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ECO-FRIENDLY PAVER BLOCK USING WASTE PLASTIC BOTTLES

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ABSTRACT

The study of eco-friendly paver bricks using a mix of waste plastics and coconut fiber. With increased worry about environmental deterioration caused by plastic waste, as well as the desire for sustainable construction materials, this study gives solution to both the problems. The study comprises a detailed investigation of the properties of waste plastics and coconut fiber to assess their acceptability for paver block construction. Waste LDPE are taken and processed coconut fiber is used for making paver block. To find the compressive strength tests, water absorption tests, and melting point test of paver block. The results shows that the addition of coconut fiber reduced the compressive strength of the paver blocks. urthermore, the usage of discarded plastics and coconut fiber contributes to the decrease of plastic pollution and supports the utilization of natural and renewable resources. The eco-friendly paver blocks created in this study offer a sustainable alternative for building projects, supporting waste management programs and environmental conservation efforts. Future research possibilities include refining the manufacturing process, looking into new additives or reinforcements, and undertaking life cycle evaluations to analyze the overall environmental effect of the eco-friendly paver blocks.

Keywords: Coconut fiber, Ammonium polyphosphate, LDPE plastic waste, additives, and contaminants.

INTRODUCTION

Plastic composites degrade at a considerably slower pace because of their endurance and chemical bonding that resist natural deterioration. Many pollutants, including plastic, are deposited directly or indirectly in the marine environment and landfills. Production of bricks has expanded dramatically over the years as emerging countries' need for housing and infrastructure has grown. The increasing growth in building activity has prompted academics to develop alternate construction materials for masonry works. Many impoverished individuals in India are unable to purchase their own homes due to the high cost of constructing materials. India has a high need for low-cost and efficient construction materials to help impoverished people realize their ambitions of owning their own homes. In India, about 40 million metric tons of plastics are consumed each year, and after some time, the majority of them become garbage, endangering the environment. According to reports, this quantity grows by 1.5-2% every year displays the global production of different plastics in 2015, as well as their recycling codes. 17% of LDPE-based items are made; this is the third largest proportion of produced polymers, and they are utilized just once before being discarded. This study focuses on the conversion and characterisation of LDPE trash into bricks in order to utilize huge amounts of single-use LDPE plastic waste for sustainable development. Develop LDPE-based paver blocks that offer comparable or superior durability and performance to traditional concrete or clay pavers.

Enhance the sustainability quotient by utilizing recycled LDPE materials and ensuring recyclability at the end of the product's life cycle. Address challenges such as UV stability, temperature resistance, and load-bearing capacity to ensure suitability for outdoor applications.
Using plastic for building provides cost-effectiveness, strength, and durability. In the process of taking Low Density Polyethylene (LDPE) plastic wastes to convert the plastic brick's use for environmental degradation. In the building sector, low density polyethylene (LDPE) plastics are frequently employed. LDEP plastic bricks have 2.5 and 3 times better stress strength and manufacturing temperatures. Those bricks were around five times cheaper than burning plastic bricks.

Bricks having a higher percentage of LDEP (5%) outperformed typical fire plastic bricks. It increases compressive strength by 0.5%. Ammonium polyphosphate, a fire-proof chemical, should be used to reduce fires.

1.1CONSEQUENCESFACTSOF PLASTIC

- To produce one ton of plastic, more than 20,000 plastic bottles are required.
- Annual production of plastic is anticipated to be 100 million tons.
- The annual plastic waste of the average European is 36 kilograms.
- Recycled plastic makes about 64% of the material in some plastic garbage sacks.
- Only a small portion of the 42% of plastic packaging used year is recycled.
- According to ENSO Bottles, there was very little plastic bottle manufacture in the 1960s, but over time, the number of bottles produced and sold increased alarmingly, while recycling rates remained extremely low.

1.2 PLASTIC IN PAVER BLOCK

One creative method of getting rid of plastic debris that is lying around and helping to clean up the environment is to use it to make paver blocks.
In comparison to concrete paver blocks, plastic trash paver blocks are more affordable, robust, and resistant to corrosion and heat.

