International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 05 | May - 2023 SJIF 2023: 8.176 ISSN: 2582-3930

A RESEARCH PAPER ON "UTILIZATION OF MUNICIPAL SOLID WASTE IN ROAD CONSTRUCTION"

Balaji Bhise
Student, BE Civil
Universal Collage Of Engineering & Research Pune ,Sasewadi
Sachin Kashyap
Student, BE Civil
Universal Collage Of Engineering & Research Pune ,Sasewadi
Vishal Malave
Student, BE Civil
Universal Collage Of Engineering & Research Pune ,Sasewadi
Prof. Yash Tandale
Project Guide

ABSTRACT

India has a road network of over 5,603,293 kilometres (3,481,725 mi) of roads as of 31 March 2016., the second largest road network in the world. One of the solutions proposed and demonstrated was by Professor Vasudevan in utilising waste environmental plastic in road construction. Road construction projects were pioneered in the state of Tamil Nadu followed by Karnataka as early as 2001. Both states have made significant progress since in rural and urban roads respectively. Other states such as Andhra Pradesh, Goa, Jharkhand, Delhi, and Maharashtra have demonstrated projects in other states as well.

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 by Dr Vasudevan, incorporates the use of 'Plastone', a mixture of stone chips and waste plastic bags (thickness 40-70 μm) which is heated at 150-170 degree C 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.

***Key Words*:** Plastic Waste, Dry Process, Wet Process

INTRODUCTION

India generates 1,88,000 tons of garbage every day. Plastic Waste in different forms is found to be almost 9% to 12% 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 poor biodegradability it creates stagnation of water and associated hygiene problems.

Plastic waste is a huge threat to the environment. In 2005, after monsoon rains flooded Mumbai, plastic bags were blamed for clogging the underground drainage system and intensifying the effect of the floods. In areas frequented by tourists, like Goa, heavy consumption of bottled water has resulted in trash on beaches, creating eyesores and endangering marine life.

Even India's cows, considered sacred, have not been spared. After 3,000cows died in Lucknow in 2000, the city investigated and found plastic bags in their stomachs. Apparently, the bags had been ingested as the animals grazed at dump sites. With more than 35 tons of plastic waste generated by every Indian state, each day India is confronted with the big question of how to get rid of this non-biodegradable menace.

AIM OF RESEARCH PAPER

1. We want to minimize plastic waste from environment and society.

2. Plastic is non-degradable waste in environment hence only reuse of plastic is the best way to dispose it.

3. To make green structure to conserve natural resource for future need.

4. To explore the possibilities of using waste PET bottles in the constructions of houses.

SCOPE OF RESEARCH PAPER

- Assessment of plastics such as polyethylene, polypropylene, polystyrene among others mentioned in the IRC standard SP-98, would include but not be limited to them.
- Report would include assessment of durability of plastic as compared to other material ls comparing the use and on a limited scale the performance. Evaluation aspects would include Technical, Financial, Administrative and Organizational efficiency aspects of operational and implementation of plastic roads.
- Financial models and implementation monitoring was included in the project.
- Qualitative assessment through interviews and field visit would be limited to 3 specific locations within India.
- Assessment geography would be limited to states and union territories of India.
- Assessment would be selective to highlight best practice and operational parameters.

- Scientific review included desktop research and would not involve any field assessments.

PROBLEM STATEMENT

As we all know the consumption of plastics is constantly increasingly. Once these materials are thrown out, they do not decompose. Hence, they are either land-filled or incinerated. But both are not eco-friendly processes as they pollute the land, water and air.

As you know uses of plastic waste construction of road protect the environment from adverse impact of waste plastic. This can help solving the problem of pollution because most of the plastic waste is polymers which are harmful for the environment**.**

OBJECTIVE OF RESEARCH PAPER

- To formulate details of roll out orders for utilizing plastic waste.
- We want to do such type of project which help to make our environment more sustainable.
- To assess the integration of technological and engineering decision of use of plastic in road construction into the policy framework and execution.
- Evaluate coordination methods between urban bodies dealing with disposal of plastic waste and road construction departments using waste in the road building.
- Review economic viability of implementing the innovation in smaller towns and rural areas in comparison to metros and bigger cities.
- Recognize need for media role in creating public awareness in replication of this innovation.
- To compare the properties of alternative material with conventional materials.

