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Use of Plastic in Road Construction

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Abstract: ***India a developing nation which is going through Rapid Infrastructure Development has done a significant progress in construction Industry.With around 6.3 million kilometers of roads covering the entire nation, India is now the country with the biggest road network in the world. India has many road networks which connects villages to districts, Districts to districts using district roadways. States are connects using state highways and national highways which connects multiple states on its way. With this type of infrastructure development in a country it becomes a very great factor of extensive growth of Commercial vehicle for transportation. In India up to 60% of total goods transportation is majorly done using Road Transportation, therefore it becomes very crucial to construct roads for the development of the country.***

Plastic waste or plastic pollution has emerged as one of the most significant threats or challenges in the world. While plastic material offers numerous benefits, it also comes with several drawbacks, and its disposal has turned into a critical issue for the world. Plastic is a material that does not decompose. It takes thousands of years to degrade and decompose which is a major threat to the world. It is the major ocean pollutant which harms the aquatic life and also the coastal regions. Micro-plastics can cause serious health risks. A million tons of plastic is thrown away in landfills which covers the landfills and is also a dangerous threat to the environment. This plastic waste can be used in bituminous road construction, Since bituminous plastics have a longer lifespan than conventional bituminous pavements, the aggregates can be coated with a bituminous plastic combination and utilized in road construction, which enhances the pavement's longevity.

I. INTRODUCTION

India has the largest road network in the entire world. Most of the goods transportation in India is done through road transportation. The infrastructure development plays a major role in country's growth. Using plastic can reduce the cost of bitumen as bitumen can be costly compared to plastic. The plastic once used is considered as a waste as it is either recycled or thrown away. This Bitumen can be used in road construction alongside discarded plastic, which greatly reduces plastic waste and may also offer benefits when added to road building. The benefits are as follows:

1) Long life: The Bituminous Plastic Road has a longer life compared to normal bituminous road. The life of roads can increase to 50%.
2) Durability: plastic roads are more resistant to wear and tear reducing the risk of cracks uniformity and potholes on roads.
3) Enhanced wear resistance: Utilizing plastic waste can enhance the wear resistance of the roads, decreasing the likelihood of damage caused by rainwater and flooding.
4) Enhanced Skid Resistance: Utilization of plastic in roads gives traction to the surface, increases road safety.
5) Lower Carbon Footprint: the use of plastic can reduce the plastic to a great extent decreasing the overall greenhouse gases release and also use of less bitumen which is also derived from the fossil fuels
6) Economical: Due to less use bitumen and less maintenance cost it proves to be very economical

With all the following benefits plastic the addition of plastic to a certain percentage can be proved advantageous to the bituminous mixture. Due to the accumulation of plastic in urban areas the plastic is available abundant in the landfills. The plastic is nothing but a waste if it cannot be recycled and reused. As the plastic is non degradable material or it takes thousand of years to decompose or breakdown.

With all the numerous benefits of plastic in road pavement the plastic can be modified according to the requirement. This modified plastic when mixed with the bitumen increases the properties of roads such as durability, flexibility and the overall performance of the pavement with increased life of the roads constructed using the modified mixture. This not only increases the lifespan of pavement but also can be very economical compared to the regular bituminous roads, which are also to be maintained time to time which increases the overall cost of the construction throughout the life.

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As this technology is not the latest but doing a certain modification in this method can also prove very beneficial to the pavements as it not only increases the properties of pavements but also reduce the plastic waste in landfills and can also be beneficial in the growth of many industries creatin employment in the country boosting the economy and also many industries which can convert waste to a very useful material. As it is seen that many countries Including India has started adopting this technology in road construction. India's first plastic road was constructed in the year 2002 in Kamaraj Nagar, Chennai using a technology developed by Dr. Rajgopalan Vasudevan, which was Later adopted across the country.

A. Objectives

There are multiple objectives regarding the use of plastic in bituminous road. Primary is increasing the use of plastic use in the road construction.

