



Review On Utilization Of Plastic Waste In Construction Field (Plastic Coated Bituminous Road)

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Abstract

Globally, 8,300 million tons of virgin plastics had been manufactured as of 2017. Only approximately 9% of material is recycled, and only about 12% is burned, leaving 79% to end up in landfills or the environment. According to "2018 Down to Earth" research, India consumes approximately 16.5 million tons. Additionally, the industry association FICCI reports that 43% of the plastics used in India are single-use plastics and are utilized in packaging. As a result, over 80% of India's entire plastic production is wasted. Some of it either gets burned, which pollutes the air, goes to landfills, or clogs sewers. Animals who consume plastic bags, etc. suffocate. Plastics found in fields inhibit germination and stop moisture from penetrating the soil. Numerous studies and researches have been conducted to find solutions to the mounting issue of disposing of plastic garbage. Some countries have improved technologies to use recycled waste plastic, but in India the plastic

waste disposal is a big problem. The current account of potential use of plastic waste in the construction industry is lacking in the literature. The review reflects that the reuse of plastic waste is very less as compared to generation of plastic waste. While every industry is trying to minimize the use of plastic, some industries have come forward to research more into waste plastic use in their products for sustainable development. Using plastic to build roads is one potential solution that has gained traction in recent years. In addition to increasing environmental sustainability, highways made of plastic are shown to be more reliable and economical. Because both plastic and bitumen are made of petroleum, they adhere to one another well. The combination lengthens the road's lifespan and increases its capacity to support weight. Additionally, the roads exhibit increased resistance to rain damage. In India almost 1 lakh roads have been built till now to help thousand tons of plastic to be used efficiently. Use of plastic waste replacing natural aggregates in concrete and plastic waste co-processing in cement have also showed a huge scope of plastic waste management in construction study. The review presented in this paper is bound to highlight the impending problem of plastic waste for the researchers to come forward with innovative solutions of minimizing and recycling with practical feasibility.

Keywords: Plastic, Traction, Petroleum, Highlight, Recycling.

Introduction

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'Plastic'. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics can be divided into two major categories: thermosets and thermoplastics. A thermoset solidifies or "sets" irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobiles and construction applications.

These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene, polytetrafluorethylene, and polyethylene terephthalate. A thermoplastic softens when exposed to heat and returns to original condition at room temperature. Thermoplastics can easily be shaped and moulded into products such as milk jugs, floor coverings, credit cards, and carpet fibres. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane. According to recent studies, plastics can stay unchanged for as long as 4500 years on earth with increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. 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. Due to its biodegradability, it creates stagnation of water and

associated hygiene problems. In order to contain this problem experiments have been carried out whether this waste plastic can be reused productively.

The experimentation at several institutes indicated 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. Waste plastic such as carry bags, disposable cups and laminated pouches like chips, pan masala, aluminium foil and packaging material used for biscuits, chocolates, milk and grocery items can be used for surfacing roads. Use of plastic along with the bitumen in construction of roads not only increases its life and smoothness but also makes it economically sound and environment friendly. Plastic waste is used as modifier of bitumen to improve some of bitumen properties Roads that are constructed using plastic waste are known as Plastic Roads and are found to perform better compared to those constructed with conventional bitumen.

AIM

To determine the utilization of plastic waste in construction field.

OBJECTIVES

- To find out the properties of modified bitumen with plastic waste.
- To analyses the characteristics of plastic waste.
- To check the property of mix bitumen specimen.
- To compare the properties of bitumen mix specimen with pure bitumen specimen.

BASIC PROCESS

Waste plastic is ground and made into powder; 3 to 4 % plastic is mixed with the bitumen. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Use of shredded plastic waste acts as a strong “binding agent” for tar making the asphalt last long. By mixing plastic with bitumen the ability of the bitumen to withstand high temperature increases. The plastic waste is melted and mixed with bitumen in a particular ratio. Normally, blending takes place when temperature reaches 45.5°C but when plastic is mixed, it remains stable even at 55°C. The vigorous tests at the laboratory level proved that the bituminous concrete mixes prepared using the treated bitumen binder fulfilled all the specified Marshall mix design criteria for surface course of road pavement. There was a substantial increase in Marshall Stability value of the BC mix, of the order of two to three times higher value

in comparison with the untreated or ordinary bitumen. Another important observation was that the bituminous mixes prepared using the treated binder could withstand adverse soaking conditions under water for longer duration.

