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USE OF WASTE PLASTIC IN CONSTRUCTION OF ROAD

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ABSTRACT

Of this various waste materials, plastic waste and municipal solid waste are of great concern. On the other side, the road traffic is increasing. The traffic intensity is increasing. The load bearing capacities of the road are to be increased. The present study investigates the potential use of waste plastic as a modifier for asphalt concrete and cement concrete pavement. Plastic waste, consisting of carry bags, cups etc can be used as a coating over aggregate and this coated stone can be used for road construction. Different ratios of plastic such as Polypropylene (PP), Low Density Polyethylene (LDPE), and High Density Polyethylene (HDPE) by weight of asphalt were blended with 80/100 paving grade asphalt. Unmodified and modified asphalt binders were subjected to rheological test. The performance tests including, Marshall Stability, loss of stability tests were conducted using plastic coated aggregates and polymer modified bitumen on HMA mixtures. Work has been done by using plastic coated aggregates in cement concrete pavements. The results showed better values for asphalt concrete. This is an eco-friendly process. The mix polymer coated aggregate have shown higher strength. Use of this mix for road construction helps to use plastics waste. Once the plastic waste is separated from municipal solid waste, the organic matter can be converted into manure and used. The main object of paper is to analyze & study how the waste plastic will be effectively utilized in construction of flexible pavement as a binder material for replacing the content of bitumen and in detail process & its successful application.

Keywords—Plastic waste, flexible pavement ,bitumen.

I. INTRODUCTION

In general there are two types of road rigid pavement roads and flexible pavement roads. For rigid roads material used is concrete and for flexible roads bitumen is used. In India mostly the flexible pavement roads are available. And for economical road construction new techniques, new material is used. The significant variation in daily and seasonal temperature demand improved road characteristics. Any improvement in the property of the binder is needed. Bitumen is a useful binder for road construction. Different grades of bitumen like 30/40, 60/70 and 80/ 100 are available on the basis of their penetration values. The steady increase in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demand improved road characteristics. Any improvement in the property of the binder is the needed. Today the availability of the waste plastics is enormous, as the plastic materials have become part and parcel of daily life. They either get mixed with Municipal Solid Waste and/or thrown over land area. If not recycled, their present disposal is either by land filling or by incineration. Both the processes have certain impact on the environment. Under this circumstance, an alternate use for the waste plastics is also the needed. Plastic waste when mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road. In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It also helps to improve the strength of the road. But its resistance towards water is poor. Anti-stripping agents are being used. A common method to improve the quality of bitumen is by modifying the rheological properties of bitumen by blending with organic synthetic polymers like rubber and plastics Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics can be divided in to two

major categories: thermoses and thermoplastics. A thermoset solidifies or “sets” irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobiles and construction applications. These plastics are polyethylene, polypropylene , polyamide, polyoxymethylene , polytetra fluorethylene , and polyethylene terephthalate. A thermoplastic softens when exposed to heat and returns to original condition at room temperature. Thermoplastics can easily be shaped and moulded into products such as milk jugs, floor coverings, credit cards, and carpet fibers. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane. Studies on this subject are going on both at national.

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II. STUDY OF WASTE PLASTIC

Waste plastics - as binder and modifier

130°C Thermo gravimetric analysis has shown that there is no gas evolution in the temperature range of 130-180°C. Moreover the softened plastics have a binding property. Hence, the molten plastics materials can be used as a binder and/or they can be mixed with binder like bitumen to enhance their binding property. This may be a good modifier for the bitumen, used for road construction.

egg boxes, disposable cups, protective packaging etc

Polyvinyl Chloride (PVC): mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders and pens; medical disposables; etc Need for the study

- Disposal of waste plastic is a major problem
- It is non-biodegradable
- Burning of these waste plastic bags causes environmental pollution.
- It mainly consists of low-density polyethylene
- To find its utility in bituminous mixes for road construction
- Laboratory performance studies were conducted Waste plastics (polythene carry bags, etc. on heating soften at around d on bituminous mixes. Laboratory studies proved that waste plastic enhances the property of the mix
- Improvement in properties of bituminous mix provides the solution for disposal in an useful way.

Different type of waste plastic (polymer) and its Origin Type of waste plastic (polymer) Origin

- Low density polyethylene (LDPE): bags, sacks, bin lining and Squeezable detergent bottles etc
- High density polyethylene (HDPE): bottles of pharmaceuticals, disinfectants, milk, fruit juices, bottle caps etc Polypropylene (PP): bottle cap and closures, film wrapping for biscuits, microwave trays for ready-made Meals etc.
- Polystyrene (PS): yoghurt pots, clear egg packs, bottle caps.
- Foamed Polystyrene: food trays

Materials used

1) AGGREGATE

· Aggregate of 20mm, 10 mm.

