IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Waste Plastics for Eco-Friendly and Long-Term Road Construction

Md Wahid Hassan Shihab

B-Tech in Civil Engineer

Marwadi University, Rajkot, Gujarat, India

Abstract: **Waste plastics are an environmental hazard, but their potential usage could assist to improve both our road network and the environment. In India, bituminous roads suffer from early deterioration due to cracking and pothole formation. According to studies conducted in several nations, the use of misuse plastics in bituminous road construction in India will result in a better road network for traffic and environmental circumstances. It is a suitable way to use recycled plastics in road construction that may be easily implemented into local construction methods. According to the research, India has waste plastics ideal for road construction. As a result, government road agencies may take the proper steps to examine the material's potential for improving the country's road network.**

Keywords **– Waste plastic, bituminous, environmental circumstance, hazard.**

Introduction

with a total length of 5.89 million kilometers, India has the second-largest road network in the world (kms). this road network moves 64.5 percent of all commodities in india, while 90 percent of all passenger traffic in india travels by road, with better interconnection between cities, towns, and villages across the country, road transportation has gradually increased over time. this network contributes to the country's economic development; however, it is still in poor condition in terms of durability. the durability of the pavement can be considerably enhanced by using the available local and international studies to improve the pavement design methodology.

1. Pavement Issues in India

On Indian highways, insufficient pavement thickness, inadequately concreted speed breakers, a bad drainage system, and poor ride quality due to potholes are all prevalent issues. In the last three years, they have killed nearly 10,000 people. Roads are destroyed as a result of a lack of maintenance funds, the passage of laden vehicles like trucks, and heavy rains, resulting in traffic congestion and accidents. The government spends crores on pothole repair every year. The predicament of rural communities is more of a concern, as all-weather roads are rare, and monsoons increase the difficulties of navigating these roads.

2. Alternative Solutions

The world's industrialized countries adhere to strict quality standards and build long-lasting roads that are unaffected by adverse weather. India continues to use water-retaining bituminous mixtures for road construction, resulting in rapid road surface deterioration. Plastic roads, composed of polymer modified bitumen, last longer and are also better for the environment. This type of road can withstand severe weather. The road network in India is undergoing a challenging development through the National Highways Developmental Projects (NHDP), State Highways Improvement Programs (SHIPs), Bharat Nirman, and other projects. PMGSY (Pradhan Mantri Gram Sadak Yojana), for example. The Indian government is investing a large sum of money in order to achieve excellent pavement performance. In India, flexible pavements with bituminous layers on top are chosen because they are less expensive to build and maintain unmodified bituminous binders, like as 60/70, are often used in surface courses or modified binders such as 80/100 bitumen (depending on climatic conditions) and 80/100 bitumen CRMB. The current Indian requirements include clear suggestions for acceptance criteria for these binders based on a variety of physical tests that are entirely empirical. In India, for example, penetration testing, which are essentially an empirical test used to establish determining the hardness or softness of a binder by measuring the penetration of a standard needle at 25°C, 100 grams of loading for 5 seconds. This test has nothing to do with bitumen. to its on-the-ground performance. While there is a high demand for bituminous road infrastructure and corresponding investment, it is critical to consider the adoption of performance-based requirements for the materials used in these structures to ensure that the final goals of these projects are met. Huge sums of money may be justifiable. SHRP recently proposed performance-based binder specifications in a total quality perspective based on shear susceptibility factors, addressing each type of pavement failure. India's failure modes could be Only as a result of rutting and fatigue cracking have serious pavement distresses been detected. The impacts of low temperatures are limited to a tiny portion of the population. In light of this, an attempt is made. produced as part of this effort to investigate the performance characteristics of one unmodified 3D printer Bitumen, such as bitumen 80/100, and a modified binder, such as CRMB 55, are two commonly used materials for paving in our country.