PLASTIC ROADS

Plastic use in road construction is not new. It is already in use as PVC or HDPE pipe mat crossings built by cabling together PVC (polyvinyl chloride) or HDPE (high-density poly- ethylene) pipes to form plastic mats. The plastic roads include transition mats to ease the passage of tires up to and down from the crossing. Both options help protect wetland haul roads from rutting by distributing the load across the surface. But the use of plastic-waste has been a concern for scientists and engineers for a quite long time. Recent studies in this direction have shown some hope in terms of using plastic-waste in road construction i.e., Plastic roads. A Bangalore-based firm and a team of engineers from R. V. College of Engineering, Bangalore, have developed a way of using plastic waste for road construction. An initial study was conducted in 1997 by the team to test for strength and durability. Plastic roads mainly use plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction material. When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road.

PROBLEM STATEMENT

The debate on the use and abuse of plastics vis-à-vis environmental protection can go on, without yielding results until practical steps are initiated at the grassroots level by everyone who is in a position to do something about it. The plastic wastes could be used in road construction and the field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. The present write-up highlights the developments in using plastics waste to make plastic roads. The rapid rate of urbanization and development has led to increasing plastic waste generation. As plastic is non-biodegradable in nature, it remains in environment for several years and disposing plastic wastes at landfill are unsafe since toxic chemicals leach out into the soil, and under-ground water and pollute the water bodies. Due to littering habits, inadequate waste management system / infrastructure, plastic waste disposal continues to be a major problem for the civic authorities, especially in the urban areas. As stated above, plastic disposal is one of the major problems for developing countries like India, at a same time India needs a large network of roads for its smooth economic and social development. Scarcity of bitumen needs a deep thinking to ensure fast road construction.

LITERATURE REVIEW

The concept of utilization of waste plastic in construction of flexible road pavement has been done since 2000 in India. In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It also helps to improve the strength and life of road pavement. But its resistance towards water is poor. A common method to improve the quality of bitumen is by modifying the rheological properties of bitumen by blending with synthetic polymers like rubber and plastics. Use of plastic waste in the bitumen is similar to polymer modified bitumen. The blending of recycled LDPE to asphalt mixtures required no modification to existing plant facilities or technology. Polymer modified bitumen has better resistance to temperature, water etc. This modified bitumen is one of the important construction materials for flexible Road pavement. Since 90's, considerable research has been carried out to determine the suitability of plastic waste modifier in construction of bituminous mixes. Zoorab & Suparma reported the use of recycled plastics composed predominantly of polypropylene and low density polyethylene in plain bituminous concrete mixtures with increased durability and improved fatigue life. Dense bituminous macadam with recycled plastics, mainly low density polyethylene (LDPE) replacing 30% of 2.36–5mm aggregates, reduced the mix density by 16% and showed a 250% increase in Marshall Stability; the indirect tensile strength (ITS) was also improved in the 'Plastiphalt' mixtures D.N. Little worked on the same theme and he found that resistance to deformation of asphaltic concrete modified with low density polythene was improved in comparison with unmodified mixes. It is found that the recycled polyethylene bags may be useful in bituminous pavements resulting in reduced permanent deformation in the form of rutting and reduced low temperature cracking of pavement surfacing Bidental. Investigates the benefits of stabilizing the stone mastic asphalt (SMA) mixture in flexible pavement with shredded waste plastic.

METHODOLOGY

PLAIN BITUMINOS MIX

Bitumen is a black, oily, viscous material that is a naturally-occurring organic by product of decomposed organic materials. Also known as asphalt or tar, bitumen was mixed with other materials throughout prehistory and throughout the world for use as a sealant, adhesive, building mortar, incense, and decorative application on pots, buildings, or human skin. The material was also useful in waterproofing canoes and other water transport. A good design of bituminous mix is expected to result in a mix which is adequately (i) strong (ii) durable (iii) resistive to fatigue and permanent deformation (iv) Environment friendly (v) economical and so on.

