An Overview of Potential and Feasibility of Plastic Road for Indian Scenario

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Abstract*—Roads play a vital part in a country's development. In a densely populated country like India, Roads portray are an indispensable part in transportation of goods and passengers. Did u ever think of the process behind laying a road? Road laying involves lot of processes and is a high labour demanding industry. But have you ever wondered from where do we get resource for such huge magnitude of roads? Conventional road laying methods involve mainly Asphalt which is a by-product of petroleum which makes it non-renewable. This throws a major challenge against Sustainable development which the globe urges. This is where the modern marvel of Plastic roads comes into play. There is around 34,000 km of plastic roads in India, mostly in Rural India. Plastic roads involve Shredded pieces of day to day plastics like Polyvinyl chloride (PVC) Polypropylene (PP) High Density Poly Ethylene (HDPE), Low Density Poly Ethylene (LDPE). The Plastic roads where first introduced by Prof.Rajagopalan Vasudevan of the Chemistry department of Thiyagaraja College of Engineering, Madurai, Tamil Nadu. It was patented and then laid for the first time in Jamshedpur, Jharkhand on 30th November 2011 by the government of India. The pros of a plastic road are that it gives all weather and wear resistance roads. It uses tonnes and tonnes of plastic in its production which is aneco-friendlyapproach. This also saves the cost of road laying by around 8% when compared to Conventional methods. Plastic roads are a testament to the fact that Science leads to betterment of life when used appropriate.

I. INTRODUCTION

Roads play a key role in a country's growth and development. Roads bring accessibility to amenities and economic prosperity of a nation Roads simulate educational, health and employment services which are the most essential options to eradicate poverty of a nation. In a country like India where the population is sky high roads are indispensable as they transport goods and passengers of huge multitudes. Door to door services are only possible due the existence of roads. In India which is a geographically diverse nation, roads are the most convenient and possible mode of transportation

Bechtel and Hochtief are the pioneers in the infrastructure industry. Their notable works are the London Airport project and the Gotthard tunnel in Switzerland. L&T and Tata are also mentionable leaders in the civil industry. Their noteworthy works are the Parliament building in New Delhi and the Kanteveera stadium in Bangalore.

II. CONVENTIONAL ROADS

Roads today are made of deep strength asphalt, bitumen, crushed rock, chalk rocks, compacted sand, and as far as rural roads are concerned, they are made of earth sand, loam, gravel, and bituminous spray seal. A road is said to be in its optimal condition when water is kept away from roads, built on a firm foundation, when designed as all-weather resistance, when they are built on well compacted soil and obviously when they maintain good track records.

But the problem with conventional roads is that they lead to several ecological and environmental constraints which leave a never ending impact not only on human life but also on other life forms. Conventional roads lead to blockage of rainwater, Causes fragmentation of forests [1]. Roads not only serve as a source of interference, but also provide space for all other kinds of pollution.

The conventional roads are less durable and not all weather resistant. They become soft at hot weather and heavy duty vehicle on such a road always possess a threat of an accident occurrence which could prove to be fatal. At the same time, Roads at cold temperature could lead to formation of cracks which may result in deformation of roads [2]. Moreover, the most used component in conventional road laying techniques is Asphalt which is a

by-product of Petroleum which is non-renewable. So the durability of this method is severely questioned.

III. PLASTIC ROADS

Plastic roads are roads that are either laid completely made of plastic or by collaborating with other construction components. This is an eco-friendly innovation where it uses tonnes and tonnes of plastic which needs to be eradicated from this globe to lead a pollution free world. Some of the plastic components used in road laying are Polyvinyl chloride (PVC), Polypropylene (PP), High Density Poly Ethylene (HDPE), Low Density Poly Ethylene (LDPE) [3].

