



Study of Optimum Use of Waste Plastic For Flexible Pavement A CASE STUDY

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Abstract

This study purposes use of low density polyethylene (LDPE). 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. In this study Plastic coated aggregate is mixed with different percentage of bitumen and marshal stability test is performed. The study reveals that the stability and flow value of bituminous concrete in road increases with use of plastic coated aggregate. 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.

Key words: LDPE, flexible pavement, marshal stability

Introduction

Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. In the mean time, the plastic pollution in the ocean will be doing untold damage to wildlife. There is a giant plastic island in the ocean called the Great Pacific Garbage Patch that measures 1.6 million square kilometers, about the size of Mexico and 80000 tons of plastic (which is four times previous estimates). Over 1 million marine animals (including mammals, fish, sharks, turtles and birds) are killed each year due to plastic debris in the oceans around the world. Use of waste plastic in the bituminous concrete may help to reduce the amount of plastic available in the environment. Plastic roads are more durable, weather resistance and increase the strength and performance of the road.

Materials and Methodology

Plastic: Plastic is available in different categories which includes PS (Polystyrene), PP (polypropylene) PE (polyethylene), PVC (poly vinyl chloride), Based on their categories these are having various properties such that melting temperature, chemical structure, bond, toxicity, durability, degradation.

LDPE is used because its melting temperature is less than other categories of plastic. LDPE is widely used for manufacturing various containers, dispensing bottles, wash bottles and various molded laboratory equipments. Its most common use is in plastic bags. If we able to recycle and reuse the LDPE, it will change our environment condition and helps to rid off from single use plastic.

Table-1 Category and properties of plastic

Category of plastic	Melt temperature	Mould temperature	Density(gm /cm ³)	General properties
LDPE	180-240	20-60	0.925	Low melting point, good moisture barrier property, tough and flexible
HDPE	210-270	20-60	0.959	Hard and semi flexible, excellent moisture and chemical resistance
PET	260-280	20-30	1.38	Hard and tough, high heat resistance, solvent resistance
PS	250-290	40-80	1.05	Hard and brittle, affected by fats and solvents



Figure-1

The basic Marshall test consists essentially of crushing a cylinder of bituminous material between two semi-circular test heads and recording the maximum load achieved (i.e. the stability) and the deflection at which the maximum load occurs (i.e. the flow).

Waste plastic is collected and LDPE is separated out. After separating, LDPE is dried and shredded. Shredded plastic is added to the heated aggregate (temperature should be in range of 130-160⁰c). Mixing of aggregate and 8% plastic to be done such that a layer of plastic formed on the aggregate surface. After mixing, bitumen is heated at a temperature of ranging 90-110⁰c. Again mixing is done and pre heated moulds of marshal stability test are filled. By using compactor or rammer of weight 4.5kg blows are applied on both sides (75 blows on each side). After 24 hours sample is ejected from mould then weight of sample is taken including its submerged weight and saturated weight and sample is put in water bath for 30 to 60 minutes at a temperature of 60⁰C. After water bath sample is taken out the sample was then placed on Marshall Stability testing machine and loaded at constant deformation rate of 5mm per minute until it failed & note down stability and flow value.



Figure-2

RESULT

The marshal stability test was done to compare properties of normal bitumen mix (without plastic coated aggregate) and modified plastic bitumen mix (with plastic coated aggregate).

Table 2. Marshall Stability Test result for normal bitumen mix (without plastic coated aggregate)

Bitumen content	4.50%	5.00%	5.5%.
Diameter (mm)	101.6	101.6	101.6
Height (mm)	64	63.5	62
Area (mm ²)	8110.58	8110.58	8110.6
Volume (mm ³)	519077	515022	502856
Normal weight (gm)	1177	1219	1236
Submerged weight (gm)	715	740	760
Saturated weight (gm)	1205	1257	1268
Stability (kg)	447	476	565
Flow (mm)	3.7	3.4	3.2
Corrected stability value (kg)	449.23	476	587.6

Table 3. Marshall Stability Test result for modified bitumen mix (with plastic coated aggregate)

Bitumen content	4.50%			5.00%			5.50%		
Sample no.	Sample1	Sample2	Sample3	Sample1	Sample2	Sample3	Sample1	Sample2	Sample3
Diameter (mm)	101.6	101.6	101.6	101.6	101.6	101.6	101.6	101.6	101.6
Height (mm)	72	71.5	73	74	72	72.5	72.5	67	60
Area (mm ²)	8110.5	8110.5	8110.6	8110.5	8110.6	8110.6	8110.6	8110.6	8110.6
Volume (mm ³)	583962	579907	592073	600183	583962	588017	588017	543409	486635
Normal weight (gm)	1226	1284	1220	1250	1270	1314	1245	1266	1108
Submerged weight (gm)	700	715	700	710	725	745	725	735	650
Saturated weight (gm)	1301	1326	1266	1289	1304	1365	1281	1300	1149
Stability (kg)	322.2	358.8	388.2	729.1	699.4	645.3	950	832.3	979.4
Flow (mm)	2.2	2.1	5.2	5.3	5	4	4	2.5	4.3
Corrected stability value (kg)	277.1	308.5	333.8	627.0	601.4	554.9	817	774.1	1067.6
Average flow value (mm)	3.16			4.76			3.6		
Average stability value (kg)	306.5			594.5			886.2		

CONCLUSION :-

Plastic waste disposal is a major concern and one such effective measure to dispose off non-biodegradable plastic is to recycle it. Use of plastics in road construction has gained momentum in recent times. The study reveals that the stability value of bituminous concrete in road increases by 50%. (High marshal stability means high resistance to permanent rutting.) The optimum content of plastic for this strength gain was found to be 8% experimentally. Also addition of in bitumen concrete can save bitumen by 0.5%. Thus we may conclude that non-biodegradable plastic may be conveniently used in the coating of aggregates in bituminous concrete and it withstand with heavy traffic and show better durability.

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