Utilization of Plastic Waste in Flexible Pavement Road

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Abstract— **The increase inwaste plastic is due to increase in population, urbanization development activities and changes ina life style.Thus disposal of plastic waster becomes a seriousglobally problem because it is non-biodegradable. Wasteplastics can be used in the production of bituminous mixes. Itsmainly used for packingandmade up ofPolyethylene, Polypropylene, and Polystyrene. Their softening range is in between 110-140 and does acting. When it is sprayed over hot bitumen then it makes a thin film over aggregate. The load bearing capacity of road is also increased than the plain bitumen road.**

Index Terms – flexible pavement Polyethylene, Polypropylene, Polystyrene aggregate bitumen road.

I.INTRODUCTION

The disposal of plastic is not easily solved. If waste plastic is used in the bituminous road then quality of road is increased. Plastic is versatile material. Due to industrial revolution and production of large scale plastic is cheaper. Plastic is non-biodegradable material and remains 4500 years on earth without degradation. Due to this health hazard problem such as reproductive problem of human and animals occurs. We cannot ban the use of plastic but reuse the plastics. Plastic are mostly dropped and left to litter the environment. The littered plastic is non-biodegradable material and it causes both the land and air pollution.. Disposal of a variety of plastic wastes in an eco-friendly way is the thrust area of today's research. The innovative techniquesto use the waste plastics for the construction of flexible pavement, for making pathway blocks, and for making laminated roofing sheets form a good solution for the waste disposal problem of bothplastic waste and municipal solid waste.

II.MATERIAL USED

Aggregates (Aggregate of 20mm, 10 mm, Stone Dust etc) The aggregates may be classified into natural and artificial aggregates. The natural aggregates again are classified as coarse aggregates consisting of crushed rock aggregates or gravels and fine aggregates or sand. The blast furnace slag obtained as by-product from blast furnaces is the one extensively used as road construction material. Stone aggregate used for road work should be hard, tough, durable and hydrophobic for bituminous surface. Gravel should be well graded (6.4mm to 38mm) and should have a fineness modulus of not less than 5.75. Sand should be sharp, well graded, clean of all silts, clay and organic matter. The quantity of aggregates used in first coat of surface dressing should be 0.15m3/10m2 areas of 12mm nominal size. On the other hand, the quantity of aggregate used in second coat of surface dressing should be 0.15m3/10m2 areas and of 10mm nominal size.

Bitumen (80/100 grade)

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. In India mostly 80/100 and 180/200 grade bitumen is used. Heavier grade cut backs, rapid setting emulsions or heavier grade tars may also be used. The grade of basic bitumen is altered either by controlled refining or by mixing with diesel oil or other oils. For single dressings on WBM base course, quantity of bitumen needed ranges from 17 to 195kg per 10m2 areas and 10 to 12kg per 10m2 area in case of renewal of black top surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12kg per 10m2 area.

Important properties of bitumen are

Viscosity of bitumen should be adequate at the time of mixing and compaction. It is achieved by heating prior to mixing and by use of cutbacks and emulsion. In presence of water bitumen should not strip off from aggregate.

Bitumen should be durable in all seasons. It should not become too soft during summers and develop cracks during winters.

Plastic material

Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene (PTFE) In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulfur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky. The properties of plastics are hardness, density, ionizing radiation, organic solvents, oxidation and resistance to heat. Thermoplastics can be re-melted and reused, and thermo-set plastics can be ground up and used as filler, although the purity of the material tends to degrade with each reuse cycle. There are methods by which plastics can be broken back down to a feedstock state.

Classification of Plastic Waste

Polyethylene:

LDPE (Low Density Poly-Ethylene):

Low density poly-ethylene this plastic waste available in the form of carry bags generally in stores these plastic bags are very thin and also easily available.

HDPE (High Density Poly-Ethylene):

Generally High density poly-ethylene type of plastic waste is available in the form of carry bags and easily available.