PLASTIC WASTE

Plastic isn't as simple as you may think. Each one of them is different from the others. Some of them are reusable, the others produce hazardous material after several uses. Some are easily recyclable; others need more sophisticated and intricate handlings in its recycling process.

To summarize, there are 7 types of plastic exist in our current modern days:

1) Polyethylene Terephthalate (PET or PETE or Polyester)

PET is also known as a wrinkle-free fiber. It's different from the plastic bag that we commonly see at the supermarket. PET is mostly used for food and drink packaging purposes due to its strong ability to prevent oxygen from getting in and spoiling the product inside. It also helps to keep the carbon dioxide in carbonated drinks from getting out.

Although PET is most likely to be picked up by recycling programs, this type of plastic contains antimony trioxide—a matter that is considered as a carcinogen—capable of causing cancer in a living tissue. The longer a liquid is left in a PET container the greater the potential for the release of the antimony. Warm temperatures inside cars, garages, and enclosed storage could also increase the release of the hazardous matter.

2) High-Density Polyethylene (HDPE)

Quite special compared to the other types, HDPE has long virtually unbranched polymer chains which makes them really dense and thus, stronger and thicker from PET. HDPE is commonly used as the grocery bag, opaque milk, juice container, shampoo bottles, and medicine bottle.

Not only recyclable, HDPE is relatively more stable than PET. It is considered as a safer option for food and drinks use, although some studies have shown that it can leach estrogen-mimicking additive chemicals that could disrupt human's hormonal system when exposed to ultraviolet light.

3) Low-Density Polyethylene (LDPE)

As said before, Polyethylenes are the most used family of plastics in the world. This type of plastic has the simplest plastic polymer chemical structure, making it very easy and very cheap to process. LDPE polymers have significant chain branching including long side chains making it less dense and less crystalline (structurally ordered) and thus a generally thinner more flexible form of polyethylene.

LDPE is mostly used for bags (grocery, dry cleaning, bread, frozen food bags, newspapers, garbage), plastic wraps; coatings for paper milk cartons and hot & cold beverage cups; some squeezable bottles (honey, mustard), food storage containers, container lids. Also used for wire and cable covering.

Although some studies have shown that LDPE could also cause unhealthy hormonal effects in humans, LDPE is considered as a safer plastic option for food and drink use. Unfortunately, this type of plastic is quite difficult to be recycled.

5) Polypropylene (PP)

Stiffer and more resistant to heat, PP is widely used for hot food containers. Its strength quality is somewhere between LDPE and HDPE. Besides in thermal vests, and car parts, PP is also included in the disposable diaper and sanitary pad liners.

Same as LDPE, PP is considered a safer plastic option for food and drink use. And although it bears all those amazing qualities, PP isn't quite recyclable and could also cause asthma and hormone disruption in human.

6) Polystyrene (PS)

Polystyrene is the Styrofoam we all commonly used for food containers, egg cartons, disposable cups and bowls, packaging, and also bike helmet. When exposed with hot and oily food, PS could leach styrene that is considered as brain and nervous system toxicant, it could also affect genes, lungs, liver, and immune system. On top of all of those risks, PS has a low recycling rate.

7) Other

Number 7 is for all plastics other than those identified by number 1-6 and also plastics that may be layered or mixed with other types of plastics, such as bioplastics. Polycarbonate (PC) is the most common plastic in this category, isn't used as much in recent years due to it being associated with bisphenol A (BPA). PC is also known by various name: Lexan, Makrolon, and Makroclear. Ironically, PC is typically used for baby bottles, sippy cups, water bottles, water gallon, metal food can liner, ketchup container, and dental sealants. Due to its toxicity, several countries have banned the use of PC for baby bottles and infant formula packaging.

METHODS OF PLASTIC ROAD CONSTRUCTION

Waste plastic is made powder and varying percent plastic is mixed with bitumen. Plastic increases the melting point of the bitumen and makes the road flexible during winters resulting in its long life. By mixing plastic with bitumen the brittleness overcomes and elastic nature enhances. The plastic waste is melted and mixed with bitumen in a particular ratio.

