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USE OF RECYCLED WASTE WITH BITUMEN IN ROAD CONSTRUCTION

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***Abstract**:* Disposal of waste materials, including plastic bags, has become a serious problem, and plastic waste is burned for apparent disposal, resulting in environmental pollution. The use of plastic bags in bituminous mixtures has been shown to improve the properties of the mixture and also solve disposal problems. The cleaned plastic waste is cut to a size that fits through a 2-3 mm sieve using a shredding machine. The aggregate mixture is heated and the plastic is effectively applied over the aggregate. This aggregate, coated with plastic waste, is mixed with hot bitumen and the resulting mixture is used for road construction. The use of innovative technology will not only strengthen road construction, but also increase the lifespan of the road and contribute to improving the environment. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures often exceed 50°C and torrential rains wreak havoc, leaving most roads with large potholes. As part of my research work, I thoroughly studied the methodology of using plastic waste in bituminous mixtures and presented the various tests carried out on aggregates and bitumen.

KEYWORDS: Plastic Waste, Bitumen, Aggregates, Plastic Roads

INTRODUCTION

A material that contains one or more high molecular weight organic polymers, is solid in the finished state and can be formed into finished articles by its flow at some point during manufacturing or processing is called “plastic”. Plastics are durable and decompose very slowly; The chemical bonds that make plastic so durable also make it resistant to natural degradation processes. Plastics can be divided into two main categories: thermoses and thermoplastics. A thermoset solidifies or “hardens” irreversibly when heated. They are characterized by their durability and strength and are therefore mainly used in automobiles and construction applications. These plastics are polyethylene, polypropylene, polyamide, poly oxymethylene, polytetrafluoroethylene and polyethylene terephthalate. A thermoplastic softens when exposed to heat and returns to its original state at room temperature. Thermoplastics are easily molded and processed into products such as milk jugs, flooring, credit cards and carpet fibers. These types of plastics are known as phenol, melamine, unsaturated polyester, epoxy, silicone and polyurethane.

According to recent studies, plastics can remain unchanged on Earth for up to 4,500 years. As the world's population increases and the demand for food and other essential goods increases, the amount of waste generated every day in every household has also increased. Plastic in various forms constitutes almost 5% of municipal waste, which is toxic in nature. In both urban and rural areas, it is a common sight to find empty plastic bags and other plastic packaging materials on the streets and drains. Due to its biodegradability, it leads to water stagnation and associated hygiene problems. To curb this problem, experiments have been carried out to see whether this plastic waste can be productively reused. The experiments at several institutes showed that the waste plastic when added to hot aggregate forms a fine plastic layer over the aggregate and that this aggregate when mixed with the binder has higher strength, higher water resistance and better performance results in a time period. Plastic waste such as carrier bags, disposable cups and laminated bags such as chips, pan masala, aluminum foil and packaging material for biscuits, chocolate, milk and food can be used as road surface.

The use of plastic together with bitumen in the construction of roads not only increases their lifespan and smoothness, but also makes them economically viable and environmentally friendly. Plastic waste is used as a modifier for bitumen to improve some of the bitumen properties. Roads built from plastic waste are called plastic roads and have better performance compared to roads built with traditional bitumen. In addition, it was found that such roads did not erode when in contact with water. Using a higher proportion of plastic waste reduces the need for bitumen by 10%. It also increases the strength and performance of the road. Plastic increases the melting point of bitumen and can therefore be removed better and easier. According to Dr. R. Vasudevan, dean of ECA and professor of the department of chemistry at Thiagarajar College of Engineering in Madurai, plastic waste replaces 10 to 15% of bitumen, thereby saving around Rupees 35,000 to 45,000 per kilometer of road stretch. Incorporating plastic waste into road construction will prevent the cracking of the road surface caused by plastic shrinkage and reduce the drying shrinkage to a certain extent.

The use of plastic waste contributes to significantly improving the abrasion and slip resistance of flexible coverings and also makes it possible to achieve splitting tensile strength values that correspond to the specified limits, even when the proportion of plastic waste exceeds 30% of the weight of the mixture. If constant mixing time and mixing temperature are not guaranteed for the bitumen-modifier mixture, modified bitumen cannot perform well on site, resulting in premature failure. Therefore, there are specific recommended mixing times, mixing temperatures and modifier levels for all single brand polymers. All of this should be taken into account when using plastic waste when surveying and laying roads. Plastic roads would be a blessing for India. In hot and extremely humid climates, durable and environmentally friendly plastic roads are a great advantage. This will also help rid the earth of all types of plastic waste.