Premature pavement distresses caused by ever-increasing loaded truck traffic and adverse weather conditions necessitated the addition of suitable chemicals to fresh bitumen. The need for extended life and little maintenance necessitates the use of a road for comfort and convenience. The economics also need bitumen change. Increased shear modulus and higher resilience to thermal fracture at high temperatures, as well as reduced plastic flow at high temperatures in the teens, are engineering features of bitumen synthetic polymers modified naturally or chemically (Uranga 2002). In many countries, virgin polymer modified bitumen has been used in road 3 construction since the mid-seventies of the twentieth century. Academics, on the other hand, have expressed concern about environmental damage as a result of the rapid disposal of plastic goods. Figuring out how to recycle the discarded plastics, which led to its application in road construction. Petrochemicals are used to make plastics. Bitumen is another product derived from the tar sands. crude petroleum distillation Furthermore, waste plastics, like bitumen, are thermoplastic. Nature. The usage of shredded waste plastics has been proved in various studies to enhance the environment. Bitumen's binding and long-lasting properties. In many regions of the world, a laboratory-determined amount of particular types of polymers in bitumen, usually 6-10 percent, has given roads up to two times their original life.

. The following benefits of waste plastic modified road pavement have been noted by researchers and engineers: road strength is up to twice that of standard roads;

- High resilience to water damage, resulting in fewer potholes;
- During the summer, there is less bitumen bleeding;
- Waste plastics could be saved from being burned;
- It does not necessitate the use of any additional equipment.
- It has a negligible impact on the cost of road construction; and
- It aids in the reduction of bituminous mix consumption while also lowering costs.

3. BITUMINOUS MIX WITH PLASTIC MODIFIED PROPERTIES

There are six different types of plastics. The three types (High Density Polyethylene), PS (Polyvinyl Chloride), PP (Polypropylene), and PVC (Polyvinyl Chloride) are PET (Polyethylene Terephthalate), LDPE (Low Density Polyethylene), and HDPE (High Density Polyethylene) (Polystyrene). According to study, LDPE, HDPE, and PP can be used to construct roads. There are two varieties of plastic: HDPE and LDPE. PE is a term that refers to a group of people who collaborate.

Table- 1 illustrates the thermal properties of various types of plastics as well as bitumen with a penetration grade of 80/100. LDPE, HDPE, and PP have virtually comparable specific gravity and melting points to 80/100 grade bitumen. This likeness ensures that the two are well-connected. Materials for the required maximum heating temperature of bitumen for the best results.

P. Jew et al. (1986) discovered that at lower temperatures, the bitumen mixture had higher flexural strength, flexural modulus, elongation, and fracture energy as it approached the optimum polyethylene concentration of 8% by weight. They According to the company, polyethylene in bituminous hot-mix paving materials can extend service life. temperature range at both high and low temperatures, reducing both pavement rutting and low-temperature cracking at the same time, allowing pavement lifetimes to be increased by a factor of two.

A recent field survey (BUET Study 2008) revealed that waste plastics of any category in a pure state would be difficult to obtain for road construction due to the difficulty in separating waste plastics of any category in a pure state. In practice, a combination of PP and PE (HDPE and LDPE) will almost certainly be required. As a result, the fundamental properties of bitumen of 80/100 grade combined with PE and PP in two different amounts were studied. tested. The BUET results of the two blends are compared to the virgin value in Table 2. Bitumen with a grade of 80/100. Lower penetration and higher softening point, i.e. greater resistance to deformation in high summer temperatures, as well as comparably higher Ductility, i.e. less prone to cracking, have been achieved by combining PE and PP in a higher ratio (e.g. PE: PP = 1: 1).

As a result, it is possible to argue that PP is superior to PE for use with bitumen. The road's pavement is being repaired. As a result, a greater proportion of PP may be used as bitumen. modifier. Separate studies are required for LDPE and HDPE with or without additives in varying amounts in the absence of PP. This will enable us to make more use of the potential of waste plastics for road building.

The Central Road Research Institute (CRRI) in India has conducted a detailed laboratory study into the use of waste plastic bags in the bituminous concrete mix (CRRI Report 2002). They used 60/70-degree bitumen and plastic trash sacks. Made from a variety of sources, plastic bags are made from waste. Two types of plastic are HDPE and LDPE. There is no document specifying the HDPE/LDPE ratio of the investigation. report. The weight of aggregates was found to be the Optimum Bitumen content (OBC). The standard mix (no shreds) and the modified mix were the same in both (containing 8 percent plastic shreds). However, the Marshal stability (1700 kg) of the modified combination was much more than the standard mix (1450 kg). The samples were submerged in a water bath at 60°C for 24 hours to perform a retainable stability test. The retained stability percentage was 98 percent for the modified mix, while the conventional mix was 88 percent. This shows that the improved mix of 8% plastic bags is both stronger and cheaper. A critical quality to future India's roads, sensitive to humidity damage. A study of indirect tensile strength for both mixtures was conducted at the same time. 25°C. The tensile strengths for both conventional and modified blends were found to be 6.8 kg/sq cm and 9.0 kg/sq cm. These findings demonstrate that the enhanced mixture is more resistant to the cracking caused by winter shrinkage and shear loads. The tiredness lives of the blends were studied and test specimens were found to have a short duration of tiredness. The average repeat rate was 17,554 and 8,650 for modified and traditional mixes, respectively. This test shows that the changed

