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Use of Non-Biodegradable Material in Bituminous Pavements

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Abstract : *Plastics are everywhere in today's lifestyle and are growing rapidly throughout particularly in a developing country like India. waste plastics are burnt for apparent disposal which cause environmental pollution. As these are non-biodegradable material there is a major problem posed to the society with regard to the management of these solid wastes. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned and cut into a size such that it passes through 4.75-2.36mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used in wearing coarse in flexible road pavement. Tyre waste which is cut into a size such that it passes through 22.4-6mm sieve using rubber cutting machine. This crumb rubber as an rubber aggregates for base course. This rubber aggregate is mixed with stone aggregate & hot bitumen at 160^{0}c and the resulted mix is used in base coarse in flexible road pavement .In the present study, an attempt has been made to use reclaimed polyethylene which has been obtained from plastic packets and waste tyre used in dry form with the aggregates like a fiber in a bituminous mix. Detailed study on the effects of these locally waste polyethylene on engineering properties of bituminous mixes, has been made in this study.*

Keywords: *Waste Plastic, Crumbed Rubber , Aggregate , Bitumen.*

I. Introduction

Plastic and tyre is a non-biodegradable material. Despite, the quantum of plastic waste is also increasing day by day which is hazardous to our health. Thus using plastic waste for construction purpose of flexible pavements will be one of the alternatives for disposing them in an eco-friendly manner. The plastic waste in a road pavement in Bangalore city. Today, every vital sector of the economy starting from agriculture to packaging, automobile, building construction, been virtually revolutionized by the applications of communication or InfoTech has plastics.

Plastic in different form is found, which is toxic in nature. It is commonly collected both urban and rural areas. It creates stagnation of water and associated hygiene problems. Plastic waste hazard to the environment .Plastic waste can be reused productively in the construction of road. Post construction pavement performance studies are to be done for these waste materials for construction of low volume roads with two major benefits (i) it will help clear valuable land of huge dumps of wastes: (ii) it will also help to preserve the natural reserves of aggregates, thus protecting the environment. Rubber tyres are user friendly but not eco-friendly as they are non-biodegradable generally.

1.1 Research Problem

To utilize the waste plastic & waste tyre and reduce the problem created in the environment by this Non-biodegradable Material &To reduce the cost of construction of road pavement & increase the strength of the road.

II. Literature Review

Justo et al (2002),At the Centre for Transportation Engineering of Bangalore University on the possible use of the processed plastic bags as an additive in bituminous concrete mixes. The properties of the modified bitumen were compared with ordinary bitumen. It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive, up to 12 % by weight. Therefore the life of the pavement surfacing course using the modified bitumen is also expected to increase substantially in comparison to the use of ordinary bitumen.

Niraj D. Baraiya, Volume 2, Issue 7, July 2013 ISSN 2319 – 4847,He reported that the waste tyres can be used as well sized aggregate in the various bituminous mixes if it is cut in the form of aggregate and can be

called as rubber aggregate. This not only minimizes the pollution occurred due to waste tyres but also minimizes the use of conventional aggregate which is available in exhaustible quantity

Ms. Apurva Chavan (2013*)* says that using plastic waste in mix will help reduction in need of bitumen by around 10%,increase the strength and performance of road, avoid use of anti stripping agent, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco friendly.