METHODOLOGY

The following tests were carried out to investigate the properties of the aggregate and bitumen.

TESTS FOR AGGREGATE

- 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]

Flakiness and Elongation Index Test [IS: 2386 (Part 1) 1963]

PREPARATION OF PLASTIC WASTE MATERIAL

Plastic Waste Scenario:

The use of plastic materials like carry bags, cups etc. is constantly increasing. Plastic consumption has increased from 4000 tons/year to 4 million tons/year and is expected to increase by 8 million tons/year in 2010. Almost 50 to 60% of all plastic is used for packaging.

Waste plastic shredding:

During shredding, the plastic is cut into small sizes between 2.36 mm and 4.75 mm with the help of the plastic shredding machine. Agglomerator and scrap shredders. Thin films made of polyethylene and polypropylene carrier bags are shredded in the agglomerator and solid plastic material is shredded in the scrap grinder, e.g. B. Plastic bottles, drip lines, electrical cable lines, etc.

Details of Shredding Machine:

a) Agglomerator:

An “agglomerator” is used to shred polyethylene. In this process, thin plastic waste bags are cut into small pieces using fixed and rotary knives. The entire process took 20 to 25 minutes to chop.

b) Specification of Agglomerator:

- Vessels with a diameter of 600 mm. X 900mm high.
- Rotating blades – 4.

• Fixed blades – 6.

• Ph-induction AC motor – 30 HP. Manufacturer: Crompton Greaves ATK 222, model SE/A2, 30 HP.

• Blade length: 200 mm.

PLASTIC WASTE BLENDING MATERIALS

a) Preparation of blend:

Preparation of the mixture Polyethylene carrier bags are cut into pieces using a shredding machine. They are sieved and the plastic parts that pass through a 4.75 mm sieve and remain at a 2.36 mm sieve are collected. These plastic pieces are slowly added to the hot bitumen at a temperature of around 170-1800°C. The mixture was stirred well with a mechanical stirrer for approximately 20 to 30 minutes. Polymer-bitumen mixtures of different compositions can be prepared and used to carry out various tests.

b) Characterization of blend:

At the time of laboratory tests for the characterization of bitumen, the following test is adopted:

c) Separation Test (IRC-SP: 53-1999):

(IRC-SP: 53-1999) Samples of different composition can be subjected to the separation test. Homogeneity can be achieved up to a mixture of around 1.5%. Beyond this composition, the variation in softening point is large

d) Characterization of Plastic Waste-Bitumen Blend for Flexible Pavement:

The usefulness of the bitumen-aggregate mixture mixed with plastic waste for flexible road construction is characterized by the study of the pull-off value and the Marshall stability value of the mixture for mixtures with a maximum of 1.5% plastic waste.

Preparation of Plastic-Waste Coated Aggregate:

Production of aggregates coated with plastic waste The aggregates are heated to around 1700C; The plastic waste is shredded to a size between 2.36 mm and 4.75 mm. This shredded plastic waste is placed over hot aggregate with constant mixing to achieve even distribution. The plastic is softened and placed over the aggregate. The hot plastic waste coated aggregates are mixed with hot grade 60/70 or 80/100 bitumen (160°C).

A scrap shredding machine is used to shred solid plastic waste made of polypropylene. In this process, solid plastic waste is cut into small pieces using two rotating and one fixed blades. This entire process results in one output per hour. Below are the specifications of the scrap mill:

• Output 7.5 kg/h.

• Rotor length: 200 mm

• Blade length: 200 mm

• No. Number of rotating blades: 2 pieces

• Fixed blade: 1 piece

• Motor: 3 HP, 900 rpm

Figure: Scrap Shredding Machine

RESULTS AND DISCUSSIONS

Based on the above methodology, various aspects of polymer coated aggregates are discussed below:

Aggregate Impact Value

Coating of plastics improves the aggregate impact value and therefore the quality of the aggregate. In addition, poor aggregate quality can be made usable by coating with polymers. It helps to improve the quality of flexible coverings. This shows the resistance of the unit to shocks. Its range should be less than 10%.

