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Eco-Friendly Blocks from High Density Polyethylene Waste and Rice Husk

Arshida Unas[1]; Fiya Jafar[2]; Muhammed Sahad N.S[3]; Noorul Abid[4]; Dr. Shaina Beegam N[5]

[5]Assistant Professor, [1,2,3,4] UG student

Department of civil engineering, Ilenia College of Engineering and Technology
A.P.J Abdul Kalam Technological University Thiruvananthapuram, India

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Abstract: This project aims to create eco-friendly paving blocks by combining high-density polyethylene (HDPE) waste and rice husk, offering a sustainable alternative to traditional concrete blocks. By blending and molding these materials, the resulting blocks are tested for key properties like strength, water absorption, and density. HDPE, a common plastic pollutant, and rice husk, an agricultural byproduct, are repurposed to reduce landfill waste and promote environmental sustainability. The blocks are lightweight, durable, and provide thermal insulation, making them suitable for construction. This innovative process supports the circular economy and reduces the environmental impact of conventional building materials. Overall, the project demonstrates the potential of recycling waste materials to create greener, more sustainable construction options.

Keywords: *Eco-Friendly ,Paving Blocks ,High-Density Polyethylene (HDPE) ,Rice Husk, Sustainable Alternative, Concrete Blocks , Recycling.*

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I. INTRODUCTION

Blocks made from recycled high-density polyethylene (HDPE) waste and rice husk provide an eco-friendly alternative to traditional construction materials. By repurposing HDPE plastic waste and using rice husk, a byproduct of rice milling, these blocks help reduce landfill waste and enhance qualities results in a durable, lightweight material with excellent thermal and sound insulation. Furthermore, producing these blocks uses less energy and generates fewer greenhouse gas emissions, supporting more sustainable building practices.

II. OBJECTIVES

- To design and prepare paving blocks using HDPE plastic waste and rice husk.
- To investigate the strength properties of the developed paving blocks and evaluate the potentiality as sustainable material in construction.
- To compare the strength properties of developed paving blocks with standard block.

III. LITERATURE REVIEW

Sabiha & Molla (2023) show that eco-friendly bricks made from recycled HDPE waste are durable, lightweight, and water-resistant, outperforming traditional clay bricks in strength and insulation. Adding rice husk ash enhances properties and reduces costs, with a 70:30 HDPE-to-sand ratio proving optimal. This offers a sustainable way to repurpose plastic waste in construction.

Sanjay (2022) highlights sustainable bricks made from phosphor gypsum (PG) and rice husk (RH), offering improved strength, insulation, and reduced water absorption. Despite challenges in scaling and standardization, these eco-friendly bricks show strong potential as a viable alternative to traditional bricks.

Prathik (2022) highlights the successful recycling of HDPE and PP plastic waste into durable bricks with excellent compressive and tensile strengths. Optimal mixing ratios and additives enhance performance, while improved insulation, water resistance, and reduced density make them a sustainable construction alternative.