1) To evaluate the performance of standard Aggregates against bituminous coated aggregates along with Aggregates that are coated with both bituminous and plastic-coated Aggregates. Tests like the Los Angeles abrasion value test and Impact value tests are carried out on Aggregates, while tests including flash and fire point test and softening point test are conducted on the bitumen infused with and without plastic.
2) Following the completion of specific laboratory tests and identifying the ideal percentage of the plastic that can be utilized in road construction for improved performance while maintaining all properties of the pavement and boosting the effectiveness of the paved roads.
3) To use the plastic which is a major threat to the environment. To help in the proper disposal of plastic decreasing the environmental pollution and decreasing the burden of plastic disposal on the respective departments such as the government bodies and municipal corporation

Through the following fulfilment of the objectives the study provides you a valuable insight in the field of sustainable and environmental Infrastructure development for the future generations by understanding the feasibility in the usage of plastic waste in infrastructure development.

B. Methodology

This research throws the lights on the methods of the process that are followed in the using of plastic such as the source of plastic, segregation of plastic, cleaning process, shredding of plastic and collection of plastic

1) Source of Plastic: The sources of plastic can vary according to different locations and localities such as a landfill, recycling plant, Rag pickers and other sources.
2) Segregation of plastic: Once the source is detected the plastic that can be used for the construction of roads i.e. Low-Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE). the plastic used are carry bags, Sacks, Pouches of milk, carry bags, bottle caps and household items.
3) Cleaning of plastic: Once the plastic is sourced and segregated the plastic is cleaned to remove any kind of impurities and dirt which are accommodated on the plastic due to landfills. The plastic once cleaned is dried and to remove all the moisture present in plastic after washing. This step plays an important role as clean and dry plastic improves the adhesion properties and the plastics can be distributed evenly with the bituminous mixture and enhance the overall performance
4) Shredding of plastic: Once the plastic is clean and dry the shredding of plastic is done in which the plastic is shredded into the size of 2.36 mm. the plastic shredded is to be of same size for proper distribution and mixing with bitumen for proper homogeneous mixture.
5) Collection of plastic: Once the plastic is shred the, plastic passing IS Sieve 2.36 mm is collected and used for further process. The collected plastic is homogeneously mixed with bitumen mixed and the bitumen mixture is coated on the aggregate.

C. Testing Of Materials

Different tests are conducted on the aggregates and bitumen to determine the characteristics of the materials. Some of the tests include:

1) Tests Conducted on Aggregate: Los Angeles abrasion value test, Impact value test, Water Absorption Test and Specific Gravity test.
2) Tests conducted on Bitumen: Flash and Fire point Test, Softening Point test, and Penetration Value Test.

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Tests on Aggregates

- Los Angeles Abrasion Value: This test is used to find out Abrasion Resistance of Aggregates.
- Impact Test: To find out the hardness of Aggregates and sudden shocks and vibration on Aggregates.
- Water Absorption Test: This test is conducted to determine the aggregates' capacity to absorb water.
- Specific Gravity Test: This test is used to find out the density and porosity of the Aggregates.

Tests on Bitumen

- Flash And Fire Point Test: Establishes the ignition and combustion temperature of bitumen.
- Softening point Test: determine the temperature at which bitumen softens and becomes smooth.
- Bitumen Penetration test: this test measures the depth of penetration using a stanard needle to determine the grade of bitumen as well as softness and hardness.

D. Preparation Of Sample

All the aforementioned tests are conducted on standard Aggregates and the coated aggregates, and the comparative results are examined and the differences are identified. The tests are conducted on standard aggregates, Coated Aggregates, and Aggregates with Partial replacement at percentages of 10%, 20%, and 30%.