SELECTION OF MIX CONSTITUENTS

Binder and aggregates are the two main constituents of bituminous mix:

BINDER

Generally, binders are selected based on some simple tests and other site-specific requirements. These tests could be different depending of the type of binder viz. penetration grade, cutback, emulsion, modified binder etc. For most of these tests, the test conditions are pre-fixed in the specifications. Temperature is an important parameter which affects the modulus as well as the aging of binder. Superpave specifications [Superpave 1997, 2001] suggest that these acceptability tests are to be carried out at the prevalent field temperatures, not in a laboratory specified temperature. This is an important consideration because, binder from two different sources may show same physical properties at a particular temperature, but their performances may vary drastically at other temperatures. In Superpave specifications, therefore, only the acceptable test values are recommended, and not the test temperatures. The temperature values are found out from the most prevalent maximum and minimum temperatures at the field at a given probability level.

AGGREGATE

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. Angularity ensures adequate shear strength due to aggregate interlocking, and limiting flakiness ensures that aggregates will not break during compaction and handling. Theoretically, it is difficult [Senov 1987, Aberg 1996] to predict the aggregate volumetric parameters, even the resultant void ratio, when the gradation curve is known. The Fuller's experimental study for minimum void distribution [Fuller and Thompson 1907] still forms the basis of these exercises. Strategic Highway Research Program (SHRP), USA formed a 14 member expert task group for evolution of appropriate aggregate gradation to be used for super pave. The group, after several rounds of discussions decided to use 0.45 power Fuller's gradation as the reference gradation, with certain restricted zones and control points.

VARIOUS MIX DESIGN APPROCHES

There is no unified approach towards bituminous mix design, rather there are a number of approaches, and each has some merits and demerits. [RILEM 1998] summarizes some of the important bituminous mix design approaches as follows:

- Mix design method
- Recipe method
- Empirical mix design method
- Analytical method
- Volumetric method

- Performance related approach
- Performance based

The recent emphasis on bituminous mix design is on performance related and performance based approaches. The requirement of a good mix design has changed from time to time. Gives some idea of how the mix design requirements have changed from past to present. Some of the above requirements are sometimes mutually conflicting. For, example, the higher is the bitumen content; the better is the fatigue life, provided all the other parameters are kept unchanged. But with the increase of bitumen content, the resistance to rutting may decrease. Increase in bitumen content not accompanied by adequate amount of air voids will result in the fall of stability of the mix, the chances of bleeding will increase. The only way to increase bitumen content keeping sufficient air voids (VA) is by maximizing VMA and suitably gradation can be designed. Heavy duty bituminous pavements are composed of bituminous binder course and wearing course, for example, Dense Bituminous Macadam (DBM) and BC [MORT&H 2001], as per Indian specification. Same grades of bitumen are generally used for construction of these layers. Generally same grades of bitumen are used for construction of these layers. Stiffer grade of bitumen has higher value of stiffness, and it causes lesser stains to the pavement layers and also it is expected to show lesser rutting. On the other hand, higher fatigue life as observed for bituminous mixes with softer grade of bitumen [Das 1998], indicates greater longevity of the pavement against fracture. It can be shown computationally [Das and Pandey 2000, Das 2004] that if a pavement is constructed with softer grade of bitumen at the lower layer, and harder grade at the top layer, the pavement is expected to last longer, than a pavement constructed with same grades for both the layers – this technique is known as rich-bottom pavement construction [Harvey et. al. 1997, Monismith 2001] in other countries.

COATED BITUMINOUS MIX

The generation of waste plastics is increasing day by day. The major polymers are namely polyethylene, polypropylene, polystyrene show adhesion property in their molten state. The plastic coated aggregate bitumen mix and plastic modified bitumen forms better materials for flexible pavement construction as the mixes show higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods of easy disposal of waste plastics. The use of polymer coated aggregate is better than the use of polymer modified bitumen in many aspects. The studies on the thermal behaviour and binding property promoted a study on the preparation of plastic waste-bitumen blend and its properties to find the suitability of the blend for road construction. Following procedure can be adopted for using plastic in road construction:

AGGREGATE

The aggregates are bound together either by bituminous materials or by cement. In a few cases, the rock dust itself when mixed with water forms slurry which acts as a binding medium. 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 0.15 m³ per 10 m² area of 12mm nominal size. On the other hand, the quantity of aggregate used in second coat of surface dressing should be 0.15 m³ per 10 m² areas and of 10mm nominal size.