1.3 OBJECTIVE

- To prepare paver blocks by using collected plastic wastes (plastic water bottle).
- To prepare paver blocks by using collected plastic wastes and coir fiber.
- To investigate the compression strength, water absorption and melting point test of the paver block.
- To study the usage of plastic as fully replacement of all ingredients in the plastic paver block**.**

1.3 SCOPE

- Creating eco-friendly bricks from waste low-density polyethylene requires researching sustainable ingredients, establishing a cost-effective production process, testing mechanical qualities, and environmental impact.
- The project aims to reduce waste through sustainable construction techniques.
- This initiative seeks to reduce waste and encourage sustainable construction techniques.
- This study discusses the many possibilities for recycling plastic garbage and offers a broad overview of the major concerns with plastic disposal.

1. METHODOLOGY

Material Preparation

Batching

Shredding of plastic waste

Melting of plastic waste

Casting of LDPE Paver block

Discussion and Conclusion

2. MATERIAL USED:

The materials used in this project are

- Low-density polyethylene (LDPE).
- Coconut fiber.
- Ammonium polyphosphate.
- Moulds**.**

Low-density polyethylene:
LDPE plastic is combined with other admixtures to manufacture parking bricks. Following production, the brick will undergo testing to determine its compressive strength. Additionally, a fire-resistant coating will be applied to the brick to increase its fire resistance, and fire-resistant testing will be conducted. The local municipality in Abbottabad, Pakistan provided the LDPE utilized in this investigation. Following collection, the sample was cleaned and dried well to remove any contaminants that would have interfered with the melting process.

Lastly, it was shredded into little pieces. Features of the LDPE utilized in this investigation. Figure 4.1 shows the Shredded Low-density polyethylene (LDPE).

Low-density polyethylene (LDPE)

The density range of 917–930 kg/m3 is what characterizes LDPE. It is not reactive at room temperature, with the exception of strong oxidizers; certain solvents cause it to swell. It can endure temperatures as high as 90 °C (194 °F) for brief periods of time and as low as 65 °C (149 °F) continuously. It is highly durable and flexible, and it is available in translucent and versions. Compared to HDPE, LDPE contains more branching (on around 2% of the carbon atoms), which results in weaker intermolecular interactions (i.e., instantaneous dipole induced dipole attraction), lower tensile strength, and higher resilience. Its density is lower because of the side branches, which indicate that its molecules are less crystalline and more loosely packed.

Coconut fiber:

Coconut fiber, derived from the outer husk of coconuts, is used in a variety of items, including floor mats, doormats, brushes, and mattresses. Coir is the fibrous fiber found between a coconut's hard interior shell and outer covering. Brown coir, obtained from ripe coconuts, can also be used for upholstery padding, sacking, and horticulture. White coir, derived from unripe coconuts, is used to produce finer brushes, thread, rope, and fishing nets. Because it does not sink, it can be utilized in deep water for extended distances without weighing down. Coconut fibers measuring 5 mm in length were used. Coconut fiber's higher lignin content and lower cellulose and hemicellulose content, combined with its high micro fibrillary angle, provide valuable properties like resilience, strength, damping, wear, resistance to weathering, and high elongation at break. After collection, the sample was washed, sanitized, and dried to remove impurities that could disrupt the melting process.

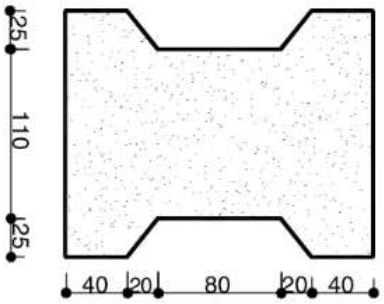
Ammonium polyphosphate:

An inorganic salt of ammonia and polyphosphoric acid, ammonium polyphosphate has two chains and the capacity to branch. Each monomer is made up of the orthophosphate radical of a phosphorus atom with three oxygen atoms, as shown by the chemical formula [NH4 PO3] n(OH)2, where one negative charge is neutralized by an ammonium cation, leaving two bonds open for polymerization. Certain monomers bind to three other monomers in branching conditions because they do not have the ammonium anion. In addition, paints and coatings as well as a variety of polymers—the most significant of which are polyolefins, especially polypropylene—also use ammonium polyphosphate (APP) as a flame retardant. APP is included into intumescent systems for these purposes. It is spoken of compounding with flame retardants based on APP in polypropylene.