Aggregate Crushing Value

The aggregate with lower crushing value indicates less crushed fraction under load and would result in longer road life. Weaker aggregates would be crushed under the traffic load. It is clear from the table that plastic-coated aggregates have a lower refractive index and can withstand traffic loads more efficiently than the plain aggregates. The results show that the aggregates are within the range according to ISS. Its range should be less than 30-35%.

The specific gravity of an aggregate is an indirect measure of its strength. The greater the specific gravity, the higher the strength. The specific gravity value of simple aggregates is lower compared to that of plastic-coated aggregates. Since aggregates with low specific gravity are generally weaker than those with higher specific gravity, the results suggest that the specific gravity of the aggregates increases and thus their strength increases. The range should be between 2.5 and 3.0%.

Stripping Value

The stripping value indicates the effects of moisture on the adhesion of the bitumen film to the surface particles of the aggregate. The plastic coating of the aggregates does not result in any removal value. This indicates that the aggregates are more suitable for bituminous road construction than pure aggregates. The results obtained with the control sample are within the range of IRC standards, while the coating of the aggregate reduces the affinity of the aggregate for water. Its area should be less than 25%.

Water Absorption

The aggregate is also selected on the basis of moisture absorption capacity. Covering it with plastic improved the quality of the aggregate in terms of moisture absorption. The plastic coating reduces moisture absorption and helps improve the quality of the aggregate and its performance in the flexible pavement. The results show that the moisture absorption of the aggregate is within the IRC specifications, which decreased to zero due to the coating. Its range should be less than 10%.

Los Angeles Abrasion Value

The repeated movement of the vehicle causes some wear to the road surface. This test indicates wear in percent. This study found that the percentage wear value of plastic-coated aggregates is in descending order relative to the percentage of plastics. When the Los Angeles abrasion value of the plain aggregates is compared to that of the plastic-coated aggregates, the values for coated aggregates are lower. The results obtained are within the range and can therefore be used for construction. Its range should be less than 35%.

Percentage of Plastic	Moisture Absorption (%)	Aggregate Impact Value (%)	Aggregate Crushing Value (%)	Los Angeles Abrasion Value (%)	Specific Gravity	Stripping Value (%)
Control Specimen	1.7	5.43	19.2	13.42	2.45	8%
PP8	Nil	4.91	13.33	10.74	2.7	Nil
PP10	Nil		4.26		9.82	9.41

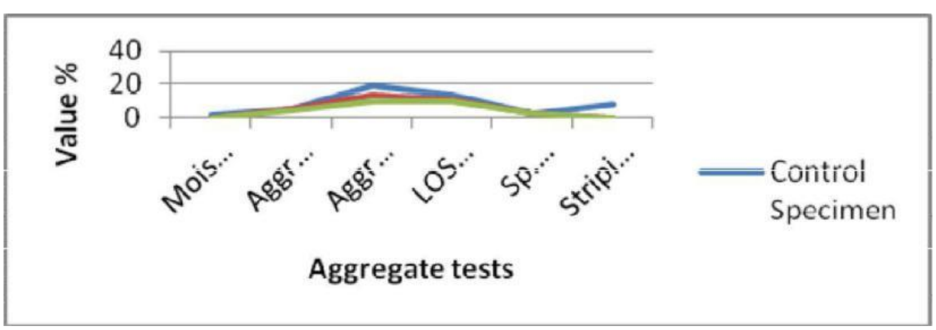
Results of tests on aggregates:

Based on the tests conducted on aggregates and bitumen, the following results are obtained. The tables are followed by the standard ranges of the respective tests.

Table: Observation Table for Aggregates Test Results

Results of Tests on Bitumen

Comparison of Tests Results



Graph: Comparison of Aggregate Test result

The above figure shows the comparison of the test results. From the figure it can be seen that using polymer gives better results compared to pure bitumen. Additionally, a higher percentage of polymer content results in lower impact, crush and abrasion values. The percentage moisture content and the removal value for plastic-coated aggregates are zero.

