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Recycling Waste Thermoplastic for the Production of Plastic Paver Blocks

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Abstract: The discussion about the use and misuse of plastics in relation to environmental protection can continue endlessly without progress unless practical actions are taken at the grassroots level by those who have the ability to make a difference. Plastic waste can be utilized in road construction, and field tests have demonstrated that properly processed plastic waste used as an additive enhances road durability and helps solve environmental issues. This article highlights advancements in using plastic waste for making plastic roads. Rapid urbanization and development have led to an increase in plastic waste generation. Since plastic is non-biodegradable, it remains in the environment for many years, and disposing of plastic waste in landfills is unsafe because toxic chemicals can leach into the soil, groundwater, and pollute water bodies. Due to littering habits and inadequate waste management systems and infrastructure, plastic waste disposal continues to be a significant problem for municipal authorities, especially in urban areas. As mentioned earlier, plastic disposal is a major challenge for developing countries like India, which simultaneously requires an extensive road network for smooth economic and social progress. The scarcity of bitumen calls for careful consideration to ensure rapid road construction.

Keywords: roads, grassroots level, practical steps, plastic wastes, road construction.

I. INTRODUCTION

A. Introduction

The makeup of waste varies from place to place, depending on local waste management strategies and consumption habits, but plastics consistently make up a significant portion of the total waste. Polyethylene and polypropylene are the main types of plastics found in this waste, with household sources contributing the most. Across different countries, waste composition changes due to socioeconomic factors, waste management systems, and consumption patterns, yet plastic remains a major component. The main issue with plastic waste is its resistance to decomposition, taking anywhere from 20 to 1,000 years to break down, depending on its type. In India, around 25,940 tonnes of plastic waste are generated daily, with about 6,000 tonnes remaining uncollected. Most plastic waste in India is disposed of through burning, while only a small fraction is recycled.

A significant amount of plastic brought into the region ends up being discarded or incinerated, contributing to pollution. Therefore, it is crucial to find effective solutions to this problem. One proposed approach is to reuse plastic waste by incorporating it into the production of plastic paver blocks. This method allows for the efficient utilization of plastic waste. Paver block paving is known for being versatile, visually appealing, functional, cost-effective, and low-maintenance when properly produced and installed. While concrete block paving has generally performed well in India, issues such as surface wear and inconsistent block strength sometimes arise. Nowadays, construction companies often prefer paving blocks over alternatives like slabs, asphalt, stone, or clay, as mass production has made them more affordable and easier to install with modern machinery. Traditionally, these blocks are made from concrete, but the new idea is to manufacture them using waste plastic.

B. Objectives:

- To protect the environment from solid waste generated by plastic
- To coat aggregate with plastic waste in paver block
- To evaluates properties of paver block such as compressive strength, Water absorption test, Hardness test, Heat resistance test
- Economic analysis of paver block