II. RESULTS

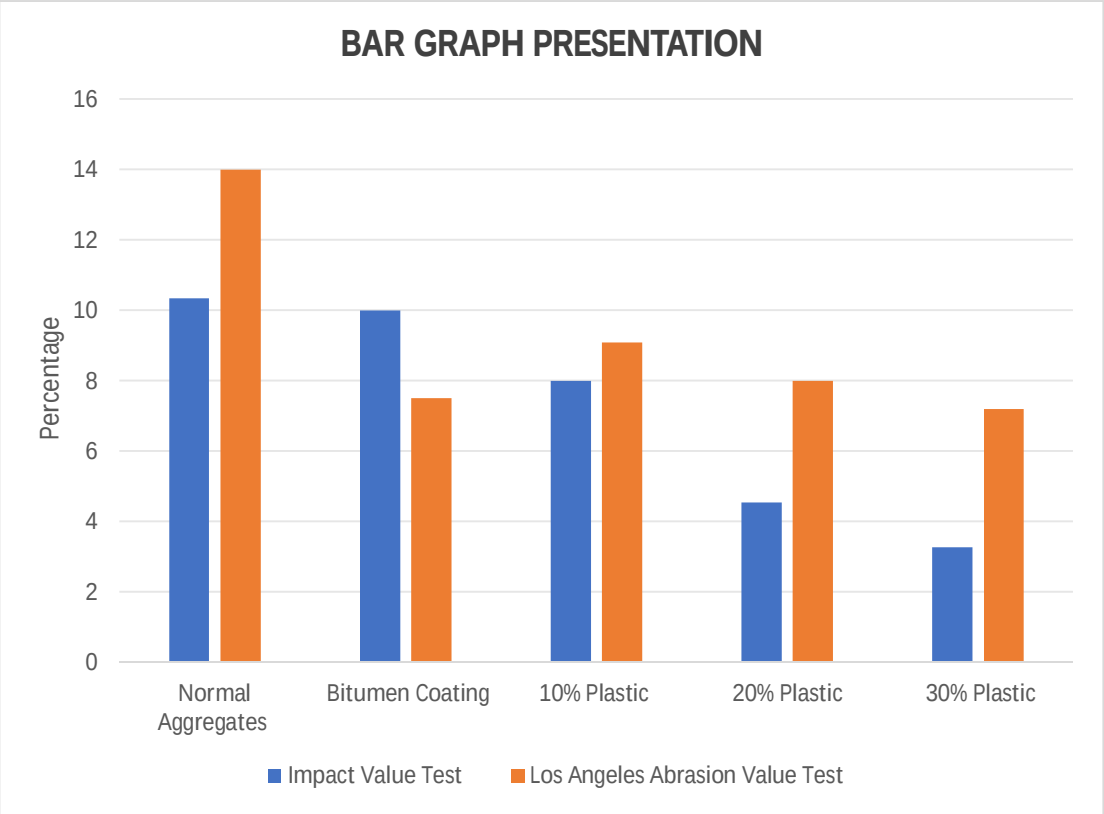
Results on aggregates Testing

Tests	Normal Aggregates	Aggregate with Bitumen Coating	Aggregate With 10% plastic Mix Bitumen Coating	Aggregate with 20% plastic Mix Bitumen Coating	Aggregate with 30% plastic mix Bitumen Coating
Impact Value Test (In Percentage)	10.34	10	8	4.54	3.26
Los Angeles Abrasion Value Test	14	7.5	9.08	8	7.2

Results on Bitumen

Tests	Normal Bitumen	10% Replacement	20% Replacement	30% Replacement
Softening Point Test (C)	55.5	65.2	68.5	70
Flash point (C)	54.2	62.3	71	73.7
Fire Point (C)	61.5	70.2	76.2	79.2
Penetration Test (mm)	45	41	39	37

