Plastic Waste to Wealth Potential

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Abstract: Garbage was never a problem in urban India until the 1950s. This organic rich resource was collected for on-farm composting; food waste returned nutrients to the soils that grew it. Two major factors killed this recycling practice completely; thin – film plastic carry bags in garbage made fields infertile by preventing water percolation and germination, and heavy subsidies for urea, easy to transport and spread, discouraged composting even of agro wastes. The Government of India is massively funding urban solid waste management. We have enough techno – economically viable and proven examples and solutions in hand for all to follow but local decision – makers are generally unaware of these. Plastic, with its exclusive qualities is now a serious worldwide environmental and health concern, essentially due to its non- biodegradable nature. More than 50% of the plastic waste generated in the country is recycled and used in the manufacture of various plastic products. Designing eco-friendly, biodegradable plastics are the need of the hour. The paper discuss the properties that makes plastic waste suitable for road construction and its different process for road construction and status on use of plastic waste in road construction and its potential prospect in India. A potential and promising solution for disposal of waste plastic in an useful way. The paper highlight energy saving during manufacture of raw material, production and transportation of plastic bags compared to jute bags, textile bags and paper bags and Environmental burden during production of jute bags, textile bags and paper bags vs plastic bags. Plastic waste act as a Green House Gas Emission Saver. Issues related to health and safety, toxicity, non-biodegradability and disposal of plastic waste are also discussed.

Keywords: **Resource, Environment, Road laying**

1. INTRODUCTION

Plastic, with its exclusive qualities is now a serious worldwide environmental and health concern, essentially due to its non-biodegradable nature. More than 50% of the plastic waste generated in the country is recycled and used in the manufacture of various plastic products.

Dioxin is a highly carcinogenic and toxic by-product of the manufacturing process of plastics. Burning of plastics, especially PVC, releases this dioxin and also furan into the atmosphere.

Plastics are so versatile in use that their impact on the environment is extremely wide ranging. Careless disposal of plastic bags chokes drains, blocks the porosity of the soil and causes problems for groundwater recharge. Plastic disturbs the soil microbial activity. Plastic bags can also contaminate foodstuffs due to leaching of toxic dyes and transfer of pathogens. In fact, a major portion of the plastic bags i.e. approximately 60-80% of the plastic waste generated in India is collected and segregated for recycling. 20 - 40% remains strewn on the ground, littered around in open drains.

Designing eco-friendly, biodegradable plastics are the need of the hour. Though partially biodegradable plastics have been developed and used, completely biodegradable plastics have only recently been developed.

The various sources of generation of plastics wastes include: Household such as (Carry bags, Pet bottles, Containers, Trash bags), Health and Medicare(Disposable syringes, Glucose bottles, Blood and urine bags, Intravenous tubes, Catheters, Surgical gloves), Hotel and Catering (Packaging items, Mineral water bottles, Plastic plates, cups, spoons) Air/Rail Travel(Mineral water bottles, Plastic plates, cups, spoons, Plastic bags)

Characterization studies indicate that MSW contains large organic fraction (30-40%), ash and fine earth (30-40%), paper (3-6%) along with plastic glass and metal (each less than 1%), calorific value of refuse ranges between 800-1000 kcal/kg and C/N ratio ranges between 20-30%. The collection bin and implements used in various cities are not properly designed. It has been observed that community bins have not been installed at proper location. This has resulted in poor collection efficiency. Lack of public awareness has made the situation worse. Various types of vehicles are used for transportation of waste to the disposal site. However, these vehicles are not designed as per requirement. In many urban centers, proper garages are not provided for the vehicles for protection from heat and rain. Preventive maintenance system is not adopted and as a result the life of the vehicle is reduced. Many of the vehicles used for transportation of waste have outlived their normal life.

Waste is disposed off in low-lying areas without taking any precautions and without any operational control. Solid waste workers handle the waste without any protective equipment and are prone to infection.

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The waste characteristics are expected to change due to urbanization, increased commercialization and standard of living. The present trend indicates that the paper and plastics content will increase while the organic content will decrease. The ash and earth content is also expected to decrease mainly due to an increase in the paved surface. Although, the organic content is expected to decrease, the material will still be amenable to biodegradation and the calorific value will continue to be unsuitable for incineration.

In keeping with the present practices and estimates of waste generation, around 90% of the generated wastes are land filled requiring around 1200 hectare of land every year with an average depth of 3 m. Due to rapid urbanization, prevailing land use regulation and completing demands for available land, it is desirable that adequate land be earmarked at the planning stage itself for solid waste disposal. The larger quantities of solid waste and higher degree of urbanization will necessitate better management involving a higher level of expenditure on manpower and equipment.

Plastic in Municipal Solid Waste

- Toxic Nature
- Stagnation of waste water due to waste plastic causing hygiene problems
- When mixed with solid waste, it reduces the rate of composting of the organic solid waste.
- When waste plastic is mixed with earth, the water flow is affected. .
- Misuse and its dumping in the dustbins and drains.

