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FEASIBILITY OF PLASTIC SOLID WASTE MANAGEMENT THROUGH ROAD ASPHALTING

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Abstract: Plastic waste management is major problem with growing cities and population. With increase in consumer demand the amount of waste generated has been very difficult to manage and mostly all of it fills our landfills. There have been many efforts in recycling it or reuse but it isn't enough for non-biodegradables, plastics etc. One such progress in plastic waste management is through using it in roads and improving it to make efficient compared to bituminous roads.

Key words

Plastic Road, Aggregates, Plastic Waste, Bitumen.

I. INTRODUCTION

The technology behind this innovation was first introduced by Professor Dr. Vasudevan in the year 2002. And henceforth Government of various states has been using plastics in a road which therefore cuts down the use of bitumen. The Indian Road Congress introduced a code IRC: SP: 98:2013 for to use 8 percentage of plastic in road construction. Plastic Roads over these years have been constructed in India and also it has been adapted by various countries.

II. OBJECTIVE

- Case studies on the implementation of plastic waste in roads in the states of Tamil Nadu, Karnataka and Jharkhand. Also, the potential replication of model these states in Pune district, Maharashtra.
- To find the estimate cost that will be saved in the Outer ring road 173 Km Road stretch project of Pune using waste plastics.

III. Process of Manufacturing Roads using Plastic Waste.

The process of making Plastic Road is as follows: -

Plastic waste can be used in hot mix to improve physical properties of bituminous aggregate mix by 'Dry Process' or 'Wet Process'. The technology as developed and explained by Dr Vasudevan, a Chemistry Professor at Thiagarajan College of Engineering, Madurai, incorporates the use of 'Plastone', a mixture of stone chips and waste plastic bags (thickness 40-70 μm) which is heated at 150-170C during production, in laying roads, pavements and flooring purposes as an alternative to interlocking paver blocks. At this processing temperature, the plastic waste is heated enough to act as an adhesive in binding stone chips and not generating any toxic gases. The aggregate becomes water proof after getting coated with molten plastic. This step is followed by the addition of hot plastic-aggregate mix to hot bitumen while maintain the process temperature. This approach is known as 'Dry Process'. The 'Wet Process' involves mixing of plastic to hot bitumen followed by mixing with hot aggregate. Both the processes lead to the formation of plastic modified bituminous aggregate mix with enhanced properties imparting strength, stability and durability to the roads. [1]

IV. CASE STUDY

4.1 TAMIL NADU

The first plastic road was laid in the year 2002 in the village Kovilpatti of Tuticorin district. The objective to achieve involves Panchayati Raj, state nodal agency, Ministry of Rural development, District Rural Development Agency (DRDA) and Self-Help Groups (SHGs).

The initiation promotes a better way to deal with the plastic waste generated at urban, sub urban and rural areas. The Tamil Nadu Corporation for Development of Women Ltd. under the control of Rural development and Panchayati Raj is important to develop the SHGs which is primarily involved in setting up these SHGs and Centre which collect, segregate and help in operations of plastic waste and up till today there have been 21454 centers in 29 districts.

- The Execution and selection of project is done by the district collector and sub ordinates with funds been allocated through Ministry of Rural Development, Environment, Forest departments.
- The state government also allocates some funds under Pradhan Mantri Gram Sadak Yojana with policies such that a percentage of roads will be constructed as plastic roads. SHGs plays a vital role in providing the shredded plastics to the hot mix plant, thereafter the contractors are the key links between the SHGs and roads projects. [1]

4.2 Karnataka

This state constructed a road using plastic waste material and bituminous material. The main purpose was to dispose of plastic material, reduce the cost of construction as well as reduce maintenance costs. In order to improve the supply chain of plastic and properly navigate according to the MOU between KK Plastic Private Limited and BBMP (Bruhat Bengaluru Municipal Palike), they directly involve a private partnership.

Plastic waste has been successfully used in urban road construction in Karnataka. There is a memorandum of understanding between the government and the contractor in Karnataka. It was a combination of municipal administration, Pradhan Mantri Gram Sadak Yojana (PMGSY), KRRDA (Karnataka Rural Road Development Agencies) and KK Plastics Private Limited working on this project.

Plastic has been widely used in rural road construction in Karnataka for the past 10 years. A major responsibility of the Bengaluru City Municipal Board is to provide civic and infrastructure services to the city more than 10,000 tons of plastic waste have been reused in Karnataka since 2002 to build about 2500 kilometers of plastic roads. [1]

4.3 JHARKHAND

Jamshedpur utility and Services Company (Jusco limited and Tata steel subsidiary) has been dealing with the hazard of waste plastic and using it productively since 2004. In this project, Tarapore and Jamshedpur (construction and building services) have partnered with Singh Industries based in Jamshedpur This private organization carried out all activities associated with municipal authorities, such as collecting waste plastics, segregating them, shedding them, transporting them, and using them for road construction.