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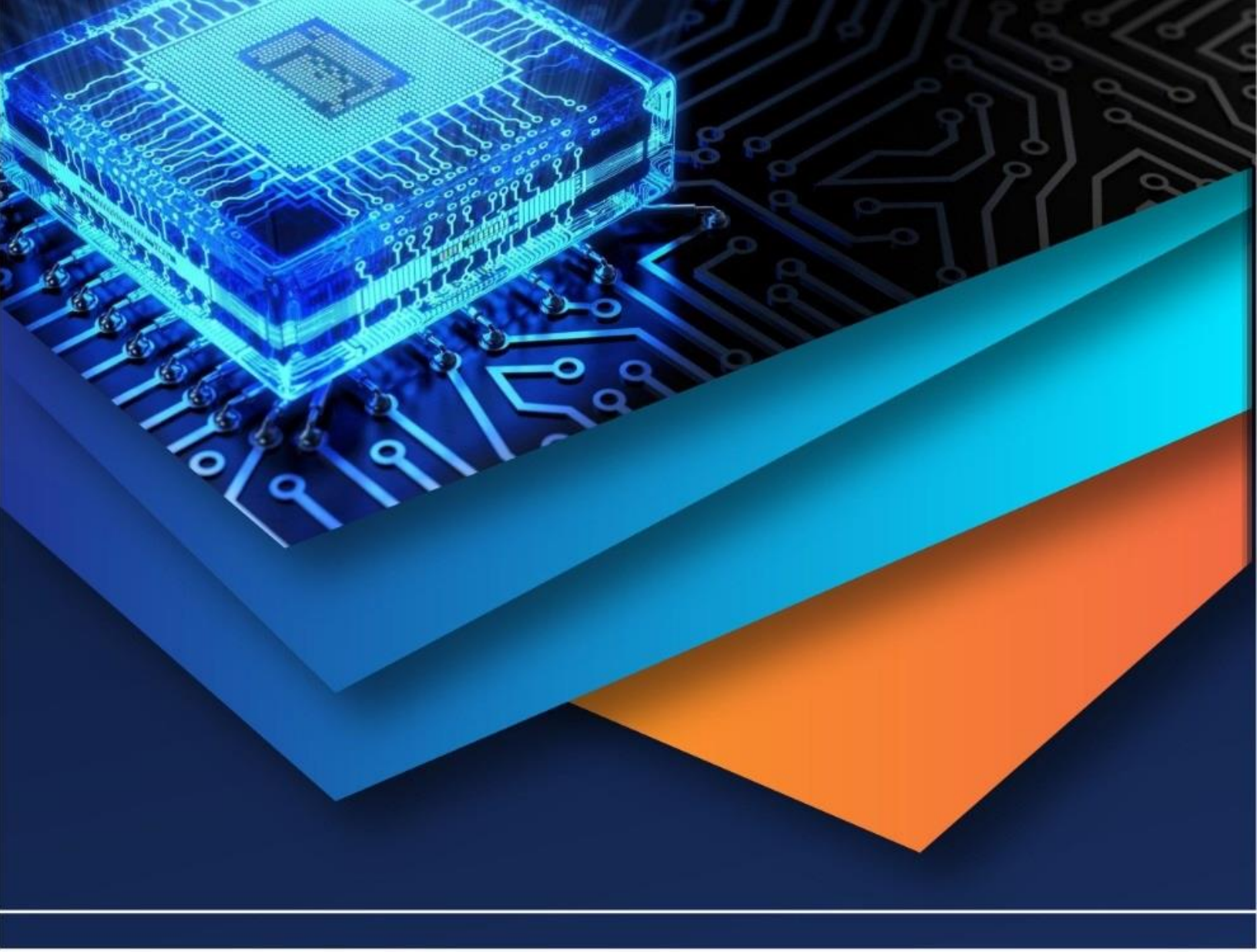
III. CONCLUSION

By conducting this research, it is concluded that utilizing plastic in road construction can be very advantageous for mitigating environmental degradation and decreasing the reliance on bitumen in road building. The pavements created with plastic bituminous materials offer numerous benefits and advantages in comparison to standard bitumen pavements. The performance of the plastic bituminous pavements is observed to be superior to that of conventional bituminous pavements.

In conclusion, the incorporation of plastic waste has been shown to be highly beneficial to the environment by diminishing the risks associated with plastic disposal to some extent. This also fosters the advancement of sustainable infrastructure projects for future generations. Such developments can establish a strong infrastructure framework within the transportation sector.

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