III. Objectives

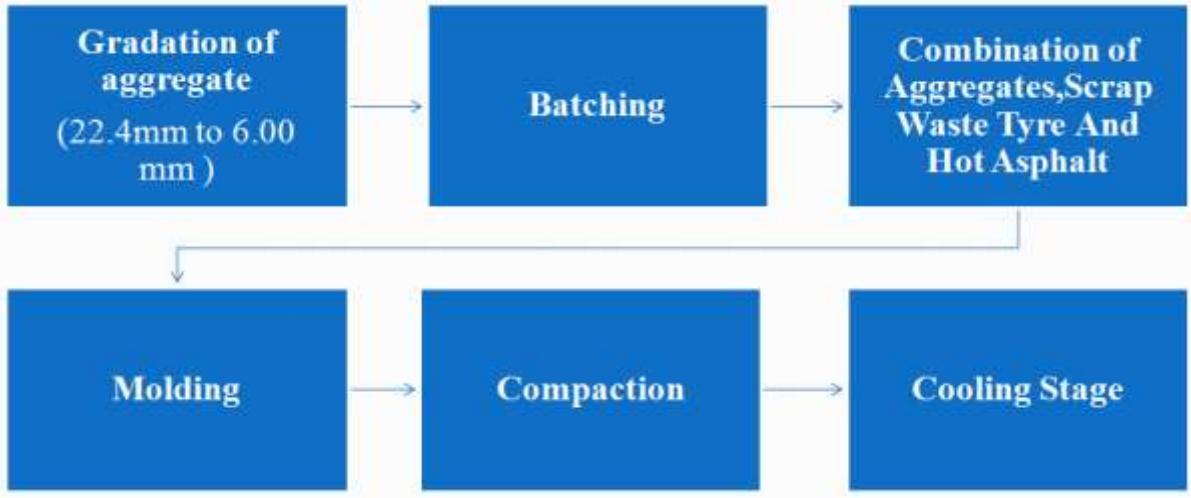
1. To study effect of addition of plastic in bitumen mix on various test for strength of bitumen mix.
2. To study effect of coating of plastic on aggregates on various test of aggregates.
3. To compare the strength of bitumen and aggregates with conventional methods.
4. To study effect of crumb rubber as an rubber aggregate in bitumen mix for base course.

IV. .Components Of Road Construction material

1. **Bitumen :**
   - Grades VG30
2. **Aggregate mix:**
   - Coarse Aggregate
   - Fine Aggregate
3. **Modifier *:***
   - Polymers (2.36mm to 6mm)
   - Crumb Rubber Tyre (5.4mm to 22mm)

V. Methodology

5.1 Flow Chart For Waste Tyre Road Laying Dry Process:-1 (Base Coarse)



5.1.1 The collected waste tyres were sorted as per the required sizes for the aggregate. The waste tyres were cut in the form of aggregate of sizes ranging from 22.4mm to 6.00 mm (as per IRC-SP20) in the tyre cutting machine which is shown in picture 1.

fig no.5.1

5.1.2 The rubber of tyre usually employed in bituminous mix, in the form of rubber particles are subjected to a dual cycle of magnetic separation, then screened and recovered in various sizes and can be called as Rubber aggregate.

fig no.5.2

5.1.3 The rubber pieces (rubber aggregate) were sieved through 22.4 mm sieve and retained at 5.6mm sieve as per the specification of mix design and these were added in bituminous mix, 10 to 20 percent by weight of the stone aggregate.

5.1.4 These rubber aggregate were mixed with stone aggregate and bitumen at temperature between 160^0c to 170^0c for proper mixing of bituminous mix.

5.2 Flow Chart For Plastic Tar Road Laying Dry Process:-2 (Wearing Coarse)

5.2.1 MIXING PROCEDURE AT HOT MIX PLANT

5.2.1.1 Plastics waste like bags, bottles made out of PE and PP cut into a size between 2.36 mm and 4.75mm using shredding machine. Care should be taken that PVC waste should be eliminated before it proceeds into next process.

5.2.1.2 The aggregate mix is heated to 165°C and then it is transferred to mixing chamber. Similarly the bitumen is to be heated up to a maximum of 160°C. This is done so as to obtain a good binding and to prevent weak bonding. During this process monitoring the temperature is very important.

5.2.1.3 At the mixing chamber, the shredded plastics waste is added over the hot aggregate. It gets coated uniformly over the aggregate within 30 to 45 seconds. It gives an oily coated look to the aggregate.

5.2.1.4 The plastics waste coated aggregate is mixed with hot bitumen. Then this final resulted mix is used for laying roads. The road laying temperature is between 110°C 120°C. The roller used should be of is 8-ton capacity.

5.2.2 Laying Process Of Bitumen Road

- preparation of existing surface
- spreading the plastic coated aggregate
- rolling
- bitumen application
- spreading of key aggregate
- seal coat
- finishing
- opening to traffic

VI. Experimental Program

6.1 Preparation Of Design Mix

Pavement Coarse	Sample Constitution	Sample Preparation	% Constituent by Weight of Aggregate
Base Coarse	Bitumen + (Rubber Aggregate + Stone Aggregate)	Dry Process	Rubber Aggregate :10%
			Rubber Aggregate :15%
			Rubber Aggregate :20%

Pavement Coarse	Sample Constitution	Sample Preparation	% Constituent by Weight of Bitumen
Wearing Coarse	Bitumen + (Plastic + Stone Aggregate at 165^0c)	Dry Process	Plastic:8%
			Plastic:10%
			Plastic:12%

6.2 Experimental Work

Following Tests were conducted to investigate the properties of the aggregate as well as bitumen.

