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UTILIZATION OF PLASTIC WASTE IN ROADWAY CONSTRUCTION

Subtitle: Utilizing plastic waste in roadway construction is an innovative approach that benefits both waste management and road quality. By incorporating a small amount of plastic (around 5-10% by weight) into bituminous mixes (asphalt), pavement stability, strength, and durability can be improved. These roads demonstrate good longevity and performance.

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Abstract: We face challenges and for developing countries like India, China, etc. The major problem they are suffering is the disposal of plastic waste and establishing a road network which is economical and durable with the help of this presentation we are trying to introduce various ways in which plastic can be utilized and since our project is mainly focusing on plastic roads, we have also explained various steps to be followed for using plastic in roads. With the help of this technology a major problem of disposal of plastics waste can be solved at the same time, using plastic in roads increases the strength and durability of roads, On the other hand it is economic pollution free and safe. Plastic technology has a wide range of scope. Since this can be used in cloth making, Rail Sleepers and also plastic can be used as construction material and if plastic roads are brought into regular practice this will increase the demand of transportation engineers who are aware of this technology. Increasing demand of plastics will also enhance the work of plastics pickers, hence solving the problem of employment.

Index Terms - Plastic-modified roads, Bitumen replacement, Strength enhancement, Environmental impact, Durability concern.

I. INTRODUCTION

India has a road network of more than 5,512,436 kilometers (3,425,268 mi) in 2019, the second largest road network globally. Adjusted for its huge population, India has less than 4.0 kilometers of roads per 1000 people, consisting of all its paved and unpaved roads. In terms of quality, all season, 4 or more lane highways, India has less than 0.08 kilometers of highways per 1000 people, as per 2015 statistics.

Plastic products are an essential component in our daily life as a basic need. One such approach is the usage of municipal plastic waste as binder in flexible pavements. Municipal waste, normally referred to as trash or garbage, is a combination of all the town's solid and semi-solid waste. It consists of particularly household or domestic waste, but it could also incorporate commercial and industrial waste. Much of isn't always recycled, and ends up in landfills or as clutter on land, in waterways and the ocean.

The estimate of 8 million tons of plastic being dumped into the oceans by 192 coastal nations in 2010 might appear staggeringly excessive, in fact the quantity would be many times more. Municipal plastic waste comprises of 65-75 percent of the total plastic waste generated in India. At twelfth position, India is one of the worst performers. It has dumped up to 0.24 million tons of plastic into the ocean every year; the quantity

of mismanaged plastic waste throughout year is 0.6 million tons. In the case of China, the No. 1 polluter, the coastal population sends up to 3.54 million tons of plastic waste into the oceans each year.

Plastic covered/coated may have equal or even additional stiffness than traditional bitumen, but without a large increase in flexibility. These modified mixes lessen the permanent deformation or rutting of the bituminous surface course beneath traffic loads. These offer better resistance to deformation underneath higher temperatures.

The technique involved in laying plastic roads begins with collection of plastic waste (bags, cups, bottles, etc.) produced from PE, PP, & PS which are separated, cleaned if needed and shredded to small portions (passing through 4.35mm sieve) The aggregate (granite) is heated to 170°C in the Mini Hot Mix Plant and the shredded plastic waste is added, it gets softened and coated over the aggregate. Immediately the hot Bitumen (160°C) is added and blended well. As the polymer and the bitumen are in the molten state (liquid state) they get mixed, and the blend is formed at surface of the aggregate. The mixture is transferred to the road and the road is laid. This technique is extended to the Central Mixing Plant.

The durability of the roads laid out with plastic waste is much more compared with roads with asphalt with the ordinary mix. Roads laid with plastic waste mix are found to be better than the conventional ones. The binding property of plastic makes the road last longer besides giving added strength to withstand more loads.

II. METHODOLOGY

Waste plastic waste were collected from roads, garbage trucks, dumpsites and compost plants, waste-buyers at Rs.5-6 per kg. Household plastic was also collected for the project work, like empty milk bags, used plastic bags etc. The collected Plastic waste was sorted as per the required thickness. Generally, polyethylene of 60 micron or below is used for the further process. Less micron plastic is easily mixable in the bitumen at higher temperature (160°c - 170°c). It is clean by de-dusting or washing if required. Collected Plastic was cut into fine pieces as far as possible. The plastic pieces were sieved through 4.75mm sieve and retaining at 2.36 mm sieve was collected. Firstly, Bitumen was heated up to the temperature about 160°c-170°c which is its melting temp. Pieces were added slowly to the hot bitumen of temperature around 160-170°c.The mixture was stirred manually for about 20-30 minutes. In that time period temperature was kept constant about 160-170°c. Polymer bitumen mixtures of different compositions were prepared and used for carrying out tests i.e. Penetration test, Ductility test, etc.

