EXPERIMENTAL INVESTIGATIONS ON ECO-FRIENDLY BLOCKS

Abstract

Concrete blocks are widely used as a building material due to their strength, durability, and cost. However, the production of concrete blocks also has a significant effect on the environment. It uses large amounts of cement, and the production of cement produces large amounts of greenhouse gases. One promising approach is to use alternative materials that have a lower carbon footprint as a partial replacement for cement. Rice husk ash is an agricultural waste that is produced by burning the outer shell of the paddy and comes out as a waste product from mills. It has pozzolanic properties, making it a suitable substitute for the partial replacement of cement in concrete production. Another strategy for making concrete blocks more eco-friendly is to incorporate plastic waste into the concrete mix. Plastic waste is an environmental issue, with large amounts ending up in landfills or polluting the oceans. We can use plastic waste in concrete blocks, preventing it from going to landfills. In this project, the use of RHA and plastic waste is combined to produce more sustainable concrete blocks. Cement is replaced for different percentages of RHA (5%, 10%, and 15%) and RHA Concrete blocks were cast, and the optimum strength was determined at 10% replacement. Again, along with the 10% RHA replacement, coarse aggregate is replaced by 2%, 4%, and 6% shredded plastic. The compressive strength of RHA-Plastic Concrete Block was determined, and it was found that compressive strength drastically decreases with the use of plastics. With the use of RHA, the water absorption of blocks decreases. The water absorption of RHA-Plastic blocks also decreased with the use of plastic.

Keywords: Eco-Friendly, Environment, Concrete, Block, Rice Husk Ash, Shredded Plastic.

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I. INTRODUCTION

Due to excessive resource consumption and mining, the building industry's rapid expansion has resulted in environmental problems. Concerns include environmental damage, ecological imbalance, and greenhouse gas emissions. Inadequate waste recycling leads to pollution and contamination. To reduce the impact on the environment, it is necessary to increase recycling and reuse of waste materials. Extensive research has been conducted on incorporating waste materials into concrete blocks to address the significant waste generated annually. Different waste materials have been investigated as substitutes for cement and aggregates, leading to concrete blocks with improved sustainability and value. Agro-wastes, in particular, have shown potential for enhancing properties like compressive strength and fire resistance. However, careful consideration of the unique characteristics and limitations of each waste material is essential to maximizing its potential for producing environmentally friendly concrete blocks with added value.

According to studies, the majority of the rich materials might be used as a partial replacement for cement. This includes Rice husk ash, sugar bagasse ash, water hyacinth, etc. Rice husk ash, a valuable byproduct obtained from burning rice husk, the outer layer of rice grains, is rich in silica, cellulose, and lignin, typically comprising 15% to 20% silica content. In construction, this ash offers a sustainable alternative to cement. There are many benefits of using rice husk ash as a cement substitute.

Plastic, a versatile material created in 1907, has revolutionized numerous industries. However, the worldwide plastic trash epidemic has emerged as a major source of worry. Improper disposal and the non-biodegradable nature of plastics have resulted in environmental issues. In order to solve this problem, construction projects could use shredded plastic in place of coarse aggregate. Construction projects can help reduce waste and advance a circular economy by substituting shredded plastic for conventional coarse aggregate. The plastic granules may be combined with cement or other substances to produce composite materials with the desired qualities. The use of natural resources like gravel or sand is also reduced as a result of this strategy, which also lessens the amount of plastic trash that ends up in landfills. Shredded plastic can be used in buildings as a resource-saving, environmentally beneficial substitute.

Therefore, in this project, rice husk ash is used as a partial replacement for the cement, along with shredded plastics as the replacement for coarse aggregate in concrete blocks. The unique and value-added properties of each type of waste material are highlighted and discussed in detail, as are the basic properties of concrete blocks. This aims to provide a general idea of the future development of value-added eco-concrete blocks containing waste materials.

II. OBJECTIVE AND METHODOLOGY

Objectives

1. To evaluate the optimized percentage of cement replacement with Rice husk ash and determining the optimum percentage replacement of coarse aggregate by plastic waste.
2. To investigate the mechanical property of eco-friendly blocks.

