USE OF WASTE PLASTIC IN ROAD CONSTRUCTION AND ITS FUTURE IMPACTS

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BACKGROUND

- Presently global production of plastic is about 360 million tonne.
- Average worldwide utilization of plastic is 45 kg/person.
- Many plastics are discarded after a very short lifecycle (e.g., single use), which causes colossal waste accumulation and critical environmental concerns. Approximately 3% of each year's plastic waste ends up in the sea, harming the environment and wildlife
- Safe disposal of waste plastic is a serious environmental problem.
- Plastic is a non-biodegradable material which can last as long as 4,000 years.
- If dumped in land fills, it can find its way back to the environment through air and water erosion, can choke the drains and drainage channels, can be eaten by grazing animals causing them illness and death and can contaminate the construction fill.
- Further, dumping on open land will result in wasteful use of scares land resource.
- Land pollution and disposal of waste plastic challenge can reduce significantly if these materials are utilised in road construction.

Waste Plastic and Sources

Themoplastic as a Waste Plastic	Origin	Yes/No
Low Density Polyethylene (LDPE)	Carry bags, Sacks, Milk pouches, bin lining, cosmetic and detergent bottles	Shall be used
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.,	Shall be used
Polyethylene Teryphthalate (PET)	Drinking Water Bottles etc.,	Shall not be used
Polypropylene (PP)	Bottle Caps and Closures, Wrappers of detergent, biscuit wrappers, microwave trays for readymade meal etc.,	Shall not be used
Polystyrene (PS)	Yoghurt pots, clear egg packs, bottle caps, foamed polystyrene, food trays, egg boxes, disposable cups, protective packaging etc.,	Shall not be used
Polyvinyl Chloride (PVC)	Mineral Water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders and pens, medical disposables etc.	Shall not be used

Advantages of using Waste plastic as modifier in binder

- There are two processes : Dry process & Wet process for blending of plastic waste in bituminous mix for road construction.
- In dry process, processed waste plastic is added after shredding in hot aggregates whereas in wet process, processed waste plastic in the form of powder is added in hot bitumen.
- Advantages of using Waste Plastic as modifier in binder:
  - Higher resistance to deformation
  - Higher resistance to water induced damages
  - Increased durability and improved fatigue life
  - Improved stability and strength
  - Environment friendly solution
    - For construction of 1 km of a road, 3.5 tonnes of savings in carbon credit were achieved on account of avoiding the burning of plastics wastes.
    - It addresses the issue of disposal of waste plastic, thereby making the use of plastic environment friendly.

IRC Guidelines

- Indian Roads Congress has prepared guidelines for the Use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses (IRC:SP:98-2013).
- As per Guidelines:
  - Waste plastic should conform to size passing 2.36 mm sieve and retained on 600 micron sieve.
  - Dust and other impurities shall not be more than 1%.
  - Plastic is coated over stones improving surface property of aggregates.
  - Waste plastic should be 6% to 8% of the weight of bitumen in the mix depending on the climatic condition of high or low rainfall areas.

CONTROLS DURING EXECUTION

- Plastic waste material should consist of only Low Density Polyethylene (LDPE) or High Density Polyethylene (HDPE)
- Black coloured plastic waste is a result of repeated recycling and shall not be used.
- PVC shall not be used since they release lethal levels of dioxins.
- The Thermo Gravimetric Analysis (TGA) of thermoplastics reveals gas evaluation and thermal degradation beyond 180^0C. Thus misuse or wrong implementation of this technology may result in release of harmful gases, premature degradation, if the temperatures are not maintained during construction.
- Size and thickness of plastic waste needs to be maintained.
- The aggregate mix is heated to 150-175^0C in a central mixing plant.
- The plastic waste coated aggregate is mixed with hot bitumen that a temperature of 150^0C to 170^0C for about 15 seconds.
- The road laying temperature is between 130^0C to 160^0C for the waste plastic bituminous mix.

Collection of Waste Plastic

Cleaning Process

Shredding Machine

Central Mixing Plant

Waste Plastic Applications in Road Construction

- First plastic was constructed in Chennai in 2002 from shredded waste plastic.
- In Tamil Nadu, the length of roads around 1,000 km on various stretches were constructed using waste plastic under the scheme “1000 km plastic road”. The performance of all these roads stretches is satisfactory.
- The performance of more than 2,000 km roads constructed with waste plastic in Bangalore found to be satisfactory.
- In Delhi, a number of test sections about 50 km were constructed using waste plastic which are performing well.
- MoRTH sponsored research scheme on the use of waste plastics in SDBC mix made on test track on NH 207 reported excellent performance of waste plastic in bituminous mixes.

Waste Plastic Applications in Road Construction

- Rural road programme (PMGSY) has completed more than 13,000 km of plastic roads. The performance of these roads has been rated as excellent.
- In order to encourage the use of plastic waste, Ministry of Road Transport & Highways decided that bituminous mix with plastic waste shall be the default mode for periodic renewal of highways falling within the 50 km periphery of an urban area, having population of more than 500 thousands.
- MoRTH, NHAI and NHIDCL have set targets for completing about 300 km length of National Highways using waste plastics in the current financial year 2020-21.

Concerns with use of Waste Plastic

- Toxicity and inherent properties of chemical additives used in plastic are unknown which may cause environmental issues.
- Heating plastics may sometimes release moderate to highly toxic emissions which may cause health and safety concerns.
- Micro plastics flushed down into rivers, lakes and seas could pose a major threat to marine life.
- Future reuse of waste plastic modified bituminous mix should consider:
  - The source of the material
  - How it is intended to be used
  - Any known or potential environmental risk and how they will be managed
  - Possibility of reuse of the mix effectively

Revised IRC:SP:98

- Based on the feedback received from stakeholders, Indian Roads Congress has recently revised Guidelines for the Use of Waste Plastic in hot bituminous mixes in wearing coarse.
- Certain type of plastics having melting temperature above 180^0C have now been deleted.
- Quantity of waste plastic allowed in the mix is now upto 8% of the weight of the bitumen.
- Certain properties of waste plastic bituminous mix have been modified based on the feedback received from users.
- These Guidelines are now applicable for works on National Highways and State Highways also.

Thank you for your kind attention