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Sustainable Construction of Paver Blocks Made from Recycled Plastic

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ABSTRACT

With an annual production of over 9.3 million tons of plastic waste, India is the world's biggest plastic polluter. The production of cement, which produce the CO_2 emissions, is another issue. Therefore, recycling plastic waste instead of cementitious materials could be a more effective way to reduce waste and remove cement. Thus, in this article, plastic waste is recycled and used to make paver blocks, a sustainable building material that eliminates the need for cement. The study looks at adding different amounts of plastic waste, more especially, PET and HDPE to blocks of sand pavers. While decreasing water absorption capacity, using plastic waste in the construction of paver blocks might improve the blocks' mechanical qualities and reduce environmental pollution. The findings indicate that used of 30% composition to develop plastic waste sand paver blocks. This paver blocks use in light weight applications like parks, footpaths, patios. These blocks have low water absorption compared to traditional concrete paver blocks, which makes these blocks impermeable.

1. INTRODUCTION

Plastic is a very useful substance in our daily life work, but after the use of plastic, it is very difficult for us to dispose of it because it is a non-biodegradable substance. After its usage, it is a hazardous material. Plastic is a new engineering material in which researchers take more interest to invest their time and money because it has a wide scope to enhance the usage of plastic in different work. The properties of plastic are very unique and it can mix with every kind of material. Plastic is a composition of synthetic and semi-synthetic organic compounds. They are malleable and ductile and remould into any solid substance. Plastic is used in various objects which we use in our daily life like polythene, plastic cups, furniture, bags, packaging of food and other accessories, drinking containers, bottles, frames, basins, etc. We need to use better-advanced techniques and methods to dispose of plastic waste properly; otherwise, the time is not too far away from where we see it as a big challenge for us to dispose of it. In India, we use incinerators to dispose of the plastic waste in which plastic waste burns at high

temperatures. The gases which evolve during this burning process pollute air and water. Due to this, a large number of people get affected and suffer from many harmful diseases. Researchers suggest that if plastic isn't disposed of soon, it can sustain for 4500 years without degradation. Now, these days the rate of plastic use keeps increasing. So, the collection of plastic waste increasing at a rapid speed. India faces a severe and growing crisis of plastic waste. With rapid urbanization and increasing consumption, the amount of plastic waste generated daily is staggering. This waste overwhelms existing infrastructure, leading to overflowing landfills, clogged waterways, and widespread pollution. A significant portion of this waste is single-use plastics, like packaging and bags, which have a short lifespan but a long-lasting environmental impact. The mismanagement of plastic waste has far-reaching consequences, affecting public health, ecosystems, and the economy. While recycling efforts exist, they are often insufficient and hampered by the informal nature of the waste management sector.

Numerous research has looked into using plastic waste as an environmentally beneficial substitute for traditional materials while making paver blocks. When PET plastic was used in place of cement in paver blocks, Nivetha C. et al. (2016) discovered that a mixture of PET (30%), fly ash (25%), and quarry dust (45%) produced stronger blocks than conventional concrete, providing a sustainable way to manage plastic waste and lowering CO2 emissions. Guruvignesh and Priyanka (2020) also showed that plastic paver blocks can reduce landfill waste by up to 40% since they are appropriate for low-traffic areas and have strong heat resistance.

Iftikhar & Alih (2023) studied plastic sand paver blocks using LDPE and basalt fibers, concluding that a 30:70 LDPE-to-sand ratio provides the best mechanical strength, meeting ASTM standards for light traffic applications. Jassim (2017) investigated the potential of recycling solid waste directly into usable components without additional processing, demonstrating that solid inert chips could be effectively utilized. Parthini & Gifta (2016) concentrated on cost-effective paver blocks.

Tapkire et al. (2014) investigated recycled plastic in concrete paver blocks and discovered that up to 20% of the coarse aggregate may be substituted with plastic while still keeping appropriate concrete characteristics. However, increased plastic content may lower strength, which might be rectified by bonding admixtures. Overall, these studies show the role of plastic waste in sustainable building, lowering environmental impact and supporting eco-friendly infrastructure solutions.