Polypropylene:

This plastic may be available in the form of carry bags or solid plastic it's depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

III.METHODOLOGY

There are following two methods

1. Dry Method
2. Wet Method

DRYMETHOD:

Collection of Waste Plastics: Waste plastic is collected from roads, garbage trucks, dumpsites or compost plants, or from school collection programs, or by purchase from rag-pickers or waste-buyers at Rs 5-6 per kg.

Cleaning of Plastics:

Waste plastic litter in the form of thin-film carry-bags, use-and-throw cups, PET bottles, etc. these are sorted, de-dusted, washed if necessary.

Shredding of Waste Plastics:

Plastic waste which is cleaned is cut into a size between 2.36mm to 4.75mm using shredding machine as shown bel

Collection Process: The plastic waste retaining in 2.36 mm is collected and used for mixing with the hot bituminous.

Dry Process:

1.The aggregate is heated to 170°C in the Mini hot Mix Plant.

2. The shredded plastic waste is added in equal proportion. The polymer gets coated over the aggregate uniformly.

3. Then hot bitumen 60/70 or 80/100 is added, mixing of bitumen with polymer takes place at the surface of the aggregate around 155°C to 163°C.

4. With the increase in surface area of contact, mixing of polymer with bitumen is better. The mixture is transferred to the road and the road is laid at 120°C.

1.Moisture Absorption and Void Measurement:

For the flexible pavement, hot stone aggregate (170°C) is mixed with hot bitumen (160°C) and the mix is used for road laying. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity as per IS coding. The bitumen is chosen on the basis of its binding property, penetration value and viscous elastic property. The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption and soundness. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement.

2.SoundnessTest:

Soundness test is intended to study the resistance of aggregate to weathering action. The weight loss is attributed to the poor quality of the aggregate. The plastic coated aggregate, did not show any weight loss, thus, confirming the improvement in the quality of the aggregate.

3. Aggregate Impact Value:

It is used to evaluate the toughness of stone or the resistance of the aggregate to fracture under repeated impacts. The aggregates were subjected to 15 blows with a hammer of weight 14kg and the crushed aggregates were sieved on 2.26mm sieve. The aggregate impact value is the percentage of fine (passing through the 2.36mm sieve size) to the total weight of the sample. The aggregate impact value should not exceed 30% for use in wearing course of pavements. Maximum permissible values are 35% for bituminous macadam and 40 % for water bound macadam. The plastic coated aggregates were subjected to this test and the results are tabulated in

Table;Aggregate impact value

Percentage of plastic	Aggregate impact value
Nil	25.4
1%	21.20
2%	18.50

4: Los Angel's Abrasion Test

The repeated movement of the vehicle with iron wheeled or rubber tire will produce some wear and tear over the surface of the pavement. This wear and tear percentage of an aggregate is determined with the help of Los Angeles abrasion study. Under this study the percentage of wear and tear values of the plastic coated aggregate is found to be in decreasing order with respect to the percentage of plastics (eg.37% without plastic, 32% with 1% plastic and 29% with 2% plastic). When the Los Angeles abrasion value of plain aggregate value is compared with the Plastic coated aggregate the values are less for polymer coated aggregate.

Characteristics of Modified Bitumen:

An alternate use of plastic waste is also under study where plastics is mixed with bitumen and used for preparing the mix. The mix was used to study the basic properties of bitumen like softening point, penetration point and ductility. The penetration value was decreased to a very low value and similarly the ductility. More than 3% addition of waste plastics to the bitumen results in a hard polymer modified bitumen with very poor viscous elastic property (The minimum values for a suitable bitumen P.V = 80; Ductility 50).