Table: Aggregate Impact Value

Aggregate Impact Value(%)	Nature
0-10	Exceptionally Strong
10-15	Strong
15-20	Medium
Above 20	Weak

Figure: Aggregate Figure Impact Testing Machine

Water Absorption of Aggregates

Purpose

Water absorption shows one way the porosity of aggregates. The more it absorbs, the less durable it is.

It must not be spread out more than a stone deep on the second cloth and exposed to an atmosphere protected from direct sunlight or other heat sources for less than 10 minutes until it appears The surface must be completely dry. The sample is then weighed (B). Water absorption must be calculated using the formula.

Table: Water Absorption Value

Water Absorption Value(%)	Use Of Aggregate
0-2	Surface Course
2-4	Base Course
Above 4	Subbase Course And Below

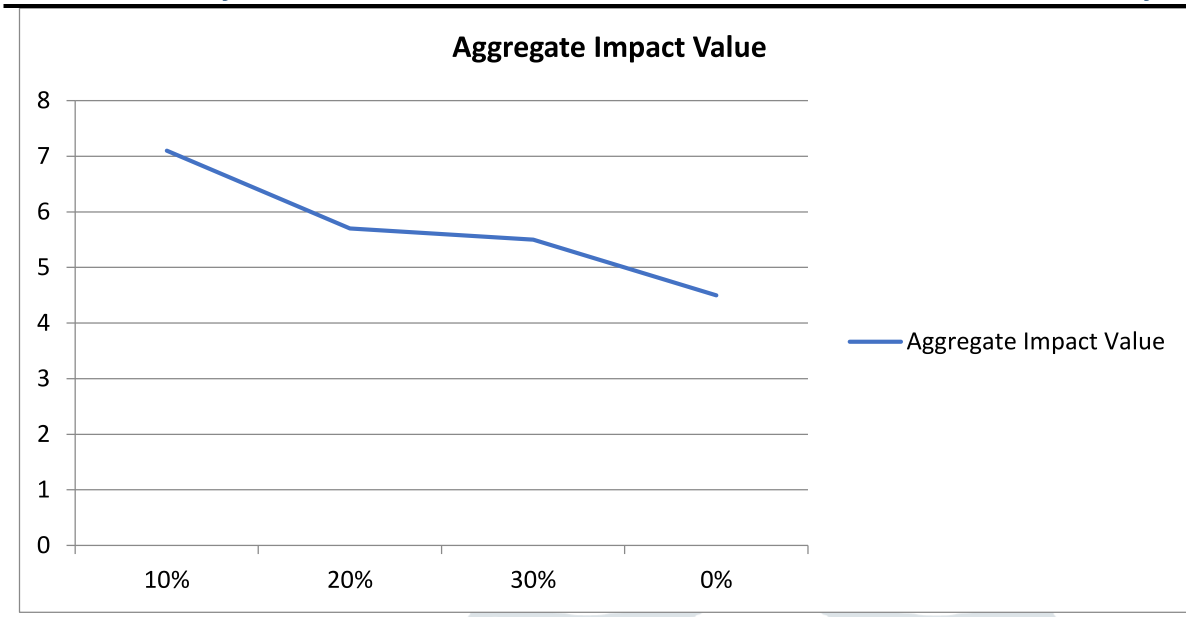
Bituminous Stripping of Aggregates Test

Purpose

The stripping value indicates the adhesion properties of aggregates with different types of bituminous binders, so that the suitability of aggregates can be determined.

Table: Comparison Table

Plasticity (%)	Aggregate Impact Value	Water Absorption Value	Stripping Value
10	7.1	2.3	2
20	5.7	1.9	3
30	5.5	1.9	5
0	11.1	3.4	7