Management of Waste Plastic

- Reduce (A ban on thinnest Polybags)
- Reuse (Bisleri & cold drinks bottles)
- Recycle (60-70 %)
- Plastics as a Greenhouse Gas Emission Saver . Use of Plastic
- Plastic in Packaging
- Plastics in Automobiles
- Plastics in Insulation materials in construction industry
- Plastics in Piping

Plastics in Packaging

- Non toxic characteristics, inertness & chemical resistance
- Excellent barrier properties & water-proof characteristics
- Non-breakability and light in weight
- Transparency as well as opacity
- Resistance to bacterial and other microbial growth
- Pilfer proof characteristics etc

Benefits of plastic bags / carry bags

- Add convenience to day-to-day life
- Increases shelf life of contents / light weight
- Essential for packaging of bread, confectionery items, bakery products
- Essential for packaging of hygroscopic edible products like sugar, salt, jaggery

2. USE OF PLASTIC WASTE AS A RESOURCE

- **India Plastic Recycling Industry give Employment and business Opportunities** to many families. Its Turnover is Rs.15, 000 Crores, Volume recycled is 2.6 MillionTonnes, No. of units are 10, 000, Total employment about 3.5 Million, Rag Pickers about 1.5 Million.
- **Carbon Recycling: Fuel from Plastic Waste:** 1 MT Waste yielding 900 litres of Diesel conforming to highest quality EN 590 diesel. Maharastra signs MOU to produce fuel from plastic.
- **Unconventional Recycling:** Use of Plastic Waste for better roads.
- **Energy Recovery:** Co-Processing in cement kiln: Partial substitution of fossil fuel. Process has been certified by approved pollution control authority in India. Its benefit is all types of plastic waste fed without segregation / without adequate cleaning. ICPE-ACC Plant established in Kymore, M.P. in India for the first time.

Table 1. Plastic Waste for Better Roads

2.1. Properties that makes Plastic Waste suitable for roads construction

- Better Coating Ability to aggregates
- Improved bonding between binder & aggregates
- Higher Marshall stability
- Higher resistance to fatigue and permanent deformation characteristics.
- Less susceptibility to water damage

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- Conservation of bitumen and aggregates
- Long service life
- More durability
- Improved performance
- Can be used in all climatic conditions
- No difference in binder content
- Reduced stripping due to plastic coating
- Disposal of plastic made easy
- Value addition to plastic leading to development of management of garbage culture.

3. THREE DIFFERENT PROCESS USED IN ROAD LAYING USING WASTE PLASTIC ARE

3.1 Waste Plastic–Aggregate-Bitumen Mix Road Construction

The process of road laying using waste plastics is designed for construction of bituminous roads at various places in India. A brief description is given below.

Disposed Plastics waste (films, cups and thermocol) are sorted and cleaned

Waste Plastics to the required size(passing 6.75 mm and retaining 2.36 mm) are shredded

Heat the aggregate to around (160-170° C)

Quantitative Addition of shredded polymer waste with proper mixing technique to get a uniform coating at the surface(30-40 sec only)

Quantitative addition of hot bitumen whose temperature is maintained between 155-163 ° C

Mix the waste plastic-Aggregate bitumen to get a uniform mix(composite)

Bitumen-Polymer waste-aggregate mix(composite) is taken out around 130-140 ° C and used for road laying

Road laying is done between 110-130 ° C to get better result using 8 ton roller.

3.2. MINI HOT MIX PLANT PROCESS-RURAL ROADS AND HIGHWAYS

Following steps are followed in this Process :-

- Collected waste plastic is segregated and shredded into small piece with size passing & retaining at 4.75 mm and 2.36 respectively.
- Solid aggregate(granite, ceramic) with proper proportion of metals having different size and dust, heated up to 170ºC in mini hot mix plant is transferred to adjacent puddling chamber. Simultaneously bitumen 60/70 or 80/100 is heated to only up to 160ºC.Periodical temperature monitoring should be done during heating of both.
- Shredded plastic(5%-20% by wt of bitumen) is sprayed on hot and continuously stirred aggregate in puddling chamber to get uniform coating at surface of aggregate. This process takes 30-45 seconds.
- Bitumen(160ºC) is added to it and mix uniformly at 155ºC-163ºC (as per IRC specification).after mixing this mix which is known as **waste plastics-aggregate-bitumen** is withdrawn at around 140ºC.
- The polymer tar road is laid by spreading uniformly the waste plastics aggregate bitumen mix and rolled using 8 roller, as per the IRC specification.
- Quantity of addition of plastics to be used and proper temperature monitoring of mix during laying of road in addition to heating aggregate and bitumen, are of utmost important and should be done properly and accurately.