Prof. Rajgopalan Vasudevan of the Chemistry Department from Thiyagaraja College of Engineering regarded as the "Plastic man of India" is the creator of this innovative idea. It was first tested in his college premises and later patented and then introduced in Jamshedpur, Jharkhand on 30th November 2011 by the Government of India. Now there is around 34,000 km of plastic roads in India predominantly in rural areas [9]. The Advantages of a plastic road are:

- Heating and power generation is incorporated with these roads
- Plastics give all weather and wear resistance
- Around 8 tonnes of plastic is being used per km of plastic road, thus it greatly reduces the magnitude of plastic
- Using less asphalt saves our resources leading to sustainable development. It reduces up to 2% of global carbon emissions.
- Easier to use and maintain than asphalt roads

IV. METHODOLOGY

To begin with, the introduction of this idea provided lots and lots of rag pickers with a job where they collect plastic from house hold and they are sorted out as incorporable plastics which can be mixed with the road laying mixture. Then as the next step, this plastic material is shredded using a shredding machine into 2-3 mm sieves using a shredding machine. Now the aggregate mix is heated up to 160 degrees Celsius and added to the mixing chamber and then bitumen is added for good binding and heated at 165 degrees Celsius. Then shredded plastic is added to the aggregate. It gets coated uniformly by oil within 30-60 seconds and laid at a temperature between 110 degrees to 120 degrees Celsius [11].

The following are the different plastics that can be used as raw material for construction of plastic roads:

Polyvinylchloride (PVC) is considered to be one of the most polluting plastic which releases dioxins when burnt or incinerated. Indian researchers have PVC after modifying it but the problem remained was the formation of dioxins when burnt or directly heated in any form [7]. There is a possibility of using PVC without hazardous by products by making a homogenous blend with bitumen which can be achieve at the temperature of 160°C. But it has to be initially treated with a chemical modifier to enhance the blending. It was also found that adding PVC to the mix increases strength, stability and resistance to deformation.

High density polyethylene (HDPE) is light weighted without compromising its strength. It has a good impact resistance and high tolerance to environmental effects like mold formation, rotting and so on [11]. HDPE is very flexible as it can be molded into various shapes very easily. It has a good tolerance towards weather with increased life time.

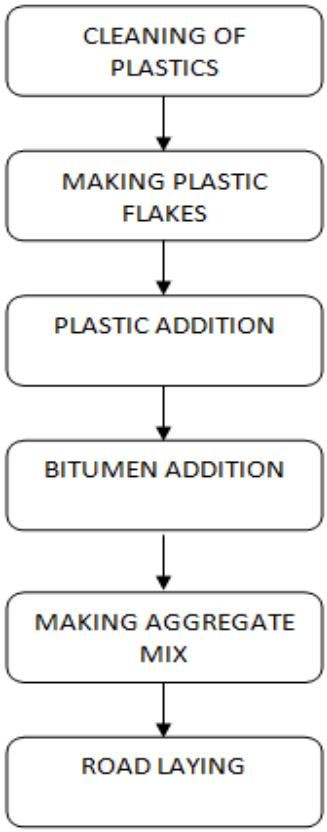

Fig.1 Process Flow of plastic Road

There are two main processes through which the waste plastics are mixed with the bitumen namely, wet process and dry process. The following table compares the processes involved in them.

WET PROCESS	DRY PROCESS
• Plastics are collects, classified and then stored	• Plastics are collects, classified and then stored
• Collected plastics are cleaned properly, dried and stored.	• Collected plastics are cleaned properly, dried and stored.
• The cleaned plastics	• The cleaned plastics

are shredded to a size ranging from 2 to 4 mm.	are shredded to a size ranging from 1.2 to 4.5 mm.
• The plastic flakes obtained is mixed with bitumen at 180°C	• In the mixing chamber, the aggregate is raised to the temperature of 165°C.
• The blend is then stirred with mechanical stirrer at an elevated temperature of 130-150°C	• The shredded plastics are added to the hot aggregate forming a uniform coating in less than 45 seconds.
• The blend is cooled and added with the aggregate from 120 to 140°C	• The bitumen is added to the aggregate between 150-160°C.
• The road is laid with this mixture from 110 to 130°C	• The road is laid with this mixture from 110 to 120°C

Table.1 Comparison of wet process and dry process of plastic road methods

V. ECONOMICS OF A PLASTIC ROAD

ROAD TYPE	PER 1 KM (Rs.)	PER 10KM (Rs.)	PER 100KM (Rs.)
ASPHALT ROAD	5,00,000	5,00,0000	5,00,00,000
PLASTIC ROAD	4,55,000	4,55,0000	4,55,00,000
SAVINGS	45,000	4,50,000	4,55,00,000

Table.2 Cost of road based on the type and length

Cost plays a major role on deciding whether an innovation needs to be implemented on a daily basis or not. As far as plastic roads are concerned, every kilometer of plastic road consumes up to 8 tonnes of plastic [7]. Plastic roads roughly concedes 8% lesser than that of the cost of an asphalt road, mathematically speaking, after taking all expenses of an asphalt road into consideration we come up with a number of Rs. 5,00,000/- whereas a plastic road costs only Rs. 4,55,000/- (per kilometer), saving up to Rs. 45,000/- every kilometer.

