R. R. D. A., Ministry of Rural Development, GOI, Guidelines for use of Plastic Waste in Rural Road Construction (2007).

5.C. S. Bindu, Int. J. Engg. & Technol., 2(6), 379-387 (2010).

6.Indicative Operational Guidelines on Construction Polymer-Bitumen Road, Central Pollution Control Board, Ministry of Environment and Forests, Probes/101/2005-2006.

7.Handbook for PWD Engineers (Building & Road construction), Public Works Department, Mumbai (2002).

8.Source: M/S. Sahu Polymers, Akola, Maharashtra, India (2012).

9.Source: Sales Officer, HPCL, Akola, Maharashtra, India (2012).

10.Chief Engineer, PWD, Amravati. Maharashtra, Circular No. CE/Amt/Off. 2(1) (1)/Pri. Rates/407/Dt. 25/01/11. For Amravati Division (Amravati, Akola, Washim, Buldhana, Yavatmal), Maharashtra, India (2011).

 https://doi.org/10.5281/zenodo.14356377