BITUMEN

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. As per definition given by the American Society of Testing Materials bitumen has been defined as “Mixtures of hydrocarbons of natural or pyrogenous origin, or combination of both, frequently accompanied by their non-metallic derivatives, which may be gaseous, liquid, semi-solid or solid, and which are completely soluble in carbon disulphide.” Bitumen found in natural state known as asphalt contains large quantities of solid mineral matter. When petroleum crude is refined in a refinery, they are separated by fractional distillation in the order of decreasing volatility. On distillation of the residual bituminous residue, straight-run bitumen is obtained. This bitumen is known as penetration grade bitumen or steam refined petroleum bitumen.

The grades of bitumen used for pavement construction is known as paving grades and that used for water proofing of structures is known as industrial grades. The grade of straight run bitumen is chosen depending upon the climatic conditions of the region in which surface dressing is to be constructed. In most parts of India 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 195 kg per 10 m² areas and 10 to 12 kg per 10 m² area in case of renewal of black top surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12 kg per 10 m² area. Bulk bitumen Lorries with tanks of capacity ranging from 5000 to 15000 liters are used to transport bulk bitumen. As per PMC, the bitumen content in a mix should be 4% of weight by total mix for B.M. The paving bitumen available in India is classified into two categories: Paving bitumen from Assam petroleum denoted as A-type and designated as grades A35, A90, etc. Paving bitumen from other sources denoted as S-type and designated as grades S35, S90, etc.

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.

CUT-BACK BITUMEN: The asphaltic bitumen is very often mixed with comparatively volatile solvents to improve the workability of the material. The solvent gets evaporated leaving behind the particles together. This cutback bitumen is classified into slow, medium and rapid curing depending upon the type of solvent used.

EMULSIONS: An emulsion is a mixture of normally two immiscible liquids. Asphalt gets broken up into minute globules in water in the presence of the emulsifiers. It improves the workability of bitumen or asphalt. As a result of emulsification, asphalt is available at normal temperature in the liquid form.

BITUMEN: 60/70, 80/100 grade bitumen.

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. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, polyaddition, and crosslinking. 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 defined chiefly by the organic chemistry of the polymer. such as hardness, density, and resistance to heat, organic solvents, oxidation, and ionizing radiation.

TYPES OF PLASTICS

- PET, polyethylene terephthalate
- HDPE, high-density polyethylene
- PVC, polyvinyl chloride
- LDPE, low-density polyethylene
- PP, polypropylene
- PS, polystyrene

Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Since the 1950s, one billion tons of plastic have been discarded and may persist for hundreds or even thousands of years. Perhaps the biggest environmental threat from plastic comes from nurdles, which are the raw material from which all plastics are made. They are tiny pre-plastic pellets that kill large numbers of fish and birds that mistake them for food. Prior to the ban on the use of CFCs in extrusion of polystyrene (and general use, except in life-critical fire suppression systems; see Montreal Protocol), the production of polystyrene contributed to the depletion of the ozone layer; however, non-CFCs are currently used in the extrusion process. Thermoplastics can be melted and reused, and thermoset 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.

Preparation of plastic-waste coated aggregate

The aggregate is heated to around 170°C; the plastic waste shredded to the size varying between 2.36mm and 4.75mm. This shredded plastic waste is added over hot aggregate with constant mixing to give a uniform distribution. The plastic gets softened and coated over the aggregate. The hot plastic waste coated aggregates are mixed with hot bitumen 60/70 or 80/100 grade (160°C).