Plastic waste should be used to double the eco-benefits through its reuse in road construction, rather than draining, causing flooding, killing animals that eat it, and being disposed of in landfills and incinerators. In Jamshedpur Township, Dr. Vasudevan's patent has been used to implement pioneering technology. Guidelines JRC: SP: 98:2013 are used.

With the help of Tata Steel's 100% subsidiary company, Jusco, which maintains and provides municipal services in the Tata command area in the city, the company did a lot of road construction in 2011 between 12-15 km in the steel city and Tata Steel Works as well as widening 22 roads using environmentally friendly technologies to use waste plastic as a construction material. [1]

V. SCOPE OF WORK

Thereafter case studying various implementation models across three states in Tamil Nadu, Karnataka, Jharkhand there have been several challenges to overcome but the potential replication of these models can bring out the best in plastic waste management and also road pavements. The most sustainable for the urban city would be BBMP (Burhat Bengaluru Municipal Corporation) which directly solves the irregular supply of waste plastic by signing a MOU with a private sector company KK Plastics PVT LTD.

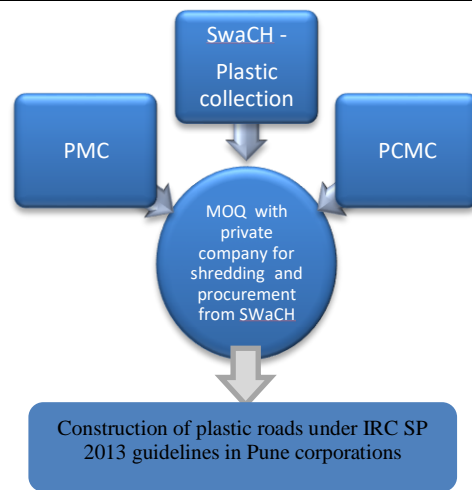
The waste management of plastics from segregating, collection, shredding to transporting directly to the hot mix plant is looked by the private entity. Therefore, the BBMP runs efficiently and has developed policies such as all 10 to 15% of black top roads will be plastic roads.

VI. Replication of BBMP (Gov. and private partnership) model in Pune

Pune one of the growing cities in India & Pimpri Chinchwad is a fast-growing township on the north-eastern borders of Pune. Pune has full potential to implement the private – municipal corporation partnership into sustainable disposal of waste plastic into pavement of roads. Pune city has two corporations and also the waste management is operated by a cooperative named by SwaCH which collects door to door waste and recycles organic waste into manure. Pimpri Chinchwad Municipal Corporation has already saved nearly Rs. 20,000,000 as a result of sorting and segregation done by SWaCH. It also stated that around out of total waste nearly 8 percent is plastic waste.

Here comes an opportunity For PCMC and PMC to use this plastic into their yearly sanctioned pavement of bituminous roads which will cut down cost and also the dispose of plastic into more useful way. As SWaCH will already be helping both corporations in waste management it solves the problem of door-to-door pickup and segregating the plastic. After this a private company with a signed MOU (just like BBMP and KK plastics PVT LTD) with both corporations can overlook the operation of procuring the plastic as per scheduled rates and shredding it to deliver to the hot mix plants where the plastic can be coated over the aggregate.

PMC and PCMC can now introduce policies to use the plastics as binder in 10 to 15 percent roads or as per the conditions from engineers and guidelines with IRC SP 2013 each year. These are more durable roads and also reduce the cost of maintenance compared to ordinary bituminous roads which can save over crore rupees over the coming years. [6]



VII. Cost Estimation on Ring Road Pune

7.1 Cost Estimation For 1KM Road

- ❖ Total Area of road 1KM

$$1000M \times 7.5M = 7500m^2$$

- ❖ Cost of road $7500M^2 \times RS 2975$

$$= Rs 2, 23, 12,500.$$

- ❖ Bitumen required for (7.5 m X 1000 m) road

$$= 42600 Kg \dots [2]$$

- ❖ Bitumen cost in road work

$$= 42,600 \times 52.04 \dots [4]$$

$$= 22, 16,904.$$

- According To JRC: SP: 98:2013 the Standard 8% of Plastic Is Used. Therefore, We Reduce the Cost of Bitumen.

