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Utilization & Minimization Of Waste Plastic In Construction Of Pavement: A Review

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ABSTRACT

Various waste materials, like plastic waste and municipal solid waste are of great concern. Among thesesolid waste management is the thrust area. On the other side, the road traffic intensity is increasing. The load bearing capacity of roads are increasing. This present review is helping to take care of both these aspects. This study discusses the suitability of plastic waste materials for pavement construction. Use of plastics in road construction can reduce the cost of road construction and pollution index of environment to an appreciable extent. Plasticacts as a good binder with bitumen. It gives better stability, binding property, resistance to water and durability. The mix polymer coated aggregate and modified bitumen have higher strength. Use of this mix for road construction helps to use plastic waste effectively. Use of plastic in construction material is becoming more and more acceptable due to the improved properties of materials.The cost of construction materials also decreases considerably due to use of waste plastic.This technology is not a new concept but rather not practiced widely.

Keywords: plastic waste, bitumen, cost of construction, binders, durability.

INTRODUCTION

Plastic are user friendly but not eco-friendly as they are non-biodegradable.Burning of plastic releases toxic gases like CO, CO_2, dioxin and ash (oxides) and is also responsible for global warming, air pollution and monsoon failure. Every day, a multitude of items that are either partly or completely made of plastic are used and these plastics eventually end up in the landfills. Depending on the quality of the plastic, it may take anywhere from a few days to several years to break down in landfills, but it never breaks down completely into particles that can be used in nature. As such, plastic is one of the worst offenders when it comes to environmental pollution [1].Polymer modified bitumen is emerging as one of the most useful material of construction for flexible pavement. This modified bitumen shows better properties for road construction. Utilization of plastic waste through this process can help solving pollution related problems. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Shredded plastic waste acts as a strong binding agent for tar making the asphalt last long[2].The current review summarizes research and studies carried out on utilization of waste plastic material in road construction material. Post construction pavement performance studies are to be done for these waste materials for construction of low volume roads with two-fold benefits: (a) it will help clear valuable land of huge dumps of wastes; (b) it will also help to preserve the natural reserves of aggregates, thus protecting the environment[3].

POLYMER BLENDED BITUMEN ROAD

The process of road laying using waste plastics is designed and the technique is being implemented successfully for the construction of flexible roads at various places in India.

1. ***Striping and pothole formation***: Bitumen film is often stripped off the aggregate.

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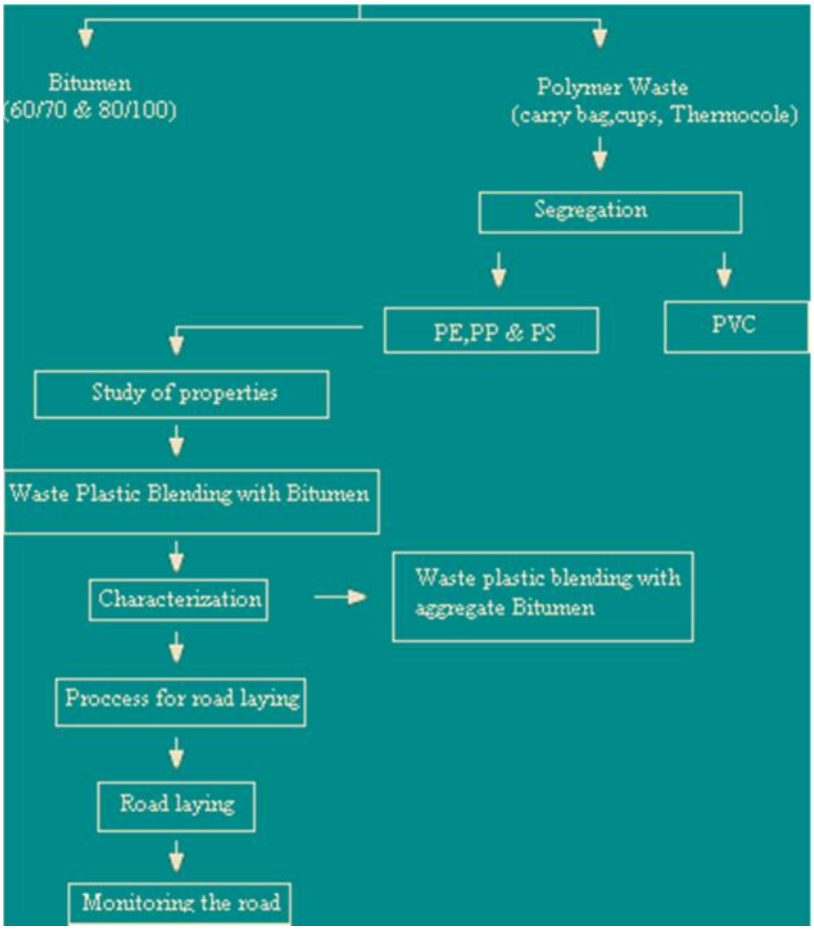
2. ***Leaching***: Polymer will not leach out of the bitumen layer.
3. ***Effect of Bleeding***: Waste polymer –bitumen blend shows higher softening temperature.
4. ***Effect of fly ash***: It is also observed that the fly ash does not leach from this mixture.



