Case Study on Plastic Roads

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Abstract

Plastic roads are made entirely of plastic or of composites of plastic with other materials. Plastic roads are different from standard roads in the respect that standard roads are made from asphalt concrete, which consists of mineral aggregates and asphalt.

Keywords*: - Asphalt Mix, Prefabricated Elements, Waste Plastic.*

INTRODUCTION

Plastic waste, or plastic pollution, is 'the accumulation of plastic objects (e.g.: plastic bottles and much more) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans. With no improvements to managing waste beyond what's already in place today, 99 million tons of uncontrolled plastic waste would end up in the environment by 2030.

... It would be the equivalent of one dump truck tipping a load of plastic into the ocean every minute every day for a year. The global campaign to gain control of plastic waste is one of the fastest-growing environmental causes ever mounted. Yet it
hasn‘t been enough to make a dent in the growing tonnage of discarded plastic that ends up in the seas. In the next 10 years, the waste that slides into waterways, and ultimately the oceans, will reach 22 million tons and possibly as much as 58 million tons a year. And that‘s the ―good‖ news—because that estimate takes into account thousands of ambitious commitments by government and industry to reduce plastic pollution.

Without those pledges, a business-as-usual scenario would be almost twice as bad. With no improvements to managing waste beyond what‘s already in place today, 99 million tons of uncontrolled plastic waste
would end up in the environment by 2030.

These two scenarios, the result of new research by an international team of scientists, are a far cry from the first global tally published in 2015, which estimated that an average of 8.8 million tons flow into the oceans annually. That was a figure so startling to the world when it was published five years ago, it helped invigorate the plastic trash movement.

Jenna Jambeck, the University of Georgia engineering professor who calculated that number, also came up with a vivid analogy to put it in context. It would be the equivalent of one dump truck tipping a load of plastic into the ocean every minute every day for a year. Jambeck is also part of the team that came up with the new calculations. But coming up with a new way to visualize 22 to 58 million tons proved a challenge.

―I don‘t know. We‘re getting into the realm of what‘s incomprehensible,‖ she says. ―How about a football stadium filled with plastic every day? Or enough plastic to cover Rhode Island or the country of Luxembourg ankle deep?‖

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Neither of these new analogies, while accurate, captures the magnitude of what‘s at stake. (More: We're drowning in plastic—find out why.)

Like climate change, a lot rides on how the global community responds in the next couple of decades. And, though the parallels between the problem of plastic waste and climate change are obvious— both are rooted in oil, the basic ingredient to make plastics, they are dissimilar in one key way: plastic‘s persistence. While there is some possibility, however remote, that technology and restoration of natural ecosystems could remove CO2 from the atmosphere, there is no such analog for plastic. Virtually indestructible, it doesn‘t disappear.

―For me, the biggest issue is the question of permanence,‖ says George Leonard, the Ocean Conservancy‘s chief scientist and a

member of the team that produced this newest forecast. ―If we don‘t get the plastic pollution problem in the ocean under control, we threaten contaminating the entire marine food web, from phytoplankton to whales. And by the time the science catches up to this, perhaps definitively concluding that this is problematic, it will be too late. We will not be able to go back. That massive amount of plastic will be embedded in the ocean‘s wildlife essentially forever.‖

CLASSIFICATION

There are two kinds of Plastic roads:

- The "Plastic Road": consist of modular, hollow and prefabricated road elements made from consumer waste plastics, and
- Plastic Roads: consist of an asphalt mix with plastic waste incorporated into the asphalt mixture.

Objectives

Plastic roads

First recycled glass and plastic road in New South Wales, Australia at suburb Engadine.

Plastic roads first developed by Rajagopalan Vasudevan in 2001, consist of an asphalt mix with plastic waste
incorporated into the asphalt mixture. The implementation of plastics in roads also opens a new option for recycling post- consumer plastics. Australia, Indonesia, India, the United Kingdom, the United States, and many other countries have used technology which can incorporate plastic waste into an asphalt mix.