A review of literature on studies on the use of plastic waste in concrete manufacture carried out by revealed that most of the researchers worked on the strength properties of concrete. They mainly considered compressive, flexural and tensile strengths. Some also investigated on the modulus of elasticity. Some other took a step further to examine the durability properties such as water absorption, abrasion resistance, sorptivity, permeability, UPV, sulphate attack and porosity of the concrete. They all used plastic as either a full or partial replacement for aggregates (fine).

2. METHODOLOGY

A. Collection of materials
B. Making Process
C. Experimental Investigation

A. Collection of Material

i) Plastic: Plastic Bottles. Polythene Bags are collected from various sources like Restaurants, Scrap Vendors and Domestic Sources. The Type of Plastic Collected are as follow:

a) Polyethylene Terephthalate (PET)
b) High Density Polyethylene (HDPE)

ii) Sand: It is collected from construction site. Normal River Sand is used for making the paver blocks.

B. Making Process

Heating/Melting of Plastic: Plastic bottles and polythene bags care melted at temperatures between 200-250 degrees Celsius. This process transforms the solid plastic waste into a molten liquid.

Mixing: After melting the plastic Sand is added, then mixture is stirred constantly. During the mixing precautions should be taken, because the harmful gases are released, it is recommended to wear a facial mask.

Moulding: The plastic paste still very hot and fluid is poured into the mould and firmly levelled with a trowel. Then it is compressed with a dedicated tool which is designed as per paving block shape. Mould should be greased with some oil.

Remoulding: After 5 10 Minutes remould the paver block carefully. When plastic is cool enough, the extraction of the paving block out of the mould is immediate. It is only requiring a gentle pulling off of the mould. Paving block on their metallic support is immerged in a tank with cold water.

V) Cooling: Paver should be left submerged in water for few minutes for cooling, unlike concrete no curing is required.

Fig. 1 Plastic and Sand Paver Blocks

C. Experimental Investigation

Utilizing diverse plastic types (PET, HDPE), and assessing structural integrity. Studies explore varying plastic-to-aggregate mixes, evaluating compressive strength, water absorption, and thermal resistance to ensure durability. Researchers also examine the environmental impact, aiming to reduce plastic waste.

3. TESTING ON PAVER BLOCKS

i) Water Absorption Test:

The water absorption of the various blocks was estimated after immersing specimens in water for 24 Hours,

Water Absorption = $\frac{W_2 - W_1}{W_1} \times 100$

W_2:- Wet weight of paver block

W_1:- Dry weight of paver block

Note :- IS 15658 (2006) is taken as a reference for testing

ii) **Compressive Strength Test**

A compressive strength test of a paver involves placing a paver block between two plates on a compression testing machine and applying pressure until it breaks, measuring the maximum load at failure to determine the paver's resistance to crushing, typically expressed in units like MPa (megapascals) or psi (pounds per square inch)

Compressive strength (N/mm^2) = (Ultimate load in N / Area of cross section (mm^2).

4. RESULTS

i) Water Absorption Test:

This test is done on 3 sample paver blocks

Table 1. Water Absorption test

Sr. No	Sample	Dry Weight (W_1) (Kg)	Wet Weight (W_2) (Kg)	Water Absorption $\frac{W_2 - W_1}{W_1}$ x100
1)	S1	1.429	1.437	0.56%
2)	S2	1.414	1.426	0.85%
3)	S3	1.867	1.885	0.96%

ii)Compressive Strength Test

Following Test is done on Samples

Table 2. Compressive Strength results

Sr. No	Sample	Compressive Strength N/mm^2 (Mpa)
1)	S1	16.41
2)	S2	18.07
3)	S3	19.63

CONCLUSION

We can utilize plastic for making paver blocks as the plastic paver blocks are light weight compared to traditional concrete paver blocks the plastic paver blocks weight from 1.5 to 2 Kg compared to traditional paver blocks weighing 4 to 5 Kg. We can use this paver blocks in light weight applications like parks, footpaths, patios. These blocks have low water absorption compared to traditional concrete paver blocks, which makes these blocks impermeable.

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