6.2.1 Tests For Aggregate

6.2.1.1 Sieve Analysis of Aggregates

6.2.1.2 Specific Gravity & Water Absorption Test [IS: 2386 (Part 3) 1963]

6.2.1.3 Aggregate Impact Value Test [IS: 2386 (part 4) 1963]

6.2.1.4 Aggregate Crushing Value [IS: 2386 (Part 4) 1963]

6.2.1.5 Flakiness & Elongation Index Test [is: 2386 (part 1) 1963]

6.2.2 Tests For Bitumen

6.2.2.1 Penetration Test [Is: 1203-1978]

6.2.2.2 Softening Point Test [Is: 1205-1978]

6.2.2.3 Ductility Test [IS: 1208-1978]

6.2.2.4 Viscosity Test:

6.2.2.5 Flash Point and Fire Point

VII. Site Details

Experimental construction of 300 m long & 3.2 m wide bitumen road strip using plastic with bitumen
Venue*:* Gollibar Maidan Pune Cantonment Board.
Guidance: M. B. Sable Sir (Sectional Engineer) and Patil Sir

VIII. Outline Of Project Work

SR.NO	NAME OF WORK	TIME PERIOD
1	Selection of project topic And searching data related to project concept	August
2	Searching actual sites of Plastic road And Waste Tyre Road	August
3	Visit to CIRT (Central Institute of Road Transportation)	September
4	Visit to CSRL-STRUCTWEL LAB (PUNE)PVT. LTD (shivajinagar)	October
5	Visit To Plastic Road (Pune Cantonment board)	October
6	Permission taken from the manager of Hot Mix Plant (Ravet)	December
7	Preparing the Design	December
8	Finalize the proportion of Waste material And Bitumen Percentage	January
9	Finalize of layer thickness and its feasibility	January
10	Prepare the sample	February
11	Testing of sample And Analysis	March
12	Recheck the Sample Results	April
13	Submission of Final Report	April

IX. Advantages & Disadvantages

9.1 Advantages

1) Strength of the road increased & Better soundness property.
2) Better resistance to water & water stagnation.
3) No stripping & have no potholes.
4) Increased binding & better bonding of the mix.
5) Optimum content of waste rubber tyres to be used is between the range of 5% to 20%.
6) Addition of waste tyres as rubber aggregate modifies the flexibility of sub surface layer
7) Problem like thermal cracking and permanent deformation are reduce in hot temperature region.

8) Rubber has property of absorbing sound, which also help in reducing the sound pollution of heavy traffic roads.
9) Waste rubber tyres thus can be put to use and it ultimately improves the quality and performance of road.
10) Conventional stone aggregate can be saved to a certain quantity.
11) Maintenance cost of the road is almost nil.
12) No effect of radiation like UV.

9.2 Disadvantages

1) Cleaning process -Toxic present in the co-mingled plastic waste start leaching.
2) During the road laying process- the presence of chlorine will definitely release noxious gas.

X. Comparison

1. The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix.
2. While a normal 'highway quality' road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years.
3. Rainwater will not seep through because of the plastic in the tar.
4. The cost of plastic road construction may be slightly higher compared to the conventional method.
5. The maintenance cost is low as compared to conventional method.
6. It initial cost is slightly more as compared to conventional method.

XI. Conclusion

1. Plastic will increase the melting point of the bitumen.
2. This innovative technology not only strengthened the road construction but also increased the road life.
3. Plastic roads would be boon for India's hot & extremely humid climate, where temperature frequently cross 50°C.
4. Addition of waste tyres as rubber aggregate modifies the flexibility of surface layer.
5. Optimum content of waste rubber tyres to be used is between the range of 5% to 20%.
6. Problem like thermal cracking and permanent deformation are reduce in hot temperature region.
7. Rubber has property of absorbing sound, which also help in reducing the sound pollution of heavy traffic roads.
8. Waste rubber tyres thus can be put to use and it ultimately improves the quality and performance of road.
9. Conventional stone aggregate can be saved to a certain quantity

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