There are only two methods which are adopted for construction of plastic road:-

(I) DRY PROCESS:

For the flexible pavement, hot stone aggregate (170°C) is mixed with hot bitumen (160°C) and the mix is used for road laying. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity as per IS coding.

The bitumen is chosen on the basis of its binding property, penetration value and viscous-elastic property. The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption and soundness.

In this process the shredded plastics are poured over the heated aggregates, thus forming plastic coated aggregates which are then mixed with hot bitumen to form plastic coated aggregate bitumen mixture for laying roads. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement.

(II) WET PROCESS:

These are the method used for formation of polymer based modified bitumen, in which the waste polymer directly added with bitumen and heated up to temperature of 1700C so that proper blend is to be formed with proper dispersion of waste polymer into bitumen, then the hot mix is then cooled up to 1200C into another chamber, which is then added to the aggregate in paddling chamber.

The mix is to be cooled because when hot mix poured on aggregate then there are chances to form air pocket into small gap of aggregate and chances in lower the strength of rods and chances of rutting of roads. After addition of modified bitumen at 1100C on aggregate, it is then laid on the road and then spreader material is compacted by 8-ton roller.

CASE STUDY

LOCATION OF PLASTIC WASTE ROAD CONSTRUCTION

Pune Municipal Corporation PMC) has found a way to channel plastic waste, by lying a road made of trash The construction of such a road began on Monday at the 150 meter stretch of Bhagwat lane at Navi Peth near Vaikunth Crematorium PMC has used bitumen technology on waste plastic ranging from poly bags to biscuit packets

For its construction, 220 tons of aggregate (rock). 1 tons of bitumen and 1 ton of 2.36 mm Shredded waste plastic used according to the Indian Road Congress (IRC) Guidelines has been put to use. The plastic has been provided by Rudra environmental solution (India) Ltd (RESIL) and has been collected by Keshav Sita Memorial Foundation trust. It was processed at the RESIL plant in Jejuri.

Suresh Jagtap, head of PMC's solid waste management department, told Pune Mirror that “civil body is using this promising technology for the very first time. We have used a blend of 45 kgs of bitumen and 55 tons of aggregate along with shredded plastic that corresponds to four per cent for every ton of the blend Around one ton of shredded plastic is being used for the construction of this road we will construct 11 more roads on trial basis” he said. Around 1.700 tons of garbage is generated in the day daily of which around 950 tons are segregated. The remaining 750 tons are mixed waste Mr. Jagtap claims that around 12 per cent of the city total garbage generated is plastic.

"Plastic waste is shredded and then heated up to 180 degrees Celsius after with s used to and then taken to the construction site. The Powdered plastic is then mixed with bitumen in a hot mixer which laid on road”, said Shirish Phadtare chairman of RESIL. Mr. Phadtare believes that the problematic plants has found a practical outlet in road construction furthermore, he said that improves the durability, quality and longevity of roads.

Rajendra Raut Chief Engineer of the PMC road department said, for construction, “Shredded plastic of 2.36mm to 600 microns is used (black plastic bags are avoided). For a month, PMC and RESIL have worked on suitable blends for roads. After positive Results and permission from PMC’s standing technical advisory committee, the trial run Was initiated on Monday.’’

LENGTH FOR ROAD CONSTRUCTION

Length of construction of road: 25-km

RESULT

The results of the studies on the extraction of bitumen by dry process showed that the bonding between stone aggregate and bitumen is improved due to the presence of polymers. This may be explained by the following tables:

Plastic Content (% By Weight)	Bitumen Extracted After 5 minute (%)	Bitumen Extracted After 10 minute (%)	Bitumen Extracted After 15 minute (%)
0	95.0	97.0	98.0
0.5	63.0	87.9	92.3
0.75	62.7	85.3	90.7
1.0	60.6	76.2	82.8

Use of higher percentage of plastic waste reduces the need of bitumen by 8-9%. It also increases the strength and performance of the road.