Fig.2 Percentage of cost saving for different types of roads

VI. INFERENCE

Plastic road are more durable and stable compared to conventional roads. They are comparatively less expensive and thus creates less financial burden for developing and under developed countries to take up the project. It is also eco friendly as it reduces the amount of non degradable plastic waste that is increasing in quantity day by day at an alarming rate. Though it doesn't eradicate the amount of plastic waste that is thrown in to Mother Nature, it transforms it from a hazardous non-degradable waste into much less threatening and useful commodity. Plastic roads also have the advantage of less maintenance compare to conventional roads as it doesn't inquire damage as a conventional road does and also has good stability and strength. This also is a result of its unique property which makes it all weather and wear resistant. In a longer run, when sustainability becomes the main focus, plastic roads will top the list for eco-friendly construction [10]. In a world of increasing population and decreasing employment opportunity, this can create new ventures and avenues for investment, research and development which in turn increases new job opportunity to all kinds of people.

The following chart sourced by Central Pollution Control Board under The Ministry of Environment, Forest and Climate Change (MoEFCC) [12] shows the trend of plastic waste produced by few of the largest cities in India for the year 2010-2011. Everyday these cities produce massive amount of plastic waste at an alarming rate and the figures are predicted to increase in the consecutive years. Delhi being the capital of India tops the list by producing 690 tonnes of plastic waste every day. On the other hand, Bengaluru is the least producer of plastic waste by a rate of 314 tonnes per day. This is only evidential about the ever growing threat posed by the use of plastic and its ill effects to the society and the environment at large. When plastic road becomes a ground reality in India, it can reduce these figures at some significant level as there is no appropriate method for disposing these plastic materials.

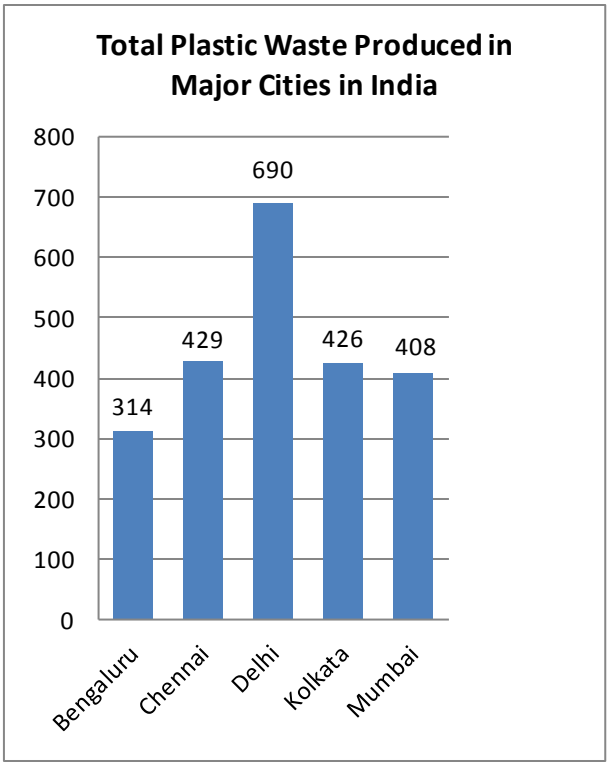

Fig.3 Total plastic waste produced in major cities of India

VII. CONCLUSION

From this above paper we have learnt a new innovative way of roads which not only reduces the cost of laying but also eliminates the treat of eliminating plastic from the society by incorporating them with the laying process. So plastic road proves to be a sustainable solution as well as an eco-friendly approach. Plastic roads also have no stripping which eliminates potholes. As plastics don't undergo leaching, it is destined to be more durable than the conventional roads. They can withstand high load under heavy traffic scenario without compromising its weather resistance capacity. Such meaningful innovations are the need of the hour and Plastic Roads prove to be a testimony to the fact that "Science leads to betterment of life when used appropriately."

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