The employ APP in polyurethane castings (intumescent systems), epoxies, unsaturated polyesters, and gel coatings (APP mixes with synergists). Moreover, flame-retardant polyurethane foams are made using APP.

Mould:

Our products include interlocking paver block pvc moulds, pvc kerbstone moulds, pvc cover blocks, pvc ventilation moulds, designer tile pvc moulds, plastic paver moulds, and recycled
paver moulds. We offer diverse shapes, sizes, and proportions. All goods are inspected for quality and authenticity before delivery. Features: Our Vergin PVC material allows for easy demolding. The mould's flexibility enhances its durability. In this procedure, we used a steel mould to cast the LDPE paver blocks. Area of the mould is 24000mm2 Fig 4.4 shoes the mould size which is used for plastic paver block.



Dimension of mould

4. METHOD OF CASTING:

Mix proportion is the process of selecting acceptable components for creating plastic paver blocks and establishing their relative amounts in order to achieve a specified minimum strength and durability while remaining as affordable as feasible. Mix proportioning involves selecting and combining appropriate components to achieve desired strength.

Casting of LDPE plastic paver block (MIX-1).

Casting of LDPE plastic paver block with coconut fiber (MIX-2).

Table 5 Mix description

S.NO	MIX DESCRIPTION	LDPE Kg/m^3	COCONUT FIBER
1	MIX-1	1.3	0
2	MIX-2	1.3	5%

Table. 5 shows the quantity of materials which is used for making a LDPE plastic paver blocks.

Casting of LDPE plastic paver block (MIX-1):

- ❖ The LDPE plastics which are shredded.
- ❖ Shredded LDPE is heated up to 110 °c to reach melting point.
- ❖ Some shuttering oil is applied to the mould.
- ❖ 100ml of ammonium polyphosphate chemical is added to the LDPE to make it as fireproof material.
- ❖ The melted substance is poured into the mould.
- ❖ After 24 hours the mould is demolded and ammonium polyphosphate is applied to the outer surface like a skin.

Casting of LDPE plastic paver block with coconut fiber (MIX-2):

- ❖ The LDPE plastics which are shredded.
- ❖ Shredded LDPE is heated up to 110 °c to reach melting point.
- ❖ Some shuttering oil is applied to the mould.
- ❖ 100ml of ammonium polyphosphate chemical is added to the LDPE to make it as fireproof material.
- ❖ Some shuttering oil is applied to the mould.
- ❖ Pour the melted substance in the mould by first layer.
- ❖ Add second layer the coconut fiber 5% is added.
- ❖ Third layer the melted substances.
- ❖ After 24 hours the mould is demolded and ammonium polyphosphate is applied to the outer surface like a skin.

5. TESTS OF PAVER BLOCK:

The strength tests carried out on hardened concrete specimens are:

- Compression test.
- Water absorption.
- Melting point test.

Compressive strength:

A compression testing equipment, a compressive strength test was conducted on waste plastic, I-section paver blocks, and plastic brick pavers to determine their capacity to support a weight under compression. A compressive testing machine was used to conduct the test (CTM). The Indian Standard Code IS 3495: 1992 (Part I) was followed in the process. It is necessary to test the plastic specimens' compressive strength. Prior to testing, the specimens' weight and measurements must be recorded. The test specimen must be inserted into the machine such that the load is applied to the cubes' opposing sides rather than their top and bottom. The load must be administered without shock and raised steadily at a rate of about until the specimen's ability to withstand the growing load is no longer possible and no higher load can be maintained. After that, the maximum load applied to the specimen must be noted, along with the concrete's appearance and any peculiarities in the failure type.