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II. LITERATURE REVIEW

Sr. No.	Name of Author	Significance / Outcome
1	Raghate Atul M.	His paper is based on experimental results of concrete sample casted with use of plastic bags pieces to study the compressive and split tensile strength. He used concrete mix by using Ordinary Portland Cement, Natural River sand as fine aggregate and crushed granite stones as coarse aggregate, portable water free from impurities and containing varying percentage of waste plastic bags. He has investigated the tensile strength of concrete by adding up to 0.8% of plastic bag pieces in the concrete mix. He concluded that utility of plastic bags pieces can be used for possible increase in split tensile strength.
2	Revathi et al.	She has Noticed that used of concrete paver block in road pavement is common. Concrete paver block is better option when light weight traffic for that road, concrete paver block is cheap and low maintains compared to content bituminous road. Pre-cast concrete block made with m40 concrete mix proportions.
3	B. Shanmugavalli, K.Gowtham , P. Jeba Nalwin , B. Eswara , Moorthy Sethu	They focused on The utilization of waste plastic in production of paver block has productive way of disposal of plastic waste, also studied about good heat resistance. Though the compressive strength is low when compared to the concrete paver block it can be used in gardens, pedestrian path and cycle way etc.
4	Jeevan Ghuge, Saurabh Surale	They prove results about plastic paver block has almost equal strength as that of ordinary one, It reduce up to 600 kg plastic over 1000 blocks.
5	Avinash G. B., Roja A. P., Santhosh M. R. , Puneetha Kumari H. M	They studied about From the above results it can be concluded that, the addition of 60% waste plastic is required to get desired shape of paver Block and 70% of waste plastic is required to get the compressive strength of 15MPa Waste plastic paver block can be used in Non-traffic and traffic road.
6	Pooja Bhatia, Nupoor Dewangan, Abhyuday Titiksh	They noticed that adding LDPE plastics over heated sand effectively melted the plastics which formed a layer over the sand particles, thereby enabling easy blending of the mix. The particle size of the sand played a crucial role in determining the final behaviour of the paver blocks. Coarser particles sizes led to lower sample strengths.
7	S. Arjun Kumar, S. Ganesh Babu, B. Gowri Kumar, S. Afrid Sukkur	From the experimental investigation, it they observed that paver blocks made by using waste plastics shows enhanced compressive strength at the age of 7 days. In regard of water absorption, paver blocks made with waste plastics shows better resistance against water absorption and can be effectively used in path ways.
8	Reddy et al.	Study said that concrete paver block is made with material of nylon fibers and risk husk ash gives good compression strength. For an optimum dose of nylon fibers and risk husk ash is 0.3% and 20% give maximum strength for the concrete paver block.
9	Dinesh S., Dinesh A., Kirubakaran K	In this literature review, the author has used waste plastic, river sand, red oxide (ferric oxide). The three blocks of fly ash bricks, burnt bricks and plastic sand paver blocks were cast with different proportion for testing.
10	Sarang Shashikant Pawar, Shubhankar Anant Bujone	In this paper author worked on the use of fly ash and waste plastic paver block. If we use this type of plastic in our construction purpose it will help to requisite of waste material.
11	Dr. Muhammad Maqbool Siddiqi, Muhammad Rafique khattak	In this paper the author use different plastic waste material is concrete they have work on use of pulverized plastic in concrete as partial replacement of fine aggregate.
12	Youcef Ghernouti et al	The study present the partial replacement of fine aggregate in concrete by using plastic fine aggregate obtained from the crushing of waste plastic bags. Fine aggregate in the mix proportion of concrete was replaced with plastic bag waste sand at 10%, 20%, 30% and 40% whereas other concrete materials remain same for all four mixes.
13	Pramod S. Patil.et al	This study presents the use of plastic recycled aggregate as replacement of coarse aggregate for production of concrete. They have conducted various tests and observed decrease in density of concrete with increase percentage of replacement

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		of aggregate with recycle plastic concrete.
14	R L Ramesh et al.	They have used waste plastic of low density poly ethylene as replacement to coarse aggregate to determine its viable application in construction industry and to study the behaviour of fresh and harden concrete properties.
15	Zainab Z. Ismail et al.	They have conducted comprehensive study based on large number of experiments and tests in order to determine the feasibility of reusing plastic sand as partial replacement of fine aggregate in concrete. They have collected waste plastic from plastic manufacture plant consist of 80% polyethylene and 20% polystyrene which was crushed (varying length of 0.15-12mm and width of 0.15-4mm).

III. METHODOLOGY

C. Materials and Its Composition

1. Cement:

Cement is a binder used in construction, setting, hardening, and adhering to materials to create mortar and concrete. It is the most commonly used material and is primarily inorganic, lime, or Ca silicate-based. Cement can be hydraulic or non-hydraulic depending on its ability to set in water.

The physical Properties of Cement:

- Fineness
- Soundness
- Standard Consistency
- Compressive strength
- Setting time

Table 1: Chemical Properties of Cement

Sr. No.	Oxide	Percent content
1.	CaO	60–67
2.	SiO2	17–25
3.	Al2O3	3.0–8.0
4.	Fe2O3	0.5–6.0
5.	MgO	0.1–4.0
6.	Alkalies (K2O, Na2O)	0.4–1.3
7.	SO3	1.3–3.0

2. Thermoplastic

Figure 1: Sources of Thermoplastic

The material which contains one or more number of polymers having large molecular weight solid in its finished state or same state will manufacturing or processing into finished articles is known as Plastic. Thermoplastics are synthesized from plants in large amounts and transformed through chemical processing. Some of the most important thermoplastics are polyethylene Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE), polypropylene (pp), poly (vinyl chloride) (PVC), and polyethylene.

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Table 2: Sources of Thermoplastic

Waste Plastic Origin	Origin
Low-Density Polyethylene(LDPE)	Carry bags ,sacks ,milk pouches, cosmetic and detergent bottles
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold Articles etc.
Polyethylene Terephthalate (PET)	Drinking water bottles etc.
Polypropylene (PP)	detergent, biscuit packets, microwave trays for readymade Meal etc.
Polystyrene(PS)	Bottle caps. Foamed polystyrene: food trays, egg boxes, disposable

D. Mix Design

3. Theoretical Procedure

1. Slump Flow
2. Aggregate Size
3. Mixing Water and Air Content
4. Concrete Strength and Water/Cement Ratio
5. Pozzolanic Materials
6. Fine Aggregate
7. Adjustment for Moisture in Aggregates
8. Chemical Admixtures

E. Experimental Analysis

1. Collection of Waste Plastic
2. Melting of Waste Plastic
3. Coating Melted Plastic to the Aggregate
4. Mixing
5. Moulding
6. Compaction
7. Curing