In the Netherlands in the cities of Zwolle and Giethoorn there are two bicycle paths installed made purely from waste plastics. This is the result of collaboration between three companies: VolkerWessels, Wavin and Total. The "PlasticRoad" cannot be compared with normal plastic roads. The "PlasticRoad" built by the three companies consists of prefabricated, hollow, modular elements made from consumer waste plastics, and is a unique innovation all over the world. The original idea for the Plastic Road was invented by Simon Jorritsma and Anne Koudstaal but was inspired from the work that was being carried out in India. In 2015, the PlasticRoad concept was presented to the world with the goal of finding partners to bring the idea to reality The PlasticRoad has a lot of advantages compared to normal roads, including hollow space for the storage of excessive rainwater, the light weight, and the sustainability benefits.

MATERIALS

All the building structures are disposed of different types of plastic material. These materials are either called plastic waste materials or materials of construction. The following are the different types of materials used in the casting of slabs

- Asphalt mix
- Prefabricated Elements
- Waste Plastic

INTIAL DEVELOPMENT

The technology was initially developed and patented by Rajagopalan Vasudevan of the Thiagarajar College of Engineering. He developed an innovative method to reuse plastic waste to construct better, more durable and very cost-effective roads. This method will help in making roads much faster and also will save the environment from dangerous plastic waste. The roads also show greater resistance to damages caused by heavy rains. In an interview with *The Better India*, he explained, ―The advantages of using waste plastics for road construction are many. The process is easy and does not need any new machinery. For every kilo of stone, 50 gms of bitumen are used and 1/10th of this is plastic waste; this reduces the amount of bitumen being used. Plastic increases the aggregate impact value and improves the quality of flexible pavements. Wear and tear of the roads has decreased to a large extent.

The plastic-bitumen road-laying technique covered under a patent held by the Thiagarajar College of Engineering in 2006. Dr. Vasudevan has since made it free to use for the greater good. The technology is simple and is described in a dedicated TCE website.

It involves

a) collecting waste plastics, including plastic carry bags, cups, soft and hard foams, and laminated plastics;
b) cleaning it by washing;
c) shredding it to a uniform size;
d) melting the waste plastics at 165 °C, and blending it with hot aggregates and bitumen and using this mixture to lay the road.

CONSTRUCTION

Since plastic roads are a relatively new idea, construction processes vary. In Jamshedpur, India, roads are created from a mix of plastic and bitumen. [2] In Indonesia roads are also being built using a plastic-asphalt mix in many areas including Bali, Surabaya, Bekasi, Makassar, Solo, and Tangerang.

These roads are made from recycled plastics, and the first step in constructing them is to collect and manage the plastic material. The plastics involved in building these roads consist mainly of common post-consumer products such as product packaging. Some of the most common plastics used in packaging are polyethylene terephthalate (PET or PETE), polypropylene (PP), and high- and low- density polyethylene (HDPE and LDPE). These materials are first sorted from plastic waste. After sorting, the material is cleaned, dried, and shredded. The shredded plastic is mixed and melted at around 170° C. Hot bitumen is then added and mixed with the melted plastic. After mixing the mixture is laid as one would with regular asphalt concrete.

So far, no large-scale, systematic approach has been employed to build roads entirely of plastics in Netherlands. On September 13, 2018, the Dutch company Volkerwessels built a bicycle path made of recycled plastic in Zwolle, in the northeast part of the Netherlands. According to the Guardian, "A second path is to be installed in Giethoorn in Overijssel, and Rotterdam is the city most likely to take up the technology."

USEAGE BY COUNTRY

India

Chennai was among the first cities globally to adapt the technology in a big way when the municipality commissioned 1000 km of plastic roads in 2004.Since then all major municipalities in India has experimented with the technology including Pune, Mumbai, Surat, Indore, Delhi, Lucknow etc.

Chennai: While the plastic roads may be a new concept in many parts of India, Chennai has been experimenting with it since 2011. Chennai has used nearly 1,600 tonnes of plastic waste to construct 1,035.23 kilometres length of roads in recent years, which include N.S.C Bose road, Halls road, Ethiraj Silai Street and Sardar Patel Street.

Pune: Using bitumen technology on waste plastic, the Pune Municipal Corporation constructed a 150-metre stretch of Bhagwat lane at Navi Peth near Vaikunth Crematorium in 2016. The other trial patches in Pune include Dattawadi Kaka Halwai Lane, Katraj Dairy, Magarpatta City HCMTR Road, Kavde Mala Road, Koregaon Park Lane No 3 and Yeravada Sadal Baba Darga Road from Chandrama Chowk.