· Stone Dust and Lime as Filler

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2) BITUMEN

_ 60/70, 80/100 grade bitumen

3) WASTE PLASTIC: Waste plastic in the shredded form

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

i) Specific Gravity - 2.82

ii) Water Absorption Test - 2.1 %

iii) Impact Value Test - 8.77 %

iv) Abrasion test -15.7%

3.Plastic

Type Of Plastic	Chemical Formation	Density (gm/cm^3)	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

MIXING PROCEDURE AT HOT MIX PLANT

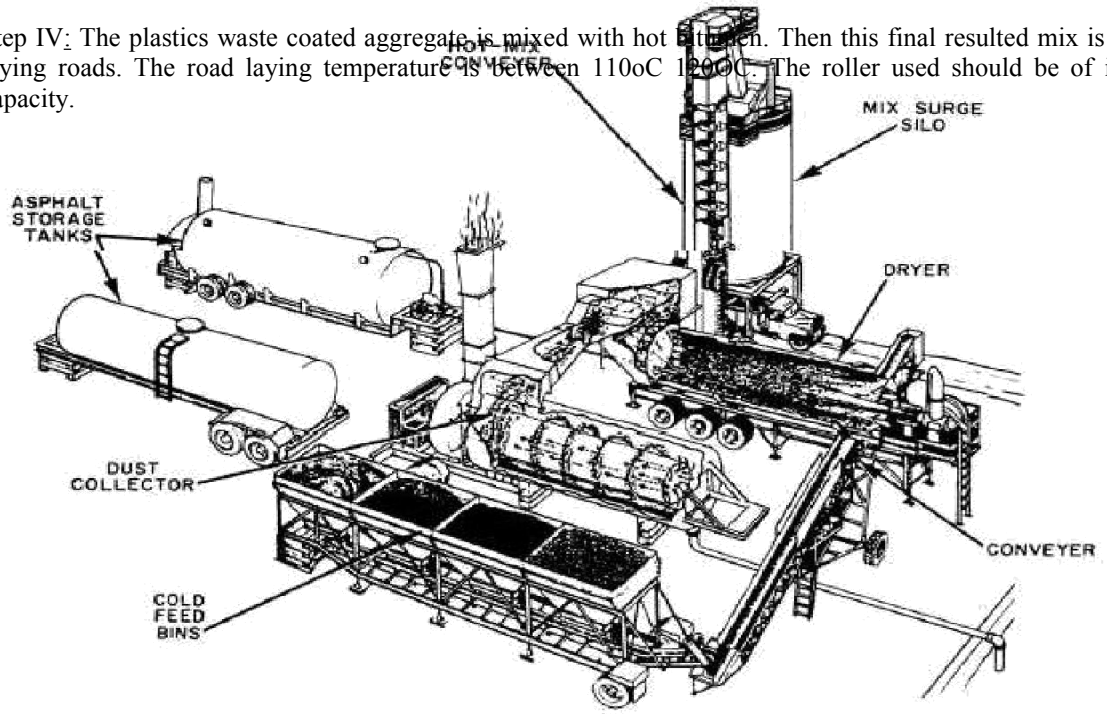
Step I: Plastics waste like bags, bottles made out of PE and PP cut into a size between 2.36 mm and 4.75mm using

shredding machine.

Step II: The aggregate mix is heated to 1650C and then it is transferred to mixing chamber. Similarly the bitumen is to be heated up to a maximum of 1600C. This is done so as to obtain a good binding and to prevent weak bonding. During this process monitoring the temperature is very important.

Step III: 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.

Step IV: 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 110oC 120oC. The roller used should be of is 8-tons capacity.



Hot mix plant

III. LABORATORY EVALUATION

A series of tests were carried out on unmodified and modified materials that is aggregates and bitumen for

different percentages of waste plastic (pp, LDPE, HDPE) as additive. The tests that were conducted include the following:

Aggregate Tests such as aggregate impact, aggregate crushing, Los Angeles abrasion test, water absorption.

Rheological tests, such as penetration, ductility and softening point.

Performance tests such as Marshall Stability and loss of stability for different types of plastic by varying % of plastic Compressive strength of concrete cubes by using plastic coated aggregates in cement concrete cubes.

Sr.no	Tests conducted	Test results			
		Plain bitumen		Modified bitumen (10% plastic replaced)	
1.	Penetration test	68mm		58mm	
2.	Ductility	83mm		52mm	
3.	Flash point	235°c		260°c	
4.	Fire point	251°c		295°c	
5.	Stripping value	0.4%		0.0%	
6.	Softening point	Temp.in°c	Time in sec	Temp.in°c	Time in sec
		53	334	64	550

Comparison between plain bitumen and modified bitumen (10% plastic waste)

IV. CONCLUSION

Plastic coating on aggregates is used for the better performance of roads. This helps to have a better binding of bitumenwith plastic wasted coated aggregate due to increased bonding and increased area of contact between polymers andbitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen

by entrapped air. This has resulted in reducing rutting, raveling and there is no pothole formation. The roads canWithstand heavy traffic and show better durability.

Following are some points which are drawn from the study:

1. Aggregate Impact value of control specimen was 5.43%. It reduced to 4.91% for PP8 and 4.26% for PP10.

Reduction in value was 10% for PP8 and 22% for PP10. This shows that the toughness of the aggregate was

increased to face the impacts.

2. Crushing Value was reduced from 19.2% to 13.33% and 9.82% for PP8 and PP10 respectively. Value reduced by 30% for PP8 and 48% for PP10. Low aggregate crushing value indicates strong aggregates, as the crushedfraction is low.

3. Specific Gravity of the aggregate increases from 2.45 for control specimen to 2.7 for PP8 and 2.85 for PP10 due

to plastic coating.

4. Stripping Value was reduced from 8% for control specimen to nil for PP8 and PP10. This shows that coated

aggregate are more suitable for bituminous construction than plain aggregates.

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5. Water Absorption is also reduced to nil for PP8 and PP10 from 1.7% for control specimen.

6. Los Angeles Abrasion Value of the control specimen was found to be 13.42%. Coating of polymer over aggregate for PP8 increased abrasion value by 19.97% and 29.88%for PP10. This indicates the hardness of the aggregate.

In short we can conclude 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. Increased traffic conditions will and are reducing the life span of roads. Plastic roads are means of prevention and Ultimately will be the cure. It will save millions of dollars in future and reduce the amount of resources used for Construction.

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