Table ; Characteristics of polymer modified bitumen

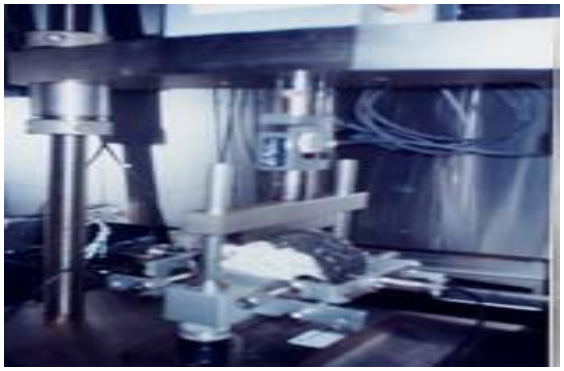
% Of Plastic	Ductility (cm)	Penetration (mm)	Softening Point (°C)
1%	64	95	54
2%	55	90	50
3%	20	80	50
5%	11	55	72
10%	7	Nil	75

On comparison it may be inferred that the use of higher percentage of plastics in polymer modified bitumen is not favorable.

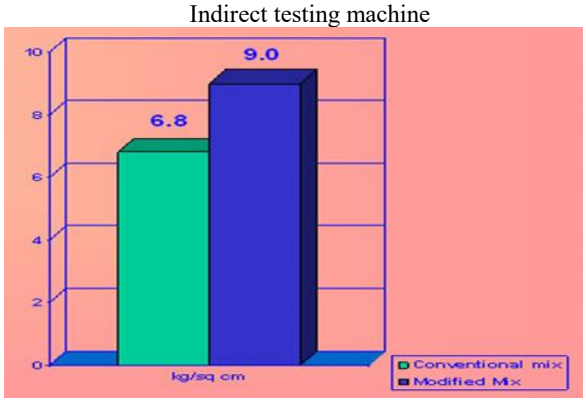
IV.Peforrmonces Studies

1) Indirect Tensile Strength
2) Running Test

Use this test method to determine the tensile strength of compacted bituminous mixtures As the figure shown below tensile strength of the Waste Plastic Bituminous Mixes is greater than Conventional Mix.



Indirect testing machine

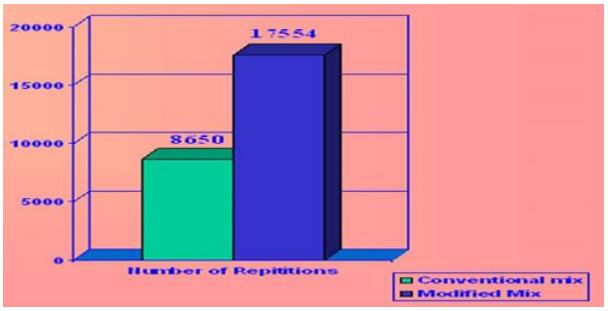


Graphical representation of indirect test

Running Test: Wheel tracking is used to assess the resistance to rutting of asphalt materials under conditions which simulate the effect of traffic.A loaded wheel tracks a sample under specified conditions of speed and temperature while the development of the rut is monitored continuously during the test. The resistance can be quantified as the rate of rutting during the test or the rut depth at the conclusion of the. Test specimens can be either slabs prepared in the laboratory or 20cm diameter cores cut from the highway.

Ordinary & waste plastic mix

Beam specimen after rutting test:
No traces of stripping even after 20,000 cycles therefore No pothole formation, rutting or raveling has been observed after 5 to 6 years after construction.



Graphical representation of running test

V. ADVANTAGES

1) Better resistance towards rain water and water stagnation. 2) No stripping and no potholes. 3) Increase binding and better bonding of the mix. 4) Reduction in pores in aggregate and hence less rutting and raveling. 5) No leaching of plastics. 6) No effect of radiation like UV. 7) The strength of the road is increased by 100%. 8) The load withstanding property increases. It helps to satisfy today's need of increased road transport.

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. 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 also creating a source of income. In addition to the improvement of the quality of the road, this technology has helped to use the waste plastics obtained from domestic and industrial packing materials. This has added more value to the dry process as this process helps to dispose 80 percentages of the waste polymers usefully by an eco-friendly method. This has already been accepted by the Central Pollution Control Board, New Delhi. They have already released a guideline on the technique of the road layingby dry process and its advantage.

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