PLASTIC WASTE: IT'S USE IN CONSTRUCTION OF ROADS

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ABSTRACT

Plastic waste is one such resource, a major component of solid waste which is abundantly available and disposed of without proper treatment. There has been an exponential growth in municipal plastic waste disposal especially in urban areas which deteriorates the beauty of the landscape.Plastic was found to be an effective binder for bitumen mixes used in flexible pavements. This efficient method helps the pavements to resist higher temperature by minimizing the formation of cracks and reducing rainwater infiltration which otherwise leads to development of potholes. These pavements have shown improved crushing and abrasion values and reduced water seepage. 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.

Keywords: Plastic Wastes,Polyethylene (PE), Polypropylene (PP) And Polystyrene (PS), Bitumen, Asphalt Etc.,

I. INTRODUCTION

India has a road network of over 4,689,842 kilometres (2,914,133 mi) in 2013, the second largest road network in the world. Adjusted for its large population, India has less than 3.8 kilometres of roads per 1000 people, including all its paved and unpaved roads. In terms of quality, all season, 4 or more lane highways, India has less than 0.07 kilometres of highways per 1000 people, as per 2010 statistics.

Plastic products are an integral part in our daily life as a basic need. One such method isusing of municipal plastic waste as binder in flexible pavements. Municipal waste, commonly knownas trash or garbage, is a combination of all of a city's solid and semisolid waste. It includes mainlyhousehold or domestic waste, but it can also contain commercial and industrial waste.Much of it is not recycled, and ends up in landfills or as litter on land, in waterways and the ocean.

The estimate of eight million tonnes of plastic being dumped into the oceans by 192 coastal countries in 2010 may appear staggeringly high, in reality 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 amount of mismanaged plastic waste per year is 0.6 million tons. In the case of China, the No. 1 polluter, the coastal population sends up to 3.53 million tons of plastic waste into the oceans each year.

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Plastic coated may have same or even higher stiffness than conventional bitumen, but without a large increase in flexibility. These modified mixes reduce the permanent deformation or rutting of the bituminous surface course under traffic loads. These offer better resistance to deformation under at higher temperatures.

The process involved in laying plastic roads begins with collection of plastic waste (bags,cups, thermocole) made out of PE, PP, & PS which are separated, cleaned if needed and shredded to small pieces (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 mixed well. As the polymer and the bitumen are is 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 Central Mixing Plant too.

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. While a normal highway quality road lasts 4-5years it is claimed that plastic-bitumen roads can last up to 10 years. Rainwater will not seep throughbecause of the plastic in the tar. So, this technology willresult in lesser road repairs. And as each km of road with an average width requires over two tons of polyblend, using plastic will help reduce on-biodegradable waste.

In recent years, applications of plastic wastes have been considered in road construction with great interest in many developing countries. The use of these materials in road making is based on technical, economic, and ecological criteria. In the state of Maharashtra they laid the test road of length up to 1,500 km. Other states like Tamil Nadu, Karnataka, Pondicherry, Kerala and Andhra Pradesh have also laid test roads. These roads have withstand loads due to heavy traffic, rain and temperature variation.

Population Growth and Impact on Overall Waste Generation and Future Predictions until 2041:

Year	Population (Millions)	Per Capita	Total Waste generation Thousand Tons/year
2001	197.3	0.439	31.63
2011	260.1	0.498	47.3
2021	342.8	0.569	71.15
2031	451.8	0.649	107.01
2036	518.6	0.693	131.24
2041	595.4	0.741	160.96

GRAPHS:-

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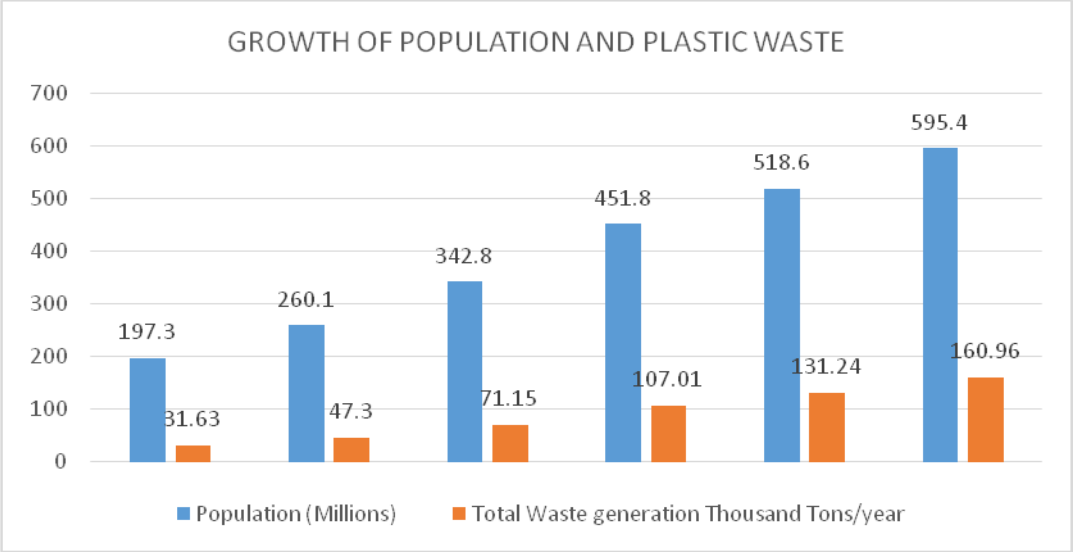