Fig. Shredding machine blade

BASIC PROCESSES

1. Segregation
2. Cleaning Process
3. Shredding Process
4. Collection Process

Two Processes used in construction of plastic road

1. Wet Process

In this process, the waste plastic is directly mixed with hot Bitumen at 1600C and this mixture is then mixed using a mechanical stirrer. This mixture also contains additional stabilisers and requires proper cooling. It is not popular because it requires huge investments, larger plants and more equipment than the Dry Process.

2. Dry Process

First the plastic waste is collected, segregated and stored. The segregation is done because certain kinds of plastic like polyvinyl chloride (PVC) and flux sheets cannot be used due to safety concerns. The next step involves the cleaning of the plastic. This is necessary because most of the plastic waste collected has been used for packaging (55% in India) and hence is likely to contain residual substances such as little bits of food which must be removed. After this the plastic goes through the process of shredding which reduces it to the correct thickness, 2-4mm. The aggregate is heated to around 1600C-1700C and then the plastic is added

and after 30-40s a uniform coating is observed. This coating gives it an oily look. The Bitumen is then added and the mixture is thoroughly mixed before laying. The Bitumen is added at a temperature of around 1550C - 1630C. This temperature is carefully regulated to make sure that the binding is strong. The process is described by the diagram below.

Types of Plastics used in Plastic coated road

The most commonly used plastics in this process are polyethylene, polystyrene, polyester, and polypropylene. Polyethylene can be made in 3 different ways. Each of these 3 different ways results in polyethylene with different properties. Hence each one is given a slightly different name. Low density polyethylene is normally used to make plastic bags. High density polyethylene is used to make plastic chairs, dustbins, bowls etc. Linear low density polyethylene is used to make plastic sheets and wraps. Polystyrene is typically used in fast food cartons and as insulation. Polyester (Polyethylene terephthalate) is mainly used as a fabric for clothes. Polypropylene is used for clothing and is applied in radio controlled toy planes. All of these plastics, upon incineration liberate large amounts of carbon dioxide and water if sufficient oxygen is used, otherwise, carbon monoxide is produced along with water. Polyvinylchloride (PVC) cannot be used because upon heating it can release dioxin which is toxic gas.