F. Tests to be conducted on Paver Block

1. Compressive strength test
2. Water absorption test
3. Fire resistance test
4. Hardness test

IV. RESULT AND DISCUSSION

G. Determination of Specific Gravity

Sr. No	Particulars	Sample 1	Sample 2
1	Mass of Pycnometer (M1)	449	449
2	Mass of Pycnometer + fine aggregate(M2)	699	699
3	Mass of Pycnometer + fine aggregate +water(M3)	1327	1327
4	Mass of Pycnometer+ water (M4)	1172	1172
5	Specific gravity = (M2-M1)/(M2-M1)- (M3-M4)	2.63	2.63

Result: - Specific Gravity of fine aggregate is = 2.63
Conclusion:The sample of fine aggregate tested so, as found out to be satisfactory.

H. Water Absorption Test

Water absorption = {[W2 – W1] / W1} x 100
Where, W1 = Weight of dry brick (kg) W2 = Weight of wet brick (kg) For concrete paver block:
Water absorption = {[W2 – W1] / W1} x 100
= {[7920 – 7289.9]/ 8166.6} x100
= 8.6434

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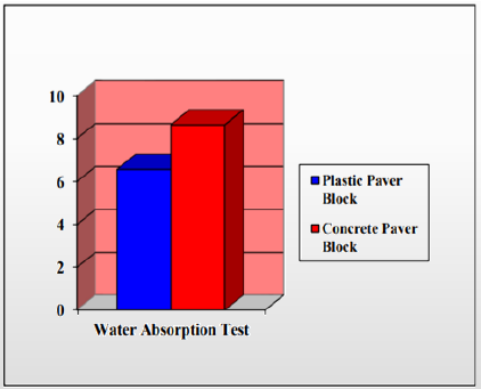
For plastic paver block:
Water absorption = {[W2 – W1] / W1} x 100
= {[8703.3– 8166.6]/ 8166.6} x100
= 6.5718

Water Absorption For Various Types Of Paver Blocks S. No	TYPES OF PAVER BLOCKS	WATER ABSORPTION
1.	Plastic paver block	6.5718
2.	Concrete paver block	8.6434



I. Fire Resistance Test

Table 3: Observation Table

Sr. no.	Temperature (°C)	Specimen sample 1	Specimen sample 2	Specimen sample 3
1.	50	no change	no change	no change
2.	100	no change	no change	no change
3.	150	Melts	Melts	Melts

J. Compression Test

Sr. No	No of days	Compressive Strength(N/mm²)	
		Concrete Paver Block	Plastic Paver Block
1	3	10.74	15.70
2	7	15.37	21.81
3	21	23.46	26.93

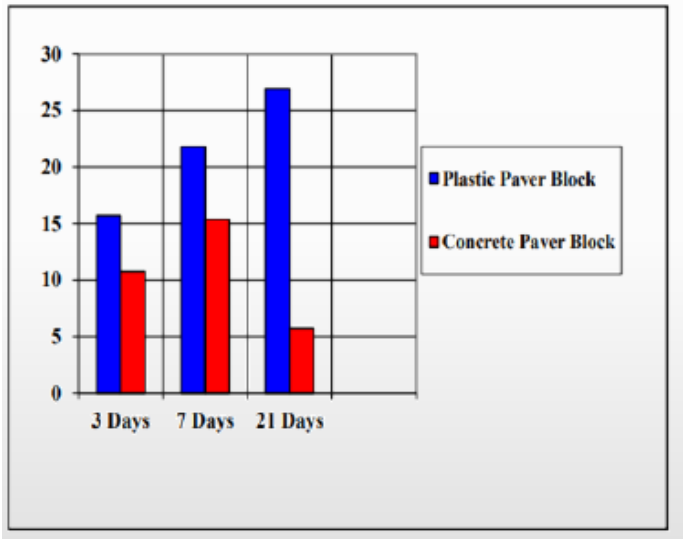


Figure 3: Compressive Strength Result

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V. CONCLUSION

- Plastic is an innovative material for using it in construction purpose.
- From Compression Strength Test conducted on plastic paver block it is concluded that the compressive strength of plastic paver block is more than ordinary concrete paver block i.e. 26.93Mpa.
- From Water Absorption Test it is concluded that the water absorption of Plastic Paver Block is more than ordinary concrete paver block, i.e. 6.5718.
- Plastic paver block is effectively Fire Resistance.
- Plastic paver block is a productive way of disposal of plastic waste thus it helps to protect the environment.
- It shows better results such as strength and water absorption, etc.
- It can be used in light traffic road or footpath it requires less time for manufacture.
- The cost of paver block is reduced when compared to that of concrete paver block.
- Though the compressive strength is high when compared to the concrete paver block.
- It also helps to generate employment.

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