3.3. ROAD LAYING USING CENTRAL MIXING PLANT(CMP)

This process is used for laying long roads with less time schedule. Following are the steps for polymer tar road laying:-

- In this process, waste plastic is used according to the proportion of bitumen in accordance with the moving time of conveyer belt. For example for one tone of bitumen 100 kg of plastic should be moved with 3.33kg/minutes on conveyer belt. Till date, this addition on conveyer belt is done manually.
- This plastics then move to hot drum where it gets melt and coated over pre-heated aggregate of 170ºC.
- The bitumen is added subsequently and the aggregate polymer bitumen mix is released and collected in tipper, having proper insulation, uniform coating and temperature of 140ºC.
- This mix is transported road laying site.
- Before spreading this mix, the surface has given tack coating using emulsion or 60/70 bitumen, as per IRC(IV) revision specification.
- Finally mix is spread over it using paver machine and then compacted with 8 tons roller.
- Convenient for carrying fish, meat, poultry and other wet food products – no other better alternative.

4. MISCONCEPTIONS ARE :

- Health & safety
- Toxicity
- Biodegradability
- Disposal & waste management

4.1. Issue: Health & Safety:

- Use of polyethylene in contact with food stuffs, pharmaceuticals and drinking water is approved by regulatory authorities across the world including that in India(BIS Specification IS 10146:1982 – Reaffirmed on Feb-2003)

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- Polythene is also approved safe material for use …
- as implants within human body
- In medical applications like IV bottles
- Packaging of tablets
- Plastic bags are generally made from polyethylene / PP– a safe product

4.2. Issue: Toxicity

Myth :

- Plastics are termed as "toxic and Injurious to health"

Reality:

- Plastics are inert materials and do not pose any danger of toxicity
- Additives used in plastics are approved as per BIS / FDA standards
- Emissions at fire situation have similar or lesser implications in comparison to situation involving natural organic materials like wood & cotton
- Emissions during burning of paper and polyethylene are similar

4.3. Issue: Non-Biodegradability

- Termed as "the major reason of waste management problem"
- Plastics are useful for its long life characteristics
- Tin, Aluminum, Glass also *are not biodegradable*
- Biodegradable plastics are needed for specific applications like nursery bags, mulch/agricultural film, one – time use cutlery / cups etc. to be carried in ships / remote areas
- New development of biodegradable plastics may include lamination with jute / paper

4.4. Issue: Disposal

Myth :

- Plastics are blamed as "the major cause of solid Waste problem"

Reality:

- According to Indian studies plastics form about 5% of total MSW
- While all solid / thick plastics waste are systematically picked up by the waste collectors for recycling, disposal of thin plastic carry bags, single-use plastic waste and multi-layer packets have created solid waste problem
- Alternatives to Plastic are
- Jute
- Textile
- Paper
- Degradable Plastics

5. COMPARISON OF PLASTIC

5.1. Plastic Vs Jute Bags : Consider the enormous environmental burden generated by Jute & Textile bags, which are not visible to naked eyes though, in comparison to Plastic Bags.

Table 2. Plasic Vs Jute Bags

Plastic Vs Jute Bags : LCA study by IIT Delhi

Energy Saving during Manufacture of Raw Materials, Production and Transportation of Plastic Bags compared to Jute Bags is 81%.

Environmental Burden (during production)		Jute Bag	Plastic Bag
Air Pollution			
CO	kg	54.30	0.6
CO2	kg	6610.20	760.0
SOx	kg	134.80	5.2
Nox	kg	68.10	4.8
CH4	kg	39.50	3.2
HCL	kg	5.30	0
Dust	kg	67.60	1.4
Water Pollution			
Suspended Solids	kg	352.30	0.2
Chlorides	kg	4535.50	0.1

The values are for packaging of one lac MTs of Atta. Source – Report by Centre for Polymer Science and Engineering, IIT - Delhi 1

5.2. Plastic Vs Textile Bags: LCA study by IIT Delhi

- Plastics manufacturing consumes 400 kwh/mt while composite textile mills consume 1310 kwh/mt
- Textile contributes 30% SOx (second highest by any sector) and 23% NOx (highest by any sector)

5.3. Plastic Vs Paper Bags:

- Plastic Carry Bags Generate 60 – 79% Less Green House Gases than Paper Bags
- Plastic grocery bags consume 40% less energy during production and generate 80% less solid waste after use than paper bags.
- Paper sacks generate 70% more air pollutants and 50 times more water pollutants than plastic bags do.
- It takes 91% less energy to recycle a kilogram **of plastic** than a kilogram of paper.
- Transportation : 150, 000 Plastic Bags of 20 cm x 30 cm x 40 micron weighs ~ 600 kgs and needs 1 small Tempo for transportation while Paper Bags of same size & number weighs ~ 1500 kgs and needs > 10 such Tempos for transportation - due to higher volume.

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Table 3. Plasic Vs Paper Bags

Plastic Vs Paper Bags - Pollution

Environmental Burden	Polyethylene	Paper
Energy in GJ for Manufacture	29.0	67.0
SO2	9.9	28.1
NOx	6.8	10.8
CH4	1.5	3.8
CO	1,0	6.4
Dust	0.5	6.8
COD	0.5	107.8
BOD	0.02	43.1

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