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Recycling Methodology of Plastic in Laying Roads and Pavements

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Abstract :- **Significant environmental and economic problem are created because all forms of plastic like carry bags, wrappers, chocolates, chips, hand bags, cold drink bottles andlids of all bottles. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems.**
The processed waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time. Therefore, Plastic roads, is a simple way to make eco-friendly constructions. The innovative technology not only strengthened the road construction but also increased the road life as well as will help to improve the environment. The main objective of this paper is to discuss the significance of plastic in terms of innovative methodology for treatment and disposing and to provide solution to reduce,recycle,reuse by applying it for pavement and road construction

Keywords: **- waste plastic bags, innovative, aggregate, pavement, reduce, recycle, reuse.**

I. INTRODUCTION

The objective of the current research is to analyze practices followed by plasticrecovery and recycling units in, India. Disposal of waste plastic is a major problem Plastic is everywhere in today's lifestyle and its disposal is a great problem.It is non-biodegradable and it mainly consists of low-density polyethylene. Burning of these waste plastic bags causes environmental pollution. To find its utility in bituminous mixes for road construction, Laboratory performance studies were conducted on bituminous mixes. Improvement in properties of bituminous mix provides the solution for disposal in a useful way.

Plastic in different forms is found to be almost 5% in municipal solid waste, which is toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains.Polymer modified bitumen is emerging as one of the important construction materials for flexible pavements. Use of plastic waste in the construction of flexible pavement is gaining importance because of the various reasons. Use of higher percentage of plastic waste reduces the need of bitumen by 10% to 12 %.The use of virgin polyethylene as an additive to asphaltic concrete is not new; however, two new processes also use recycled plastic as an asphalt cement additive: NOVOPHALT^{R} and Polyphalt^{R}. *(11, 12, 13)* These latter two processes both use recycled low-density polyethylene resin which is generally obtained from plastic trash and sandwich bags. The recycled plastic is made into pellets and added to asphalt cement at a rate of 4 to 7 percent by weight of binder (0.25 percent to 0.50 percent by weight of total mix). *(12,13).* Plastic waste after sieving, shredding and processing is cut into a size such that it passes through 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 for road construction. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable

II.PLASTIC INDUSTRY AND GENERATION OF PLASTIC WASTE IN INDIA

A boom in the consumption of plastic is experienced with the economic liberalization since 1991. Plastic consumption in India has more than doubled from 0.85 million tonnes during 1990-91 to 1.79 million tons during 1995-96.

Various resins of plastic Polyethylene tetraphthalate(PET,PETE), Density polyethylene(HDPE),Vinyl(Poly vinyl chloride or PVC),Low densitypolyethylene(LDPE),Polypropylene(PP).According to central pollution control board India generates 56 lakh tonnes of plastic waste annually. As per the CPCB report in 2014-15, 51.4 million tonnes of solid waste were generated in the country, of which 91 per

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cent was collected, and 27 per cent was treated and remaining 73 per cent disposed of at dump.

Table 1: Reprocessing in Recycling Industry: Region wise and Polymer wise in kTA

Region	PVC	HDPE	LD/LLD/ H/M	PP	Other	Total
West	60	113	78	65	12	328
North	135	45	38	35	14	267
South	53	41	30	29	09	162
East	34	29	04	20	04	91

Source: Nanavaty, 1997.

It was suggested that one million tonne of waste plastic would have been recycled or otherwise reused in 1996 - including 40% of 1995 consumption of virgin plastic and 30 % of pre 1995 production which had been reprocessed before.

A.Plastic is sorted in following varieties.

The pre-processing of plastic needs segregation and sorting the contents like Milk covers, oil and Ghee covers, thick variety of plastic packing bag, Carry bags, Sanitary pipes, irrigation pipes, window planks, vegetable cutting planks, radio case, Lids of all bottles, hard plastic, buckets, baskets, canes, toothpaste covers, disposable cups,cosmetics and detergent bottles, etc.Plastic roads mainly use plastic carry bags, disposable cups and bottles that are collected from garbage dumps as an important ingredient of the construction material.

III. RECYCLING TECHNOLOGIES

There are mainly three approaches to recycling: mechanical recycling, mixed waste recycling and feed stock recycling. A study of the thermal behavior of the polymers shows that these polymers get softened easily without any evolution of gas around 130-140^{0}C, this has been scientifically verified.At around 350^{0}C, they get decomposed releasing gasesand above 700^{0}C, they undergo combustion producing gases like CO and CO_2.

IV. PROCESS ADOPTED IN ROAD CONSTRUCTION

The process of construction for by this technology involvessegregation,cleaning process, shredding process, field trials. The details of the processes are as follows:

Segregation: Plastic waste collected from various sources must be separated from other waste, maximum thickness of 60 micron.

Cleaning process: Plastic waste gets clean and dried.

Shredding process: Plastic material will be shredded or cut into small piece

Field trials: There are two types of field trials dry process wet process

A.Material Used: Aggregate of 20mm, 10 mm, Stone Dust and Lime as Filler, 60/70/80/100grade bitumen, Waste plastic in the shredded form.

B.Methodology: The processing is required for the various constituents of plastic and analytical study is done on its operational behavior on the aggregates. The details are as follows:

1.Plastics waste cut into a size between 2.36mm and 4.75mm using shredding machine.