IV. METHODOLOGY

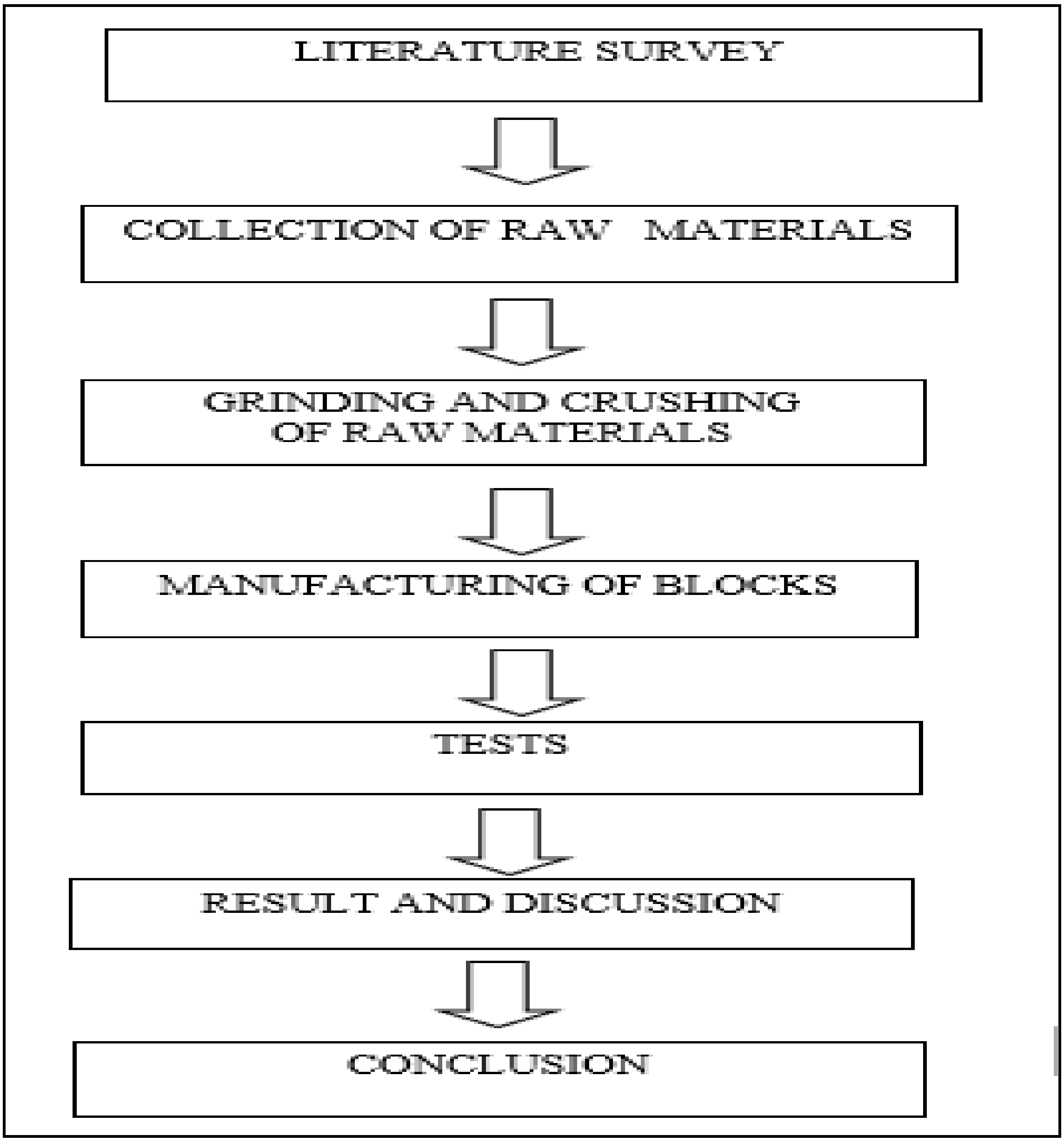

Fig 1 Methodology

V. MATERIALS USED

- *Cement:*

Portland Pozzolana Cement (PPC) is a type of amalgamated cement created by mixing Portland cement clinker with pozzolanic accoutrements similar as cover ash. It delivers bettered continuity, resistance to sulfates, and a lower heat of hydration, which helps reduce the threat of thermal cracking in large concrete structures. PPC enhances plasticity, supports environmentally friendly construction practices, and, although it has a pokily early strength development compared to Ordinary Portland Cement (OPC), it attains advanced strength over time. This makes it especially suitable for hydraulic structures, marine construction, and systems taking continuity.

- *Water:*

Essential in concrete production, acting as a catalyst for cement hydration, which binds aggregates into a cohesive structure. In this study, clean potable water was used to ensure consistent hydration and bonding, with water quality crucial for workability, setting time, and strength.

- *HDPE:*

A versatile synthetic plastic made from ethylene, polyethylene comes in flexible LDPE for packaging and rigid HDPE for bottles and pipes. Its resistance to moisture, chemicals, and UV rays makes it widely useful, but its non-biodegradable nature drives efforts toward better recycling and sustainable alternatives.

- *Rice Husk*:

A byproduct of rice milling, rice husk is rich in cellulose and silica, offering thermal insulation, pest resistance, and moisture absorption. It is used in water filtration, eco-friendly products, renewable energy, and paving blocks, promoting sustainability and farmer income.