III. RESULTS

1. Tests on Aggregate (Table No. 1)

Stone Aggregate	Plastic Content (%)	Aggregate Impact Value	Los Angeles Abrasion Test	Water Absorption Test	Flakiness Index Test	Elongation Index Test	Crushing Value Test
Without Plastic	0	24.02%	30.11%	1.11%	10.20%	9.38%	24.67%
With Plastic	3	23.39%	29.53%	1.09%	10.25%	9.43%	22.38%
	9	22.68%	26.88%	1.27%	10.24%	9.62%	21.53%

2. Tests on Bitumen (Table No. 2)

Bitumen + Aggregate + Plastic	Plastic Content (%)	Penetration Value Test	Ductility Test	Flash and Fire Point Test	Softening Point Test
Without Plastic	0	38.33 mm	63.93 cm	241 °C	54.87 °C
With Plastic	3	37.87 mm	68.43 cm	252 °C	57.73 °C
	9	32.47 mm	74 cm	270 °C	60.67 °C

3. Marshall Stability Test (Table No. 3)

Bitumen + Aggregate + Plastic	Plastic Content (%)	Marshall Stability (kg)
Without Plastic	0	1151.83
With Plastic	3	1201.61
	9	1312.47

IV. CASE STUDIES IN INDIA

Laboratory studies were carried out at the Centre for Transportation Engineering of Bangalore University, in which the plastic was used as an additive with heated bitumen n different proportions (ranging from zero to 12% by weight of bitumen) The results of the laboratory investigations indicated that, the addition of processed plastic of about 8.8% by weight of bitumen, helps in substantially improving the stability, strength, fatigue life and other desirable properties of bituminous concrete mix, even under adverse water-logging conditions. The additions of 8.0% by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.4% bitumen by weight of the mix or about 9.6% bitumen per cubic meter of BC mix.

In Tamil Nadu, length of roads around 1000 m in various stretches were constructed using waste plastic as an additive in bituminous mix under the scheme “1000 Km Plastic Tar Road”, and found that, the performance of all the road stretches are satisfactory.

The performance of the road stretches constructed using waster plastic in Karnataka is also found to be satisfactory. The construction of rods using waste plastic in the above states is based on the guidelines developed by Bangalore University. CRRI and College of Engineering, Madurai. However, standard specifications are not available on the use of waste plastic in Bituminous Road Construction. In this regard, IRC was specially requested by NRRDA for the preparation of such Guidelines for enabling the construction of rural roads under PMGSY using waster plastic. In order to facilitate the development of guidelines on this, an expert group has been appointed by NRRDA for preparation of interim guidelines for the use of waste plastic which will be sent to IRC for approval and releasing as IRC guidelines.

V. COST ANALYSIS FOR ROAD CONSTRUCTION

MATERIAL NEEDED	MATERIAL NEEDED	PLASTIC-TAR ROAD
80/100 Bitumen	11250Kg	10125Kg
Plastic waste	NIL	1125Kg
Cost	Rs.393750	(BIT)Rs.354375+(plastic)Rs.13 500 = Rs. 367875
Cost Reduced	NIL	Rs. 25875.00
Carbon Credit Achieved on avoiding burning of plastics	NIL	3.5tonnes

VI. CONCLUSION

The generation of waste plastics is increasing day by day. The major polymers namely polyethylene, polypropylene, polystyrene show adhesion property in their molten state Plastics will increase the melting point of the bitumen. The waste plastic bitumen mix forms better material for pavement construction as the mix shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for pavement is one of the best methods for easy disposal of waste plastics.

The use of the innovative technology not only strengthened the road construction but also increased the road life as well as will help to improve the environment and creating a source of income.

Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. It is hoped that in the near future we will have strong, durable and eco-friendly roads which will relieve the earth from all type of plastic-waste.

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