Compressive strength

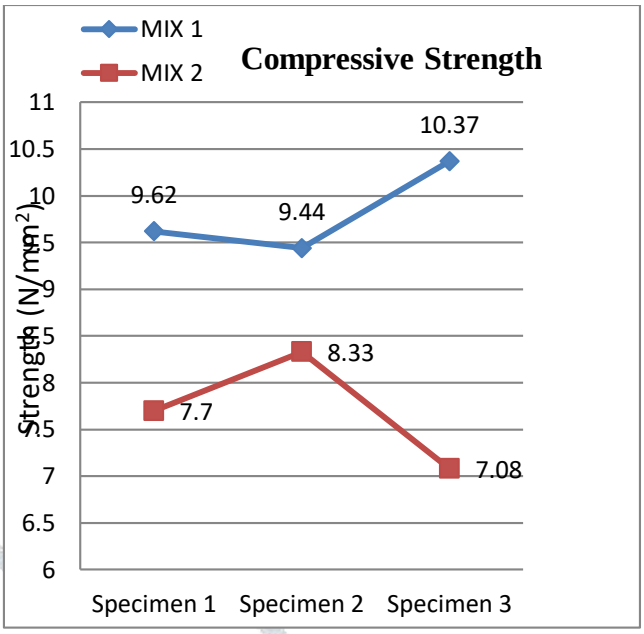
Water absorption:

The increase in a specimen's mass due to water absorption, this test method can be used to calculate the percentage of water absorption by plastic specimens. In accordance with BS 1881: Part 122, 1983, this test was performed on specimens of hardened plastic paver blocks. After weighing each specimen, submerge it entirely in the tank until there is a layer of water 25 ± 5 mm above the specimen. Unless otherwise indicated, leave the specimens submerged in the water for 30 ± 0.5 minutes. Take out each specimen, give it a shake to get rid of most of the water, and then dry it off with a cloth as quickly as you can, continuing until the surface is completely free of water. The amount of moisture that a plastic Paver block absorbs after being submerged in water for around 24 hours is referred to as water absorption. The durability of the sample is determined by water absorption.A test for water absorption was conducted. The samples were weighed and dried in an oven for a full day before being submerged in water; the weight obtained was assigned the designation W1. The samples were brought to a saturated surface dried state and weighed again after a 24-hour period; this weight was assigned W2. Equation was then used to determine the water absorption.

Melting point test:

A basic technique for figuring out a material's thermal characteristics, especially that of plastics like low-density polyethylene

(LDPE), is the melting point test. A small sample of LDPE plastic is heated under controlled conditions until it melts in this experiment. The process entails getting the sample ready, assembling a heating device, and progressively raising the temperature while tracking any changes in the plastic. The point at which LDPE changes from a solid to a liquid is known as the melting point. The exact melting point of LDPE, which normally ranges from 105°C to 115°C (221°F to 239°F), must be determined with accuracy. This test yields useful data for material characterization, quality control, and comprehending LDPE plastic's thermal behavior. When performing this test, proper safety measures, such as ventilation, should be taken to reduce any potential hazards related to heating plastics. Every specimen's measured absorption is recorded. The procedure followed IS 13360: 2013 (Part 6) of the Indian Standard Code.



Compressive Strength graph

6. RESULTS AND DISCUSSIONS:

The strength of LDPE plastic paver blocks. This chapter presents a comparative study of the properties of LDPE plastic paver blocks with coconut fiber strength added at varying percentages.

Compressive strength:

Table 6.1 shows the compressive Strength test results and strength effectiveness of LDPE paver block. The compressive strength of LDPE paver block with coconut fiber is lesser than the LDPE paver blocks.