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VI. TESTING OF MATERIALS

➢ *Test on Cement*

- *Specific Gravity:*

As per IS 4031 ,the specific gravity is the ratio between weight of given material to the weight of equal volume of water .The dry le chateliar flask was cleaned and filled with kerosine up to the mark 60g cement was taken .initial reading as (v1) after adding 60g cement final reading (v2) is taken

Specific gravity= weight of cement/weight of equal volume of water

Table 1 Specific Gravity of Cement-Experimental Readings

Trial no	Initial reading	Final reading	Specific gravity
1	0.5	23.2	2.64
2	0.5	22.9	2.67
3	0.3	21	2.89

Average specific gravity=2.73

- *Standard Consistency of Cement:*

To determine the standard consistency of cement, a 400 g sample was mixed with a measured quantity of water and kneaded thoroughly for approximately 3 to 5 minutes to form a uniform paste. This paste was then placed into the Vicat mould. The Vicat apparatus plunger was released, and its penetration was observed. The procedure was repeated with varying water content until the plunger penetrated to a point 5 to 7 mm from the bottom of the mould. The corresponding water content at this penetration depth was recorded and expressed as a percentage of the cement's weight, representing the standard consistency.

Table 2 Standard Consistency of Cement -Experimental Reading

Trail no	Percentage of Water Added	Depth of Penetration
1	34	31
2	37	17
3	39	6

Percentage of water content for standard consistency=39%

- *Initial Setting Time:*

The initial setting time refers to the point at which cement paste begins to lose plasticity. In this test, 400 g of cement was mixed with 85% of the water required for standard consistency. The paste was placed in a Vicat mould, and needle penetration was checked every two minutes. The initial setting time was recorded when the needle penetrated no more than 5 mm from the bottom.

Table 3 Initial Setting Time of Cement-Experimental Reading

Slno	Time (Min)	Depth of Penetration
1	**9**	**3**
2	**15**	**4.5**
3	**30**	**5**

Initial setting time of cement = 30 min

➢ *Test on Aggregate*

- Specific Gravity of Coarse Aggregate:

A 2 kg sample of coarse aggregate (>10 mm) was washed, submerged in water, and agitated to eliminate air bubbles. It was then weighed in water, oven-dried at 100–110°C for 24 hours, cooled, and reweighed. Specific gravity was determined as the ratio of dry weight to the weight of an equal volume of water.

Table 4 Specific Gravity of Coarse Aggregate -Experimental Reading

Trial no	Weight of Sample in Water (W1)kg	Weight of Sample in Empty Bucket(W2)Kg	Specific Gravity
1	3	1.7	2.8
2	3	1.73	2.72
3	3	1.71	2.75

Average specific gravity =2.75

- *Sieve Analysis of Coarse Aggregate:*

A 1 kg sample of coarse aggregate was sieved through a series of standard sieves (25 mm, 20mm, 12.5mm, 10mm, 4.75 mm). After shaking for a fixed duration, the material retained on each sieve was weighed to assess particle size distribution.

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Table 5 Sieve Analysis of Coarse Aggregate -Experimental Readings

Sieve Opening (Mm)	**Sieve Opening (Micron)**	**Weight Retained**	**% Weight Retained**	**Cumulative %Weight Retained**	**% Finer**
25	25000	40	4	4	96
20	20000	90	9	13	87
12.5	12500	570	57	70	30
10	10000	100	10	80	20
4.75	4750	170	17	97	3

VII. MIX DESIGN CALCULATION

Based on raw material testing the literature review, the M15 mix design has been selected for the concrete sample

M15 quantities for $1m^3$ concrete are
Cement = 316.8kg
Fine aggregate= 712.8kg
Coarse aggregate= 1364kg
Water required =0.4*316.8kg=126.72kg
Water cement ratio=126.8/316.8=0.4

Fully replacement of fine aggregate by rice husk powder weight of coarse aggregate in $1m^3$ of M15 grade =712.8kg Weight of rice husk powder required = 712.8

Partially replacement of coarse aggregate with plastic for $1m^3$ of M15 concrete
Weight of coarse aggregate=1364kg

➢ *In First Case*

- *Thirty Percentage Replacement of Coarse Aggregate with Plastic:*

Coarse aggregate (70%): plastic (30%)

