ORIGINAL RESEARCH PAPER

Engineering

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UTILIZATION OF POLYETHELENE TERYPHATHALEATE WASTE IN ASPHALTING OR RURAL ROADS AND GIS

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ABSTRACT

Today's world produces more plastic than ever. It becomes part of Fastrack supply chain management like use in parcel activity due to economic value, lighter weight, easily scalable and high durability had made it convenient. Therefore, it had made a fill a gap in our daily activity and increasing day by day. To overuse plastic, it is now challenging us in various fields such as recyclability, dumping area requirement and occupying space for many years at landfill sites are challenged due to low availability of land. The incineration plant is also used to overcome waste, but both processes are not eco-friendly. During incineration, the harmful chemical is liberating in the environment cause the various lungs diseases. Under such circumstances, there is an urgent need for another alternative of plastic. It is known that plastic had better binding properties at the molten state to help in safe disposal by using it in road construction. In this research, the waste plastic is used with Bitumen mixed with aggregate to find the right composition on Tensile Strength bases, Fatigue, stability, lower penetration value and higher Marshall Stability to construct the road. And see the new GIS approach to find the future constructional land area to reduce construction cost to support waste reduction by sustainable development.

INTRODUCTION

Various industries produce a colossal amount of by-products as waste material by increasing it daily, which cause serious concern in the proper disposal of waste to cause environmental pollution. In the past four decades, industrialisation had helped the nation achieve self-sufficient and prosperity [1]. Still, on other side produced massive waste of fly ash, Silica Fumes tiers scrap, Blast furnace slag and plastic etc. to meet the production demand. The increase in domestic supply and the adequate amount of plastic in our household also contributed to a rise in plastic waste.

The collected wastes are dumped on waste disposal area or land site. Over time, this waste increases and starts causing the severe problem of limited area availability and rapid waste growth. As a result, it acquires acres of precious land and causing a harmful and ecological impact on the environment, causing water pollution, air pollution and making inhabitable to a nearby resident [2].

This dump's challenge had become an extreme necessity and reduced pollution and hazards and free the land area or maintained the cycle of waste in the same place. Therefore to minimise such problem, the researcher is trying new concept, technology, management, and supply chain to reduce waste. Still, it could help to some extent only, as it cannot meet the demands. The one more step in this research came up with using waste plastic in road construction and other inorganic materials in MRF recycling technique [3] and organic in biogas or in composting such as seen in Bhopal Bhanpur Plant.

Figure 1: Bhanpur-Bhopal

The construction of a road using waste plastic could bring significant cost reduction, increase in durability, life span and water repellent. The current trend construction of cement concrete road construction is costly, so preference is given to bituminous road [4]. The flexible pavements, along with Bitumen, are everyday use in India for surfacing. The use of bitumen binder in surfacing is much less use than aggregate; rather, it depends upon its quantity and quality of binder in the pavement. A proliferation in the use of road traffic and commercial transportation with rash driving and excess loading on trucks in day by day in all other season help in causing early distress such as undulations, rutting, crack, raveling, uncovering bitumen surface and bleeding because of a temperature gradient [5]. The variation of temperature in a different region of the country also causes thermal stress to make it brittle such as at high temperature it makes pavement flexible and in winter make it hard.

CLASSIFICATION OF POLYMERS

The classification is based on structure, density, Physical form and deformation properties [6].

A. Based on Structure

Linear: "The molecular chain of this type of polymer is un-branched. It has a low melting point and high flow index compared to others; such as linear low-density polyethene (LLDPE), linear high-density polyethene (LHDPE) and linear polypropylene (LPP)"

Nonlinear: "The chain of this polymer is branched. This type of polymer has a high melting point."

B. Based on Density

Low-Density Polymer: "The molecular weight of this polymer is less compared to others. Example of low-density polymer is LLDPE."

High-Density Polymer: "The molecular weight of this type of polymer is high compared to other polymers. Example of high-density polymer is HDPE (high-density polyethene)."

C. Based on Physical Form

Pellet: "Most of the polymers available in the market are in pellet form."

Powder: "Polymer also available in powder or latex form."

Latex: "Natural rubber collected from the trees is in latex

form."

Recycled: "Recycled rubber or polymer is at present used in binder modification."

D. Based on Deformation Properties:

Elastomer: "Elastomer exhibits high extensibility (up to 1000%) from which they recover rapidly upon removal of the stress."

Plastomer: "It exhibit plastic behaviour at temperature, will deform, but will not return to original dimension when a load is released.