2. Theaggregate mix is heated to 165°C (as per the HRS specification) and transferred to mixing chamber. Amount of plastic to be added is @8% of bitumen

3. Bitumen is to be heated up to a maximum of 160°C (HRS Specification) to have good binding and to prevent weak bonding.

4.At the mixing chamber, the shredded plastics waste is to be added. It get coated uniformly over the aggregate within 30 to 60 seconds

5.The plastics waste coated aggregate is mixed with bitumen and the resulted mix is used for road construction.

6.The road laying temperature is between 105°c to 120 °c. And the rollers are used.

The processed plastic undergoes various tests as mentioned below:

C.Tests for the Investigation of the Properties of Aggregate and Bitumen

- **Tests for aggregate**

The tests for aggregates involves Sieve Analysis of Aggregates, Specific Gravity and Water Absorption Test [IS: 2386 (Part 3) 1963], Aggregate Impact Value Test [IS: 2386 (part 4) 1963], Aggregate Crushing Value [IS: 2386 (Part 4) 1963], Flakinessand Elongation Index Test [is: 2386 (part 1) 1963].

- **Tests for bitumen**

Various penetration test for bitumen includes Penetration Test [Is: 1203-1978],Softening Point Test [Is: 1205-1978],Ductility Test [IS: 1208-1978], Viscosity Test: ,Flash Point and Fire Point.

D.Preparation of design mix

This process involves mixing the constituents with respect to their operating parameters, which are given below

a. Plain Bituminous Mix: Bitumen is also known as asphalt or tar. A good design of bituminous mix is expected to result in a mix which is adequately strong,

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durable, resistive to fatigue and permanent deformation.

b. Selection of Mix Constituents: The binders are selected based on some simple tests. These tests could be different depending of the type of binder e.g. penetration grade, cutback, emulsion, modified binder etc. Number of tests is recommended in the specifications to judge the properties of the aggregates, e.g. strength, hardness, toughness, durability, angularity, shape factors, clay content, adhesion to binder etc.

c. Coated Bituminous Mix: The plastic coated aggregate bitumen mix and plastic modified bitumen forms better materials for flexible pavement construction as the mixes shows higher Marshall Stability value and suitable Marshall Coefficient.

V. PROCESS ADOPTED FOR PAVEMENTS PREPARATION

The process of pavement preparation involves the following phases. In-house Sorting and Cleaning, Size Reduction, High Speed Mixing,Addition of Additives, Extrusion, Pelletizing.

- Size Reduction; material is reduced in size depending upon type of plastic. Thin carry bags of LDPE, LLDPE or even PP are directly fed into extruder with or without washing.
- High Speed Mixing: increasing the bulk density and homogeneity of the matter, is to mix additives and colors. Adequate mixing is essential to achieve uniform color and shade (Balachandani, 1980).
- Additives: achieve their effect by chemical reactions such as PVC heat stabilizers, antioxidants, ultraviolet absorbers and flame retardants
- Extrusion: fundamental principle of the extrusion is plastic material is forced through an orifice of the required shape under pressure to achieve the desired shape.
- Pelletizing semi-solid material emerges; it is passed through a trough of water to harden, and then passed into a chopper which chops it into small pellets. During this pulling through water the cord thins further, to reduce the diameter to about 2mm at the chopper.In case of PP, first lumps are made which are again ground and extruded to make granules. Finally the granules are again extruded to be molded into appropriate product shape.

A.Method of Road Laying

The methodology of laying and casting theroad pavements includes various process.

1. Dry process is recommended for isolated worksIt is recommended that the percentage of shredded waste plastic will be 8% by CRRI
2. Mini hot mix plant: The stone aggregate mix (as per specification) is transferred to the mix cylinder where it is heated to 165^0c (as per the IRC specification) and then it is transferred to the mixing puddle while transferring the hot aggregate into the puddle, calculated quantity of shredded plastics is sprayed over the hot aggregate within 30seconds. The sprayed plastic films melts and gets coated over the aggregate, thus forming an oily coating. The further curing and commissioning pavement and the wearing course isidentical as regular pavement laying procedure. The surfaces are obtained are as workable as regular pavements.

VI.ADVANTAGE OF WASTE PLASTIC BITUMINOUS MIX

The bituminous mix obtained shows outstanding results showing stronger road with increased Marshall Stabilityvalue**,**better resistance towards rain water and water stagnation.There are no stripping and no potholes and has increased binding and better bonding of the mix.There is reduction in pores in aggregate and hence less rutting and raveling occurs. The load withstanding property increases and it helps to satisfy today's need of increased road transport. The use of waste plastics on the road has helped to provide better place for burying the plastic waste without causing disposal problem thus shouldering the responsibility of avoiding land pollution.

VII. CONCLUSION

Current research on the beneficial use of waste byproducts as highway construction materials has identified several promising uses for these materials. Some of these materials include:Blast furnace and steel slags,Carpet fibers,Coal ash byproducts, including fly ash, bottom ash, and Recycled plastic.

The experimentation by several researchers indicates that the waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time. Therefore, it is proposed that we may

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use waste plastic in the construction of roads. The use of the innovative technology not only strengthens the road construction but also increases the road life as well as will help to improve the environment.Plastic roads are a simple way to make eco-friendly constructions. It will save large amount of revenue in future and reduce the amount of resources used for construction.Despite all researches on potential use of recycled materials in road structures, yet there aremajor concerns due to lack of definite procedures on implementation of laying recycled concrete in pavements and requires intensive investigation to adopt it globally on massive scale.

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