➢ *In Second Case*

- *Forty Percentage Replacement of Coarse Aggregate with Plastic:*

Coarse aggregate (60%): plastic (40%)

Table 6 Material Quantities

Materials	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**Water**
Quantity of $1m^3$concret	317kg	714kg	1364kg	128kg
Mix ratio	1	2.25	4.3	0.4

VIII. TESTS ON BLOCKS

➢ *Compression Test*

According to IS 3495-1992, this test determines the highest load a material can sustain before it fails. Concrete is molded into cubes measuring 15 cm on each side, properly compacted, and then cured in water after 24 hours. Compressive strength tests are performed on the 7th, 14th, and 28th days of curing. The strength is calculated by dividing the maximum applied load by the cube's cross-sectional area.

Table 7 Compressive Strength of Different Types of Concrete Blocks

Type of Block	**Compressive Strength at 28 Days (N/Mm^2)**
Standard block	17
30% replacement of C.A	15
40% replacement of C.A	14.5

➢ *Split Tensile Strength Test*

As per IS 5816-1959, tensile strength measures concrete's resistance to tension, typically lower than its compressive strength. The split cylinder test using a universal testing machine calculates tensile strength as the ratio of load to cross-sectional area (N/mm^2 or MPa), crucial for assessing cracking resistance.

Table 8 Split Tensile Strength of Different Types of Concrete Blocks

Type of Block	**Split Tensile Strength at 28 Days (N/Mm^2)**
Standard block	2.6
30% replacement of C. A	2.3
40% replacement of C. A	2.3

➢ *Water Absorption Test*

This test evaluates the water absorption capacity of concrete by measuring the amount of water it takes in when submerged. The specimen is first oven-dried, weighed, and then immersed in water maintained at 27°C ± 2°C for 24 hours. After immersion, it is weighed again. The difference in weight helps determine the material's porosity, durability, and overall quality where lower absorption indicates greater resistance to water penetration.

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Table 9 Water Absorption of Different Types of Concrete Block

Type of Block	Water Absorption at 28 Days(%)
Standard block	4.46
30% replacement of C.A	4.37
40% replacement of C.A	4.23

➢ *Density Test*

Density test A density test for pavement blocks assesses their quality and performance. First, ensure the block is clean and dry, then weigh it to determine its mass. Measure its dimensions (length, width, height) for regular shapes or use water displacement for irregular ones to find the volume. Density is calculated as: mass by volume. Expressed in g/cm³ or kg/m³, this test ensures blocks meet strength, durability, and load-bearing standards. Testing multiple samples improves accuracy

Table 10 Density Test of Different Types of Concrete Blocks

Type of Block	Density at 28 Days (Kg/M3)
Standard block	2562
30% replacement of C.A	2447
40% replacement of C.A	2424

IX. RESULT OF EXPERIMENT

➢ *Cement*

Table 11 Test Results and Compliance of Cement Properties

Si No	Tests Conducted	Values Obtained	Is Specification and Allowable Limit	Inference
1	Specific gravity	2.73	IS:455- 1989, limit between 2.9- 3.15	The obtained value is 2.73
2	Standard consistency	39%	IS:4013 (PART 5) 1988, limit between 25% -35%	The obtained value is 39%
3	Initial setting time	45 min	IS:4301- 1968, Not less than 30 minutes	The obtained value is higher than 30 minute

➢ *Aggregate*

Table 12 Test Result and Compliance of Aggregate Properties

Slno	Tests Conducted	Results	Is Specification and Allowable Limit	Inference
1	Specific gravity	2.75	Is 2386 (part 3) limit is between 2.5-3	The obtai ned value is 2.75
2	Sieve analysis	Fineness modulus =2.64	Is 2386 (part3) limit is 4-8	The obtai ned value is 2.64