Tests conducted on materials :-

1. Bitumen

i) Penetration Test – 35 mm

ii) Ductility Test – 6.5 N/mm2

iii) Softening Point Test – 70˚ C

iv) Flash & Fire Point – 265˚ C & 290˚ C

2. Aggregate

- ✓ Specific Gravity - 2.82
- ✓ Water Absorption Test - 2.1 %
- ✓ Impact Value Test - 8.77 %
- ✓ Abrasion Test – 15.7 %

3. Plastic

Type Of Plastic	Chemical Formation	Density (gm/cm3)	Softening point
Low Density Poly ethylene Plastic (LDPEP)	(-CH2-CH2-)n	0.9 to 0.95	100˚ C to 120˚ C
High Density Poly-ethylene Plastic (HDPEP)	(-CH2=CH2-)n	0.95 to 0.96	120˚ C to 130˚ C

II. METHODOLOGY

Waste plastic bags 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

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pieces as far as possible. The plastic pieces were sieved through 4.75mm sieve and retaining at 2.36mm 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.

III. PROPERTIES OF THE MIX

Coating of plastic over aggregate to the tune of 10-15% by weight of bitumen improves the binding properties of the mix:

- ✓ It gives higher softening point and lower penetration point due to interlinking of polymer molecule with bitumen.
- ✓ Lesser moisture absorption capacity due to coating of plastics at the surface.
- ✓ Higher ductility.
- ✓ Better stripping value (No stripping even soaking in water for 72 hrs)
- ✓ High compressive strength (>100mpa) and high flexural strength (>450 Kg/cm)
- ✓ The roads are twice as strong as normal roads and resistant towards water

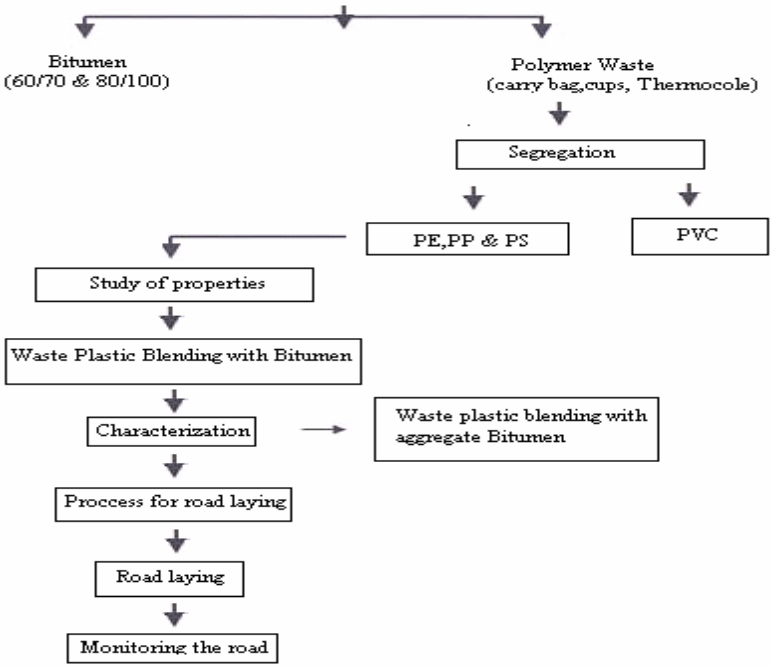
Stagnation and lesser bleeding.

Polymer blended Bitumen shows higher Softening point, lower penetration point, and better ductility.

Polymer coated aggregate blended with Bitumen shows higher Marshall value and better stripping.

IV. FLOW CHART SHOWING METHOD FOR CONSTRUCTION OF ROAD:

Rawmaterial



V. COMPARISION BETWEEN THE STRENGTH:-

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TEST	BITUMEN ROAD	PLASTIC TAR ROAD	REASONING – PLASTIC TAR ROAD
Skid Resistance <65	More than the expected value 76	Within the limit 45	Not very smooth – supported by texture value
Sand Texture .6-.8	More depth 0.83	Less depth >0.6	Due to bonding- in permissible limit
Roughness 4000	More bumps 5200	Less Bump >4000	Better binding- less rutting and raveling
Density 2.86	Moderate 2.88	Moderate Value 2.55	Better binding

VI. CONSUMPTION OF PLASTICS

Length	Width	Height	Waste plastics needed
1000m	2m	2.5 cm	50 ton
15 cm	15 cm	2.5cm	0.3Kg

VII. COST ANALYIS 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

VIII. CONCLUSION

Plastics increase the melting point of the bitumen. The use of this plastics 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 .It is hoped that in near future we will have strong, durable and eco-friendly roads which will relieve the earth from all type of plastic-waste.

IX. FUTURE SCOPE

As the population increases, the solid waste also increases proportionally.The best alternative is the usage of waste as construction material assuring a good disposal. As this method is economicthe practice would be on satisfactory extent aiding the future generations for a good solid waste management.

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