Jamshedpur: Jamshedpur Utility and Services Company (JUSCO), which is a subsidiary company of Tata Steel, constructed a 12-15 km road in the steel city as well as Tata Steel Works using plastic road, including a nearly 1 km stretch in Ranchi, 500m stretch each in Dhurwa and Morabadi, 3 km of roads in Chas and Jamtara each and 500m stretch in Giridih.

Indore: Dating 2014, the Madhya Pradesh Rural Road Development Authority (MPRRDA) has constructed around 35 km of roads in 17 districts with plastic waste

Surat: The idea of using plastic-bitumen mix was executed in January 2017. The problem of potholes significantly reduced as no cracks developed in areas where roads were layered with waste plastic

The technology has penetrated deeply and has found application even in far flung areas such as Meghalaya, where a village converted 430 kg of plastic waste into a kilometer long road in 2018.

In December 2019, India has built 21,000 miles of roads using plastic waste. Till now, the country has almost 33,700 km of plastic roadways that means every 1 km road uses 1 million plastic bags.

United Kingdom

In January 2019, the Department for Transport announced a £1.6 million UK trial of a plastic road technology developed by MacRebur, an asphalt enhancement company based in Scotland.

In MacRebur's process, anywhere between 3–10 kg of waste plastic is used in each ton of asphalt. The aim of the initiative is three-fold: to use the millions of tons of plastic waste currently sitting in UK landfills, to reduce the millions of pounds of government money spent on new roads, maintenance, and pothole repair, and to make roads stronger and longer-lasting.

MacRebur's technology includes the patent-pending MR6, MR8 and MR10, all of which use a carefully selected mixture of polymers, specifically designed to improve the strength and durability of asphalt and reduce the quantity of bitumen required in the mix. The polymers are made from 100% waste materials and are used in the making of both hot and warm mix asphalt. The method of manufacture for these polymers means they contain no microplastics.

Cumbria was the first council in the UK to use the patented asphalt enhancement. Since then, the polymers have also been

laid in Dumfries and Galloway, Gloucester, London, Newcastle upon Tyne, Durham and in the Central Belt. As part of the project, research into the technology will be carried out by Gaist, as well as The University of Nottingham, University of Central Lancashire, University of the Sunshine Coast, in Australia and the University of California.

PROPERTIES

Below are some of the advantages and disadvantages of plastic roads.

Advantages

- In the proposed model by Volkerwessels, plastic roads can have hollow space built in to allow ease of wiring, connecting pipes, etc.
- Since plastics come with various chemical and physical properties, roads can be engineered to meet specific requirements (e.g. weather and wear resistance)
- Plastic roads can be built from waste plastic --- the majority of which is usually put into landfill, incinerated, or polluted into the environment. Land- filling and incinerating plastic are both problematic methods of managing
plastic waste. Plastics in landfills can leak pollutants into the surrounding soil; incinerating creates gaseous pollutants, such as carbon dioxide.
- Plastic-bitumen composite roads need not be especially discriminating with the plastics used, thus increasing the reuse of plastic. Most plastic waste is not recycled because it is usually mixed with different types of plastic and non-plastic (e.g. paper labels) and, so far, the segregation process is labor- intensive with no easy solution.
- Using less asphalt saves on cost and resources. Asphalt concrete requires petroleum which is becoming more scarce.
- The addition of plastic in asphalt can reduce the viscosity of the mix. This allows a lower working temperature, which lowers VOC and CO emissions.
- Plastic-bitumen composite roads have better wear resistance than standard asphalt concrete roads. They do not absorb water; have better flexibility which results in less rutting and less need for repair. Road surfaces remain smooth, are lower maintenance, and absorb sound better.

Disadvantages

- Pure plastic roads require use of compatible plastics because, when melted, plastics of different types may phase-separate and cause structural weaknesses, which can lead to premature failure.

- Plastics in the road can break down into microplastics and can find their way into the soil and bodies of water. These microplastics can also absorb other pollutants.

- Every time maintenance is performed on these modular roads the flow of power, water, and internet that has been installed within will be interrupted.

CONCLUSION

Plastics increase the melting point of the bitumen. The use of this plastic in road construction is an innovative technology which not only strengthens the road but also increases the road life. The analysis in this paper reveals that Durability, strength and cost.

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