mixture has a fatigue life more than twice the initial mixture. Traditional mix critical to the increased congestion of India's traffic. A Hamburg Wheel Tracking Device was developed in Germany for the study of rusting features (HWTD). It was found that 6mm and 8mm of depression in modified and normal blends occurred for 1000-wheel passes following the compaction. This is also critical for major roads that are sensitive to routing and are responsible for a consistent flow of heavy vehicles. There is a link between depression and failure.

The bitumen mix modified with 8% shredded plastic bags is much better than virgin bitumen alone, all the typical CRRI tests show. However, 60/70-grade bitumen was used rather than 80/100-grade bitumen in CRRI investigations. India is using it. India uses it. The penetration value was reduced to 80/100 bitumen. Thus, using recycled plastic (table – 2) allows us to survive longer by using higher-grade bitumen. Improved roads and compliance with Bofinger's (2003) advice that 60/70 bitumen penetration level should be used in India without incurring additional cost for obtaining virgin, higher-grade bitumen. As a result, the conclusions of the CRRI concerning waste plastics potential in road paving and the implementation of a 60/70 grade can be taken into consideration. However, for the application of Bitumen 80/100 grade waste plastics, a comprehensively study comparable to the CRRI test programmed should be carried out in India.

The review of literature on the properties of waste plastics in bituminous mix intended for road pavements, while limited, has led to the almost obvious conclusion that the technology's application would significantly improve the behavior of waste plastics in bituminous mix intended for road pavements. Extreme environmental and traffic consequences on India's road pavements of nature.

4. MATERIALS AVAILABILITY

The Delhi based CSIR-NPL has designed a process that is eco-friendly and patented to produce plastic trash tiles. It has signed with a privately held company a commercial manufacturing licence. Rs 3.2 crore will be placed in a recycling unit that is able to produce five lakh tiles every month. NPL will help to produce waste plastic with customizable aesthetic designs in the space of 3-60 mm thick tiles. The product was evaluated using the American Society standards for testing materials for flammability, water absorption and mechanical strength.

Plastic waste has been used to construct nearly one lakh kilometers of road in 11 Indian states. According to national rural road agencies, these stretches of road will last for more than ten years. Plastic road surfaces are becoming increasingly popular in the country because they make roads more durable and heat resistant. Plastic roads have a melting point of around 66 degrees Celsius, whereas traditional roads have a melting point of 50 degrees Celsius. It is also less expensive, costing 8-9 percent less than a standard road.

5. METHODOLOGY OF CONSTRUCTION

Making bituminous road covering material with waste plastic shreds is a simple process in other countries. After heating the coarse aggregates (crushed stones) to 170°C, plastic waste shreds are put on top and raked completely yet fast. The liquidized plastic shreds formed a thin film coating on the aggregates. The hot 6 Bitumen (160°C) is added right away and thoroughly mixed. Because the polymer and the bitumen are both liquids, they mix and form molecular bonds. Plastic shreds formed a thin coating around the aggregates due to its low melting point. Because of the decreased viscosity of the plastic film, it penetrates deeper into surface cavities, resulting in a larger bonding surface area and, as a result, a stronger mix when inter-particle gaps are filled with bitumen. The mixture is then spread out on the road and compressed to form a dense layer.

Waste plastic can readily be used in the manufacture of bituminous road mix according to local construction procedures. Most of our minor roads are built using the manual mixing method, which entails simply spreading the plastic shreds on the heated aggregates into the pans. To spread the shreds over the aggregates, all the mixing man needs is a bucket that measures the shreds by volume. When hot mix asphalt plants are used, the same activity is required to complete the specified mixing, which may be completed safely with the exception of taking care not to burn plastics before applying hot bitumen. In the case of large-scale centrally mechanized asphalt plants, a modest adjustment is required to perform shred-spreading in the mixing chamber. Quality blends have been developed in various countries by making the necessary modifications. As a result, it won't be an issue here either.