IMPROVED CHARACTERISTICS OF PLASTIC COATED AGGREGATE

% of Plastic	Moisture Absorption (%)	Soundness(%)	Voids(%)	Aggregate Crushing Test(%)
Nil	4	6	4	24
1	1	Nil	2.2	19.5
2	1	Nil	1	18
3	0.5	Nil	Nil	NA
5	0.32	Nil	Nil	NA
10	0.15	Nil	Nil	NA

OBSERVATION

According to the case study of PMC and obtained data following observation are concluded. Using plastic waste.

- PMC with help from Dow Chemical International and Rudra Environment is erecting the hot mix plant at Yerawada where plastic trash would be mixed with tar material.
- The environmentally conscious approach to road construction plastic litter was developed in India around 15 years ago.
- In November 2015, the Indian government has announced that plastic roads would be the default method of construction for most city streets.
- Urban areas with more than 500,000 people are now required to construct roads using waste plastic with the project coming under the Swachh Bharat Abhiyan campaign.
- According to experts, 90 per cent of bitumen is amalgamated with 10 per cent of everyday plastic waste. These products are shredded into small pieces and mixed with the liquid before laying it on the road.
- Tar-cum-plastic roads is 25 per cent better than unmodified roads and is almost 200 per cent resistant to soaking up water and durability is high. The maintenance cost of the road is very low

CONCLUSION

- This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reduced rutting, raveling, and there is no pothole formation. The road can withstand heavy traffic and show better durability.

- we can conclude that, using plastic waste in with coated aggregate will help reduction in need of bitumen by around 8-9%, increase the strength and performance of road.

- Avoid use of anti-stripping agent, enhance the property of the aggregate as a watertight, also form proper bonding in between aggregate and bitumen, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco-friendly.

- Increased traffic conditions will and are reducing the life span of roads. Plastic roads are means of prevention and ultimately will be the cure. It will save millions of rupees in future and reduce the amount of resources used for construction.

- The use of the innovative technology will not only strengthen the road construction but will also increase the road life as well as help to improve the environment and will also create a source of income.

REFERENCES

- **Asare, P.N.A., F.A. Kuranchie, E.A. Ofosu and F. Verones (2019).** "Evaluation of incorporating plastic wastes into asphalt materials for road construction in Ghana." Cogent Environmental Science 5(1).

- **Awwad, M.T. and L. Shabeeb (2007).** "The use of polyethylene in hot asphalt mixtures." American Journal of Applied Sciences 4(6): 390-396.

- Bale, A.S. (2011). "Potential reuse of plastic waste in road construction: a review." International Journal of Advances in Engineering & Technology (IJAET) 2: 233-236.

- **Behl, A., P. Jain and G. Sharma (2012).** Study on waste polyvinyl chloride modified bitumen for paving applications. ARRB Conference, 25th, 2012, Perth, Western Australia, Australia.

- **Bhoot, K., K. Malviya and T.K. Prajapat (2012).** "Potential reuse of plastic waste In road construction: A review." International Journal of Scientific Research in Engineering 1(9): 1-5.

- **Brasileiro, L., F. Moreno-Navarro, R. Tauste-Martínez, J. Matos and M.d.C. Rubio-Gámez (2019).** "Reclaimed Polymers as Asphalt Binder Modifiers for More Sustainable Roads: A Review." Sustainability 11(3): 646.

- Centre for Innovations in Public Systems (2014). Use of Plastics in Road Construction; Implementation of Technology and Roll out. Retrieve from *http://www.cips.org.in/documents/Published_Documents/e-Books/2015/Urban-Governance/Use-of-Plastics/Use-of_Plastics.pdf*

- **Chakraborty, A. and S. Mehta (2017).** "Utilization & Minimization of Waste Plastic in Construction of Pavement: A Review." International Journal of Engineering Technology Science and Research 4(8): 2394-3386.

- **Chavan, M.A.J. (2013)**. "Use of plastic waste in flexible pavements. "International Journal of Application or Innovation in Engineering and Management 2(4): 540-552.

- **Costa, L.M.B., H.M.R.D. Silva, J. Peralta and J.R.M. Oliveira (2019).** "Using waste polymers as a reliable alternative for asphalt binder modification – Performance and morphological assessment." Construction and Building Materials 198: 237-244.