Graphical Representation

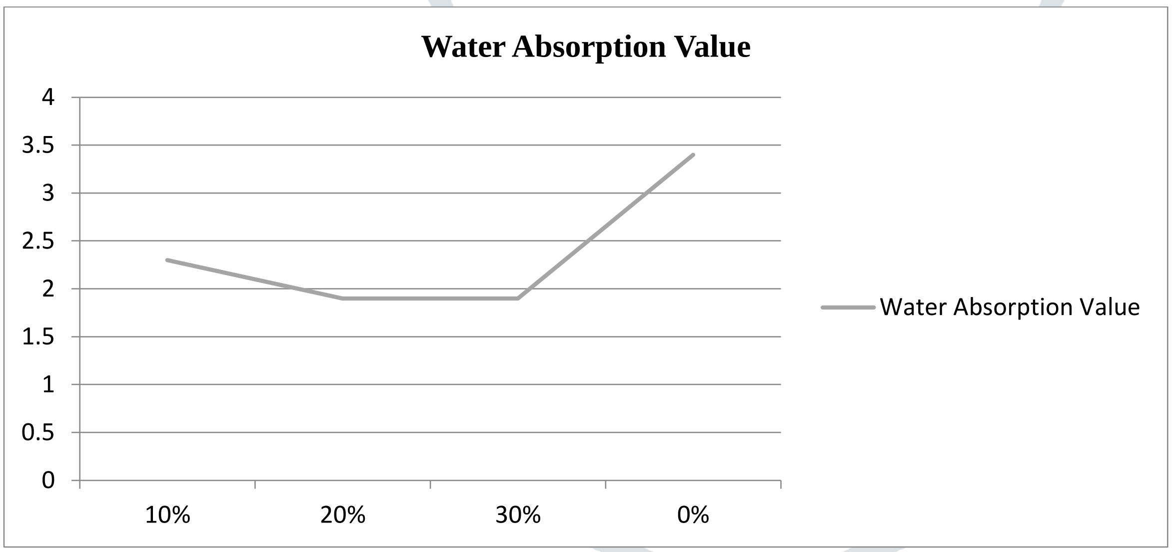


Figure: Water Absorption Value Graph

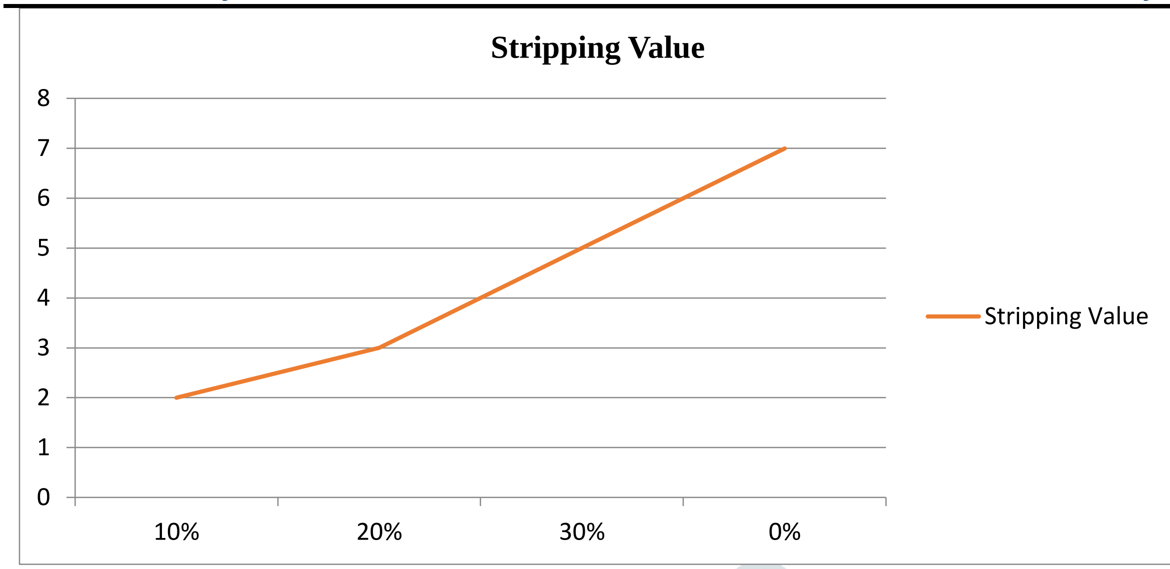


Figure: Stripping Value Graph

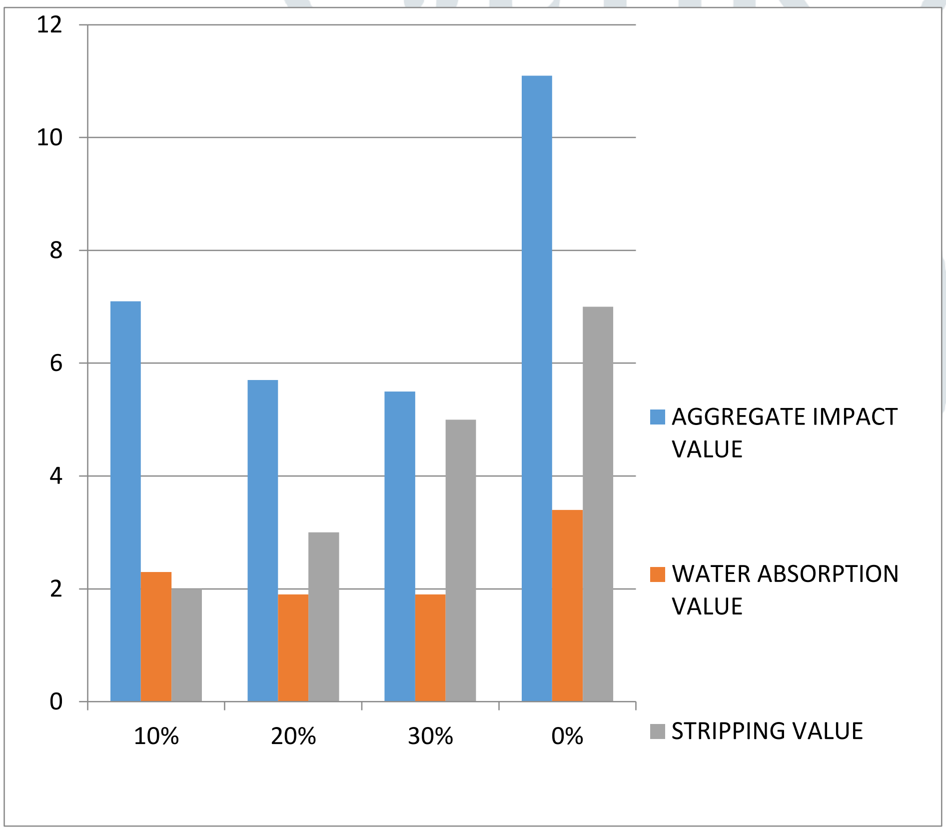


Figure: Combined Graph

CONCLUSION

Plastic coatings on aggregates are used for better performance of roads. This contributes to a better bonding of the bitumen with the plastic waste coated aggregate as the bonding is improved and the contact area between polymers and bitumen is increased. The polymer coating also reduces voids. This prevents moisture absorption and oxidation of bitumen due to trapped air. This results in less rutting and fraying and prevents potholes from forming. The roads can withstand heavy traffic and have better durability. Below are some points that emerged from the study:

1. The overall impact value of the control sample was 5.43%. For PP8 it fell to 4.91% and for PP10 to 4.26%. The impairment was 10% for PP8 and 22% for PP10. This shows that the toughness of the aggregate has been increased to withstand the impacts.

2. The refractive index 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. A low aggregate crushing value indicates strong aggregates because the fraction crushed is small.

3. The specific gravity of the aggregate increases from 2.45 for the control sample to 2.7 for PP8 and 2.85 for PP10 due to the plastic coating.

4. The stripping value was reduced from 8% for the control sample to zero for PP8 and PP10. This shows that coated aggregates are more suitable for bitumen construction than pure aggregates.

5. Water absorption was also reduced to zero for PP8 and PP10 from 1.7% in the control sample.

6. The Los Angeles abrasion value of the control sample was 13.42%. Coating the aggregate with polymer increased the abrasion value by 19.97% for PP8 and by 29.88% for PP10. This indicates the hardness of the aggregate. In short, we can conclude that the use of plastic waste in the mixture helps to reduce the need for bitumen by about 10%, increase the strength and performance of the road, avoid the use of anti-stripping agents and disposal of bitumen to eliminate plastic waste through incineration and landfill and ultimately develop a technology that is environmentally friendly.

Increased traffic conditions will and will shorten the lifespan of roads. Plastic roads serve as prevention and will ultimately be the cure. It will save millions of dollars in the future and reduce resource consumption for construction.

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