The melting of plastic wastes to combine with aggregates in open pans or typical plants used in India would not pollute the air because the plastics would only be heated to 160-170 degrees Celsius. When plastics are heated to between 600 and 700 degrees Celsius, they produce toxic carbon dioxide and carbon monoxide into the air (George, 2007).

6. Road of Waste Plastic

Indian corporations in Bangalore and Mumbai are pioneers in road construction use copper slagging. Bangalore, a project to build a 150-kilometer waste plastic bituminous road is underway. In Mumbai, a trial road was built in 2004, and work on a larger trial road is under underway. The Central Road Research Institute (CRRI) in India has authorized the technology for utilizing shredded plastic trash in road construction. The technology's success has prompted Delhi, Surat, Hyderabad, and other cities to adopt it. Canada and Brazil have also adopted the method of applying plastic shreds.

Conclusion

Local and foreign studies have shown that in addition to ecological upgrade, proper use of waste plastics on roads in Bangladesh would significantly enhance their performance. Government road agencies- RHD, LGED, City Corporations are expected to develop at least one comprehensive waste materials and road construction project. Projects include Bangladesh Road Research Laboratory and 7 institutes such as BUET to optimize design and assessment work. Part of the project fund can also be earmarked to support research students (MPhil or doctor) in order to ensure that the best potential of this promising material is

properly researched and evaluated.

Table 1: Some characteristics of various polymers and bitumen grade 80/100. (Source: BUET study).

	LDPE	HDPE	PP	PS	PVC	PET	Bitumen (80/100 grade)
Sp. Gravity	0.917-0.92	0.93- 0.95	0.90- 0.96	1.03-1.11	1.34-1.38	1.44- 1.49	1.00-1.05
Melting Point, C	100-120	130-140	120-170	235-250	130-190	265-310	54-173
Flash Point, C	>231	>360	400		>388		>220
Thermal Decomposition, C	>270	>270- 350	270-300	>300			>300

Table- 2: Certain properties with or without 80/100 grade bitumen (Source: BUET study).

Properties	80/100 grade_bitumen	8% by wt. LDPE: PP (3:1) in 80/100 grade_bitumen	8% by wt. LDPE: PP (1:1) in 80/100 grade_bitumen
Penetration, mm	80-100	42	36
Softening_Point, °C	45-52	77	81.5
Ductility, mm	100	50	70

Table 3: Importation in Bangladesh of PE and PP polymers (Source: BUET study).

Year		88-80	97-98	2005-06	2006-07
Total Import (Ton)		9,989	86,318	2,73,874	2,97,876
PE Import	Ton	3,046	30,527	72,056	82,928
	(%)	30.49	35.37	26.31	28.73
PP Import	Ton	2,105	12,835	68,742	85,497
	(%)	21.07	14.87	25.10	29.62

REFERENCES

Bofinger, H. E. (2003). "Investigation of Pavement Distress and Recommendations." Study conducted under the Third Road Rehabilitation and Maintenance Project (RRMP-III), Roads and Highways Department, Bangladesh.

BUET Study; Use of Waste Plastics with Bitumen for Road Construction. (2008). Report prepared for Practical Action, Bangladesh, Dhaka by Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.

CRRI Report; Laboratory Study on Utilization of Waste Plastic Bags in Bituminous Concrete Mix. (2002). Report prepared for K.K. Poly Flex Private Ltd., Bangalore by Central Road Research Institute (CRRI), India.

Anayetullah, I. and Maqsood Sinha, A. H. M. (2008). "Plastic Waste Recycling and its Opportunities in Bangladesh." Souvenir: 5th Dhaka International Plastics Packaging & Printing Industrial Fair, 28-31 January, 2008.

George, K. (2007). "Kerala wants waste plastic for roads." Deputy Director, Kerala Highway Research Institute. (KHRI). News published in CommodityOnline.com.

P. Jew, J. A. Shimizu, M. Svazic, R. T. Woodhams. (1986). "Polyethylene-modified bitumen for paving applications". Department of Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Canada. Journal of Applied Polymer Science, Volume 31, Issue 8, pp 2685 – 2704.

Uranga, O. G. (2002). "Rheological properties of bitumen modified with Polyethylene and Polyethylene based blends". Departamento de Ciencia y Tecnología de Polímeros, Facultad de Química, Universidad del País Vasco, San Sebastián, Spain.