➢ *Comparison Between Normal, 30% And 40% Replacement of Pavement Blocks*

- *Compression Test*

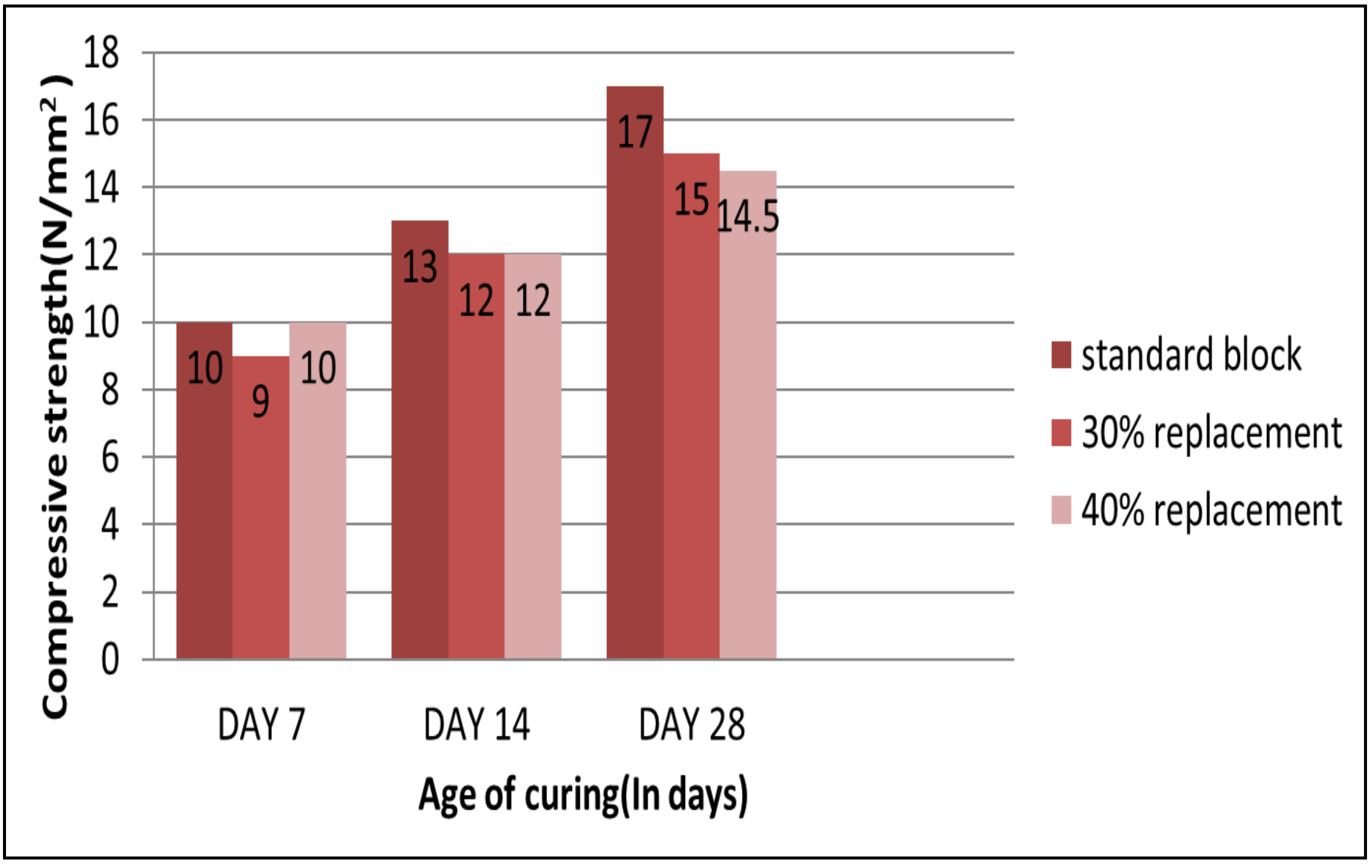

Fig 2 Comparison between Different Types of Concrete Blocks

- *Split Tensile Test*

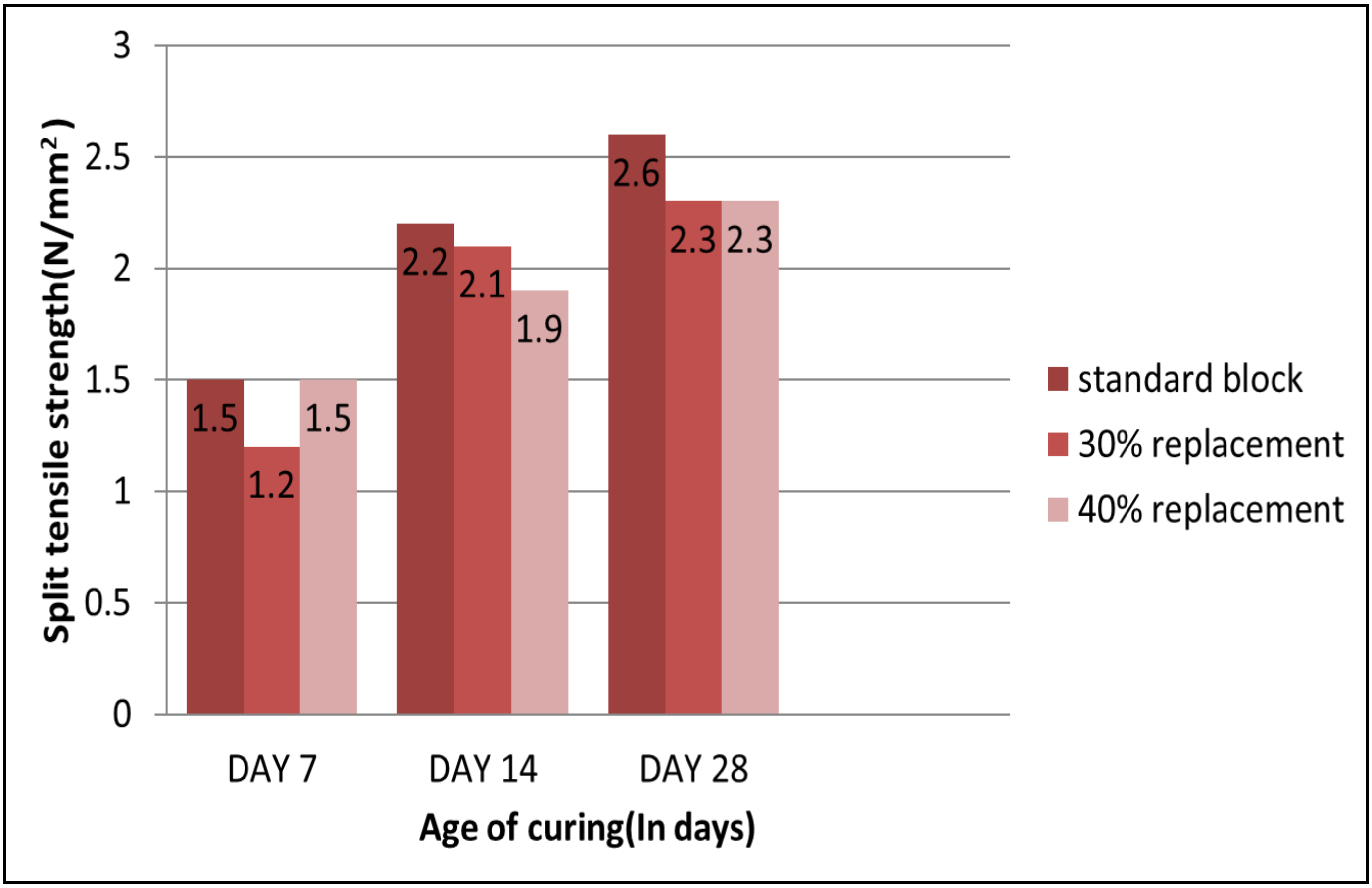

Fig 3 Comparison between Different Types of Concrete Blocks

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X. CONCLUSION

In the experimental study, replacing 30% of coarse aggregate gave the best strength. It reached 15 N/mm² in compressive strength, 2.3 N/mm² in split tensile strength. This shows that 30% replacement is the best for improving strength Lower water absorption translates to improved dimensional stability, reduced risk of mold growth, and enhanced durability in environments with high humidity or frequent spills. The manufactured blocks are less dense than standard block. So it is beneficial for applications where weight reduction is a priority, such as portable flooring or flooring for elevated spaces. Lower weight can make the tiles easier to transport maneuver, and install, reducing labor costs. Although the strength of manufactured blocks may show slight reductions compared to the standard blocks.

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