Casting of LDPE plastic paver block (MIX-1) Casting of LDPE plastic paver block with coconut fiber (MIX-2)

Table 6.1 Compressive Strength

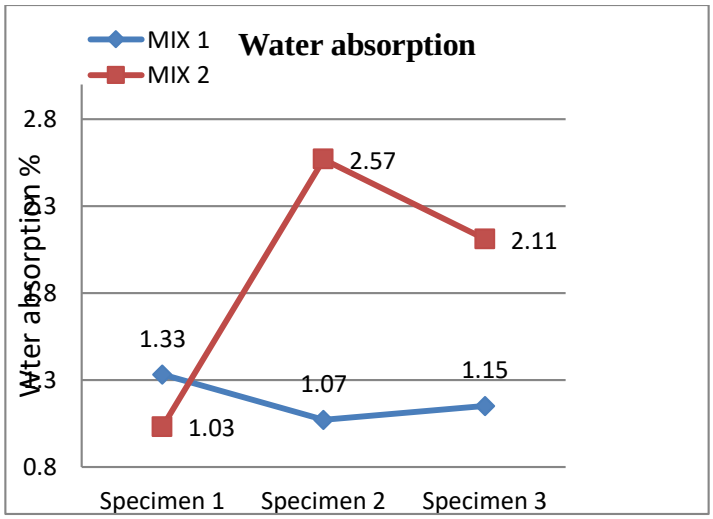
SL. NO	MIX DESCRIPTION	COMPRESSIVE STRENGTH N/mm^2
1	MIX-1	10.37
		9.44
		9.62
2	MIX-2	7.70
		8.33
		7.08

Water absorption:

Using this test technique, the mass increase of a specimen resulting from water absorption is measured in order to calculate the percentage of water absorption by LDPE paver block specimens. Table 6.2 displays the absorption of water.

Table 6.2 Water absorption

MIX	DRIED WEIGHT (W1)gm	SATURATED WEIGHT (W2)gm	WATER ABSORPTION %
1	1125	1140	1.33
	1120	1132	1.07
	1129	1142	1.15
2	965	975	1.03
	970	995	2.57
	925	945	2.11



Water absorption graph

Melting point test:

Melting point tests are performed on plastic bricks to determine the temperature at which they will melt since plastic may melt in the presence of heat. The manufactured paver block will be placed in an oven for two hours, during which time its state will be recorded.

Table 6.3 melting point test

	TEMPERATURE (°C)	STATE
LDPE PAVER BLOCK	50	No change
	100	No change
	130	Melts
LDPE PAVER BLOCK WITH COCONUT FIBER	50	No change
	100	No change
	130	Melts

The melting point of a Paver block is 130°C, as Table 6.3 demonstrates. When in use, the plastic paver block can withstand extreme temperatures. In the event of a fire, no structure or person may be impacted.

7. CONCLUSION:

The main findings of this study are as follows:

• LDPE plastic in paving blocks benefits the environment and the building sector. According to the findings of the compression test, plastic paver brick has a higher strength (9.81 N/mm2).

• When 5% of the fiber is added, the compressive strength of the LDPE plastic in the coconut fiber paving blocks decreases significantly, reaching 7.70 N/mm2.

• However, compressive strength values significantly drop with additional fibers supplied. Moreover, the fiber thickness may make it difficult for the plastic to be packed appropriately, which would further weaken it. LDPE paver block specimens are evaluated by calculating the mass gain brought on by water absorption.

• 1.9% more water is absorbed by the plastic block made of coconut fiber than by the plastic paver block. The test findings indicate that traditional paver blocks are not as effective at avoiding water absorption as plastic paver blocks.

• Stone paver blocks have a melting point of 130°C. The plastic paver block can endure high temperatures when in use. When they start, fires can not affect people or structures very much.

• Its applications in the building industry are restricted to pedestrian walkways, bike routes, gardens, and slab finishes. We can determine that the paving blocks have a high melting point of 130°C based on the results of the melting point test.

• However, because they are heat-sensitive and might malfunction in a fire, it is not advised to use them for wall finishes or building construction. Furthermore, compared to concrete paver blocks, plastic paver blocks are more water resistant.

• In addition to giving us a way to work on imaginative plastic-related projects and strive to build new civil engineering materials that will have a big influence on the industry going forward, plastic paver blocks also give us hope.

Because of resource scarcity and its effects, it is our responsibility as engineers and citizens to inform people about the need of recycling and reusing resources.

•The goal of this project is to improve future plastic waste management by preventing degradation and turning plastic trash into "Eco-Friendly" paving block**s.**

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