When using plastic, the cost of bitumen

$$= 42,600 - 3408 = 39,192Kg$$

$$\therefore 39192 \times 52.04 = Rs 20, 39,551.$$

$$\therefore 22, 16,904 - 20, 39,551$$

We save **RS 177353.**

But,

- ❖ Cost of waste processing of plastic needs to be considered.

- Cost of plastic procurement = RS7/kg

- Cost of processing = RS5/kg

- Total cost waste plastic = RS12/kg

- ❖ Cost of plastic

$$= \text{Total kg of plastic use} \times \text{Total cost waste plastic}$$

$$= 3408 \times 12 = \mathbf{Rs 40896}$$

$$\therefore \text{Final cost reduction for } 7.5M \times 1000 M$$

$$= 177353 - 40896$$

$$= \mathbf{Rs 4, 36,457}$$

RATES OF MATERIAL AS PER MAHARASHTRA PWD

Item No.	Item Description	Area	Thickness	Quantity	Unit	Rate	Amount
2.11	Excavation In soil For Road Way	1 SQ.M	1.100m	1.10M ³	M ³	111	122.1
C1.3	Transportation For 3km			1.276M ³	M ³	193.71	247.17
2.28	Earthwork In Embankment	1M ²	0.500m	0.50M ³	M ³	553	276.5
3.01	Granular Sub- Base Grade-1	1M ²	0.100M	0.10	M ³	1898	189.8
3.02	Granular Sub- Base Grade-2	1M ²	0.150M	0.15	M ³	1883	282.45
3.23	Wet Mix Macadam	1M ²	0.250M	0.25	M ³	1965	491.25
3.29	PRIME COAT(0.6kg/M ²)	1M ²		1	M ²	27	27
3.35a	MODIFYING PENETRATION MACADAM (50MM Thickness)	1M ²		1	M ²	236	236
3.30	Tack Coat (2.589mm/10M ²) Vg30	1M ²		1	M ²	14	14
3.40	Bituminous Macadam (3.3%)	1M ²	0.050M	0.05	M ³	6007	300.35
3.30	TACK COAT (2.5kg/10M ²) VG30	1M ²		1	M ²	14	14
3.44	Dense Bituminous Macadam (4.50%)	1M ²	0.060M	0.06	M ³	7377	442.62
3.30	TACK COAT (2.5kg/10M ²) VG30	1M ²		1	M ²	14	14
3.48	Bituminous Concrete (5.40%)	1M ²	0.040M	0.04	M ³	7947	317.88
TOTAL COST PER M²							2975

7.2 The proposed ring road plan in Pune

- Total road length = 173KM
- Western side = 68KM
- Eastern side =105KM
- ❖ Therefore, the bituminous road required cost is
 $7500 \times 2975 \times 173$
 22312500×173
 = **Rs 3,86,00,62,500**
- ❖ The bitumen required in this road is
 $42600 \times 173 = 7369800\text{Kg}$



- ❖ Bitumen cost in road work
 $7369800 \times 52.04 = \text{Rs } 38,35,24,392.$

According To IRC: SP: 98:2013 the Standard 8% of Plastic is used.
Therefore, we reduce the cost of Bitumen.

- ❖ When using plastic, the cost of bitumen
 $= 7369800 - 589584$
 $= 6780216 \text{ Kg}$
- ❖ Bitumen cost Using plastic Road
 $6780216 \times 52.04 = \text{Rs } 35,28,42,440.$
Therefore
 $383524392 - 352842440$
 $= \text{Rs } 3,06,81,952.$

We save **RS 3, 06, 81,952**

But,

- ❖ The cost of waste processing of plastic needs to be considered.
- Cost of plastic procurement = RS7/kg
- Cost of processing = RS5/
- Total cost waste plastic = RS12/kg
- ❖ Cost of plastic
 $= \text{Total kg of plastic use} \times \text{Total cost waste plastic} = 589584 \times 12$
 $= \text{RS } 7,075,008.$
- ❖ Therefore, final cost reduction for **7.5 M X 173KM**
 $= 30681952 - 7075008$
 $= \text{Rs } 2,36,06,944.$
- ❖ In this ring road if we use plastic road instead of conventional bituminous road, we can save up to **Rs 2, 36, 06,944** and also, we will do up to **5, 89,584 Kg** plastic waste management.

VIII. CONCLUSION

The plastic waste road is durable and also cost effective compared to conventional bituminous roads. As our project is “**Feasibility of Plastic Solid Waste Management through Road Asphaltting**” focuses on replication of various states and their used implementation strategies of the plastic generated in urban and rural areas. This sustainable approach helps in disposing waste plastic and reduce bitumen quantity used in roads. We also estimated the amount that can be saved in the Pune ring road.

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