BENEFITS OF PMB

The polymer modification of Bitumen in construction of a road to have durable pavement and stiffness and stability properties. The consumption of virgin polymer can increase the construction cost in that to improve pavement we need to use recycled polyethene "RPE" and crumb rubber (CR), which also help in reducing environmental waste [7]. The benefits of Polymer Modified Bitumen (PMB) look as:-

1. Quality improvement of the binder: The improved quality of PMB are:-

- Polymer Increases binders viscosity that allows greater film thickness in paving mixes without excessive drain down or bleeding
- Increases the binder's qualities to better cope with cracking and dynamic deformation of the internal pavement layers.
- Improves the binder's behaviour to Fatigue by increasing its mechanical resistance, particularly to tractive force.
- Raises the softening point of binder that helps in reducing bleeding.
- Increases elasticity and resilience at high temperatures
- Increases the cohesion of binder.
- Reduces thermal susceptibility to both low and high temperature.
- To rejuvenate aged asphalt binders".

2. A significant improvement in the pavement is possible as-

- "Increases flexibility of pavement.
- Reduces deformation in the pavement.
- Improved ageing and oxidation resistance due to higher binder contents, thicker binder films, and antioxidants in the tire rubber.
- Greater fatigue resistance.
- Greater resistance to stripping.
- Self-healing properties.
- Greater durability".

3. Environmental improvement

The use of waste plastic in road construction has a significant impact on plastic pollution. It uses it as vulnerable, raw materials to help combat a clean environment and remove clogging and various hazards with human health [8] and animals occupying precious land.

PMB LIMITATION

Having huge advantages, it still has an issue and may not be suitable for the pavement. Therefore, it must be adequately selected designed produced constructed as per improve pavement performance [7]. Hence its limitations are:-

- Mobilisation Cost: It can be better understood in a large project, the cost per tonnage is spread, to raise the unit price due to cost of service life and reduce lift thickness. In the case of a small project, it remains the same; thus, it increases unit cost and makes project infeasible.
- The requirement of stable temperature makes the job more rigid."
- Potential odour and air quality problems
- Make work difficult due to stiffness and course mixture.
- The CRM can only be used for limited hours and then make unsuitable to use.

The unavailability of coated aggregate in a remote area makes it harder to have chip seal as an absence of hot-mix plant.

SELECTION OF MATERIALS

The selection of raw material and in this research helps to study characteristics of a bitumen mix by reducing the Bitumen by adding plastic. The adaptability of plastic in road construction is study in Bitumen Macadam and Semi Dense Bitumen concrete (SDBC) [9]. The result of waste plastic is analysed using various tests like Fatigue test, Indirect Tensile Test and Marshall Test etc.

1 Bitumen

To prepare our sample 80/100- grade bitumen used with a specific gravity of 1.025.

Table 1: "Physical properties of bitumen."

S No.	Test	Test Result
1	Penetration	87
2	Softening Point (Ring and Ball Method) °C	51
3	Ductility	96

2Waste Plastic

The waste plastic is collected from Saharsa district of Bihar. The collection is done to reduce the plastic waste in our society and one step forward in lowering already dumped waste. The collected sample has a specific gravity of 0.48.

Figure 2: Dumpsite of Saharsa District of Bihar

3 Aggregate

Coarse and fine aggregates are collected from the nearby river of "Sone-River".

Table 2: Properties of Coarse Aggregates

Properties	Values	Recommendation Value (As per MOST)
Aggregate Impact Value (%)	20	<30
Flakiness (%)	15	<25
Aggregate Crushing Value (%)	19	<30

BITUMEN BLEND PREPARATION (BITUMEN AND PLASTIC)

In blend preparation using a polymer as a modifier like scrub tiers using a mechanical blender are very much helpful as drawn in a literature review. It is also clear that time, temperature and shear force of blending are affecting factor of blending. For our research incorporating time of 40 minutes and higher shear stress to mix evenly in the waste plastic sample with a shorter blending time, no change in the rheology occurs [10]. The mechanical blending used to have uniform missing as higher shear stress required for HDPE.

MECHANICAL BLENDING

The collected waste plastic of HDPE is reducing to size of 4-5 mm. The electric heater of waste plastic and Bitumen in a separate container is set at 175°C and 180°C respectively. After both converted into a liquid the stirrer in Bitumen is set to 1000 rpm and gradually waste plastic is added. The speed of stirrer is increased to 1500 rpm to provide sufficient shear stress for 40 minutes. These steps create a homogeneous mixture of binder and collected into storage for experimental purposes and remaining to mix it with aggregate [11]. To increase the percentage of waste plastic required a longer time to blend. To study a mix of 4%, 6%, 8% and 10% is used.

a b

Figure 3: a) Bitumen, b) 10% Waste Plastic

GIS DATA

Figure 4: GIS Image of road construction in Saharsha district of Bihar

The total length of the road till 2 June 2020 - 734.3 Kms *(http://www.diva-gis.org/gdata)*

CONCLUSIONS

The main objective is to use GIS in waste recovery in bitumen consumption by Total road estimation. The yearly construction rate is monitored to estimate the overall reduction in plastic waste by using it in road construction. On the other hand, it is also evaluating. Bitumen's properties with waste plastic sample compare with without plastic. The Bitumen is also tested with Marshall Stability, flow and other properties were studied.

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