Flow Chart showing method for construction of Road Raw material

The polymer bitumen blend is a better binder compared to plain bitumen. Blend increases softening point and decreases penetration value with a suitable ductility. When it used for road construction it can withstand higher temperature and load[4]. The coating of plastic reduces the porosity & absorption of moisture. The polymer coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods for easy disposal of waste plastics.

BASIC PROCESS

- ***Segregation***: Plastic waste collected from various sources must be separated from other waste. Maximum thickness is 60 microns.
- ***Cleaning Process***: Plastic wastes get cleaned and dried
- ***Shredding process***: Will be shredded or cut into small piece. The different types of plastic wastes are mixed together
- ***Collection process***: The plastic waste retaining in 2.36 mm is collected.

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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, egg boxes, disposablecups, protective packaging etc.
Polyvinyl Chloride (PVC)	mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders, etc.

WHY DO WE NEED TO USE PLASTIC

Polymers have a number of vital properties, which when exploited alone or together make a significant and expanding contribution to construction needs.

1. Durable & corrosion resistant.
2. Good insulation for cold, heat & energy saving and reducing noise pollution.
3. It is economical and has a longer life.
4. Maintenance free & Light Weight.
5. Hygienic & problems.
6. Ease of processing/ installation.

THERMAL CHARACTERISTIC OF PLASTIC WASTE:

A study of the thermal behavior of the polymers namely polyethylene, polypropylene, polystyrene, shows that those polymers get softened easily without any evolution of gas around 130-1400^{0}C, this has been scientifically verified. At around 3500^{0}C they get decomposed releasing gases like methane, ethane etc. and at 7000^{0}C they undergo combustion, producing gases like CO and CO_2[5].

ADVANTAGES& DIS-ADVANTAGES

Advantages

1. Strength of the road gets increased.
2. Better resistance to water & water stagnation.
3. No stripping & no potholes.
4. Increases binding & better bonding of the mix.
5. Better soundness property.
6. Maintenance cost of the road is almost nil.
7. No effect of radiation like UV.

Dis-Advantages

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.

COMPARISON

The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. Roads made up of plastic waste mix are found to be better than the conventional ones[6]. The binding property of plastic makes the road last longer giving strength to withstand more loads. A normal highway road lasts for 4 to 5 years whereas the plastic-bitumen roads can last up to 10 years. Rainwater will not seep through because of the plastic in the tar. So, this technology will give better roads. The cost of plastic road construction may be slightly higher compared to the conventional method. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 45°C and torrential rains create havoc, leaving most of the roads with big potholes[7].

CONCLUSION

Critical problem of solid waste minimization lies with non-biodegradable waste. Use of plastic in construction material is becoming more and more acceptable due to the improved properties of materials[8].The production of waste plastics is increasing every now and then. The major polymers like polyethylene, polypropylene, polystyrene show adhesion property in their molten state. Plastic increases the melting point of the bitumen. Plastic bottles, polymers, cups, etc. can be re-used by powdering and blending. Recycled polyethylene terephthalate (PET) can be mixed in engineering materials to reduce cost and improve properties[9].

The use of waste plastics for pavement is one of the best method for easy disposal of waste plastics. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reduced rutting, raveling, and there is not pothole formation. The road can withstand heavy traffic and shows better durability[10]. Use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements.

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