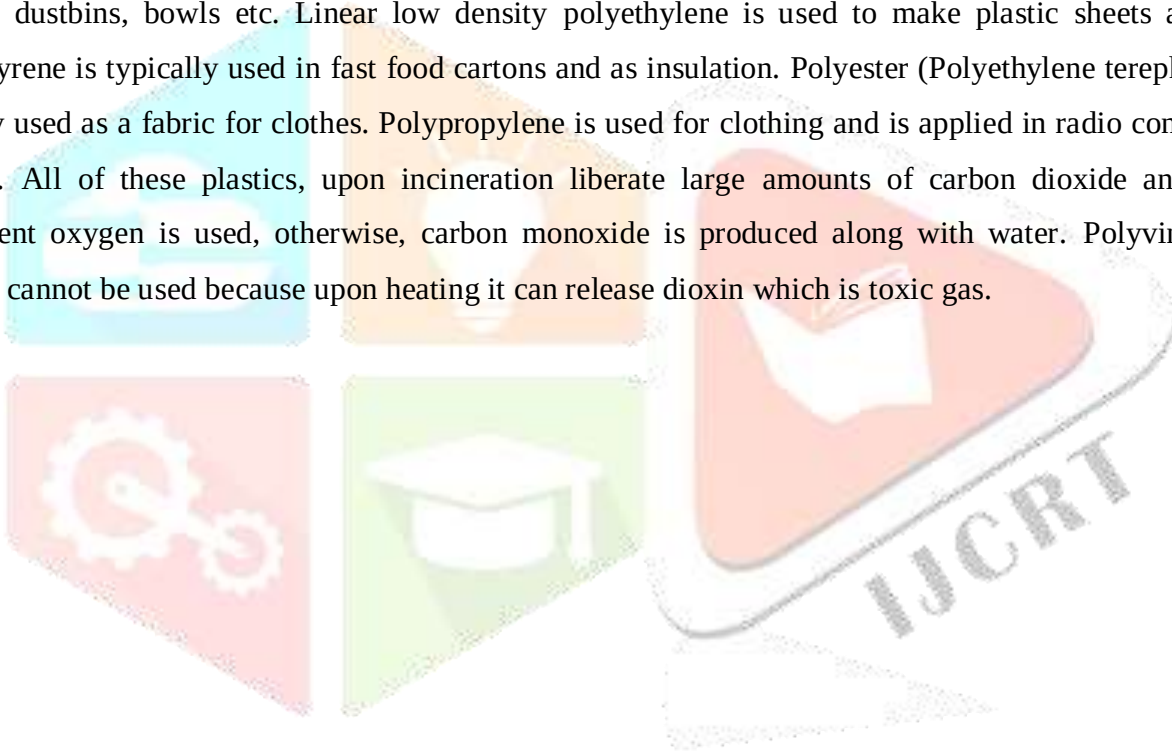




Fig. Construction Process of Plastic-Coated Bituminous Road

FUTURE SCOPE

The future scope of utilizing plastic-coated bituminous roads presents significant potential in both environmental and infrastructural contexts. As concerns over plastic waste management and sustainable construction practices continue to grow, this innovative solution can help address multiple challenges:

1. Waste Plastic Management

Plastic-coated bituminous roads can help in recycling and managing plastic waste. By incorporating waste plastics (such as PET bottles, plastic bags, and other forms of non-biodegradable plastics) into road construction, the amount of plastic waste that would otherwise end up in landfills or oceans can be reduced significantly.

2. Improved Road Durability and Performance

Plastic-coated bituminous roads have been shown to enhance the durability of the road surface. The addition of plastic to bitumen improves its resistance to weathering, water damage, and rutting, which results in longer-lasting roads with reduced maintenance costs. This can be especially valuable in areas prone to high temperatures, heavy rainfall, and extreme weather conditions.

3. Cost-Effectiveness

Incorporating waste plastic into road construction can reduce material costs, as plastic is often less expensive than conventional raw materials. Moreover, the longevity and reduced maintenance needs of plastic-coated roads can lead to long-term savings for municipalities and governments.

4. Environmental Sustainability

By using waste plastic in road construction, the carbon footprint of both plastic production and road maintenance can be reduced. Moreover, plastic-coated roads contribute to reducing plastic pollution, which is a growing environmental issue.

5. Global Adoption and Innovation

Countries like India, which have already begun implementing plastic in road construction, are likely to see wider adoption. This could also encourage innovations in material science, leading to the development of new types of sustainable and cost-effective construction materials.

6. Infrastructure Resilience in Developing Countries

For many developing countries, plastic-coated bituminous roads offer a way to improve infrastructure without heavily relying on imported materials. This can be a boon for economic development, as road networks will be more resilient, longer-lasting, and require less frequent repairs.

7. Research and Technological Advancements

As research into the effects of plastic on bituminous materials progresses, the use of plastic in road construction may become more refined, leading to new types of plastics or additives that further improve road quality, sustainability, and environmental impact.

CONCLUSION

Plastic coating on aggregates is used for the better performance of roads. This helps to have a better binding of bitumen with plastic wasted coated aggregate due to increased bonding and increased area of contact between polymers and bitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reducing rutting, raveling and there is no pothole formation. The roads can withstand heavy traffic and show better durability. Following are some points which are drawn from the study:

1. Aggregate Impact value of control specimen was 5.43%. It reduced to 4.91% for PP8 and 4.26% for PP10. Reduction in value was 10% for PP8 and 22% for PP10. This shows that the toughness of the aggregate was increased to face the impacts.
2. Crushing Value was reduced from 19.2% to 13.33% and 9.82% for PP8 and PP10 respectively. Value reduced by 30% for PP8 and 48% for PP10. Low aggregate crushing value indicates strong aggregates, as the crushed fraction is low.
3. Specific Gravity of the aggregate increases from 2.45 for control specimen to 2.7 for PP8 and 2.85 for PP10 due to plastic coating
4. Stripping Value was reduced from 8% for control specimen to nil for PP8 and PP10. This shows that coated aggregate is more suitable for bituminous construction than plain aggregates.
5. Water Absorption is also reduced to nil for PP8 and PP10 from 1.7% for control specimen.

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