3. To study the durability property of eco-friendly blocks.

Methodology

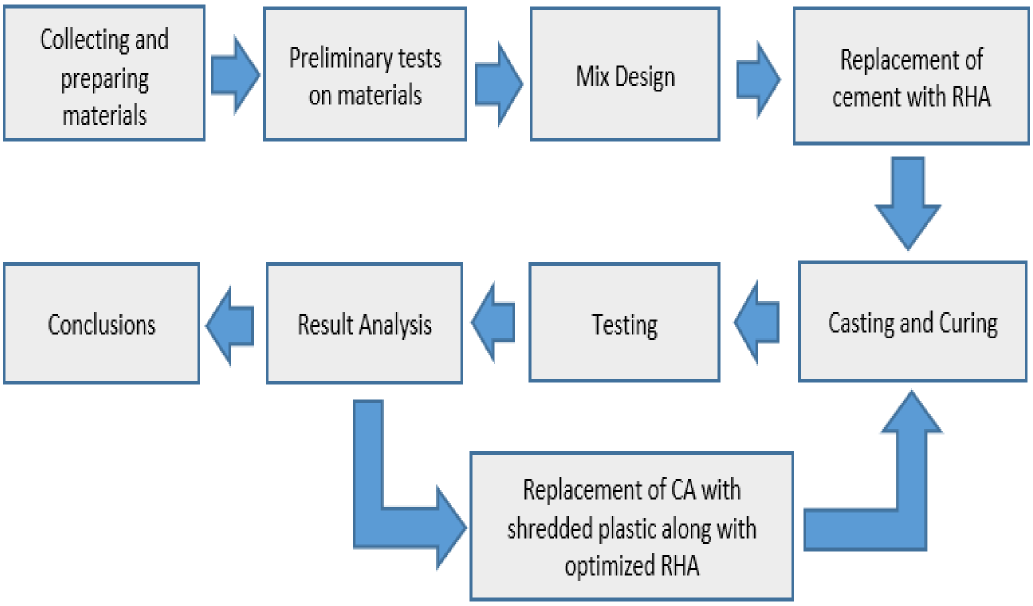

Figure 1: Flowchart for Methodology

III. MATERIAL PROPERTIES

1. **Cement:** Ordinary Portland Cement (Birla) of Grade 53 was used in this project.

Table 1: Physical Properties of Cement

S. N	Property	Test Method	Test Results	Limitation As per IS 12269-2004
1.	Fineness	Sieve test on 90micron sieve (IS:4031 Part-1)	1%	<10%
2.	Specific gravity	Sp. Gravity Bottle (IS:4031 Part-4)	3.13	<3.15
3.	Consistency	Vicant Apparatus (IS:4031 Part-4)	28%	26%-33%
4.	Initial Setting Time	Vicant Apparatus (IS:4031 Part-4)	55 minutes	>30
5.	Final Setting Time		490 minutes	<600

2. **Rice Husk Ash:** Rice husk ash was imported from the ACT Laboratory and used as a replacement for cement.

Table 2: Physical properties of RHA

S. N	Property	Test Method	Test Results
1.	Fineness	Sieve test on 90micron sieve (IS:4031 Part-1)	6%
2.	Specific gravity	Sp. Gravity Bottle (IS:4031 Part-4)	2.19%

3. **Shredded Plastic:** Low density Polyethylene was collected from the campus hostel and outside of Jain university. Plastic was cleaned and dried in the sunlight and shredded into pieces with the help of scissor and grinder.

Table 3: Physical Properties of Shredded Plastic

S. N	Property	Test Results
1.	Specific gravity of plastic	0.87
3.	Water absorption of plastic	-
4.	Melting point of shredded plastic	106 °C

4. **Chemical Properties of OPC VS RHA**

Table 4: Chemical Properties of OPC, & RHA

System	SiO_2	AL_2O_3	Fe_2O_3	CaO	MgO	K_2O	N_2O	TiO_2	SO_3	IR	LOI
OPC	21.4	5.03	4.40	61.14	1.35	0.48	0.24	-	2.53	1.65	1.29
RHA	69	1.29	0.56	0.37	3.59	3.14	0.4	-	0.65	1.7	14.3

5. **Water:** Potable water from the laboratory tap is used for mixing.

6. **Aggregate:** Manufactured sand is used as fine aggregate, and 8mm coarse aggregate is used. For this project, the same type of coarse aggregate that is used in block factories is utilized.

Table 5: Physical Properties of Aggregates

S. N	Property	Test Results	Code of References	As per IS code
1.	Specific gravity of fine aggregate	2.58	IS 2386 part 3-1963	2.5-2.8
2.	Buckling of fine aggregate	15.5%	IS 2386 part 3-1963	15%-30%
3.	Water absorption of fine aggregate	2.7%	IS 2386 part 3-1963	Below 3%
4.	Specific gravity of coarse aggregate	2.7	IS 2386 part 3-1963	2.5-2.8
5.	Water absorption of coarse aggregate	1.4%	IS 2386 part 3-1963	Below 3%

IV. MIX PROPORTION

1. Cement- 416kg
2. Fine Aggregate-919.51kg
3. Coarse Aggregate-819.72kg
4. Water to cement ratio -0.5
5. Mix Proportion By weight = **1:2.21:1.97**

Materials Required for Making 1 Block: The total amount of dry volume of concrete required to cast 1 cube was 8.2 kg as per calculation. By considering losses we have taken 8.5 kg of concrete cube of size 150mm*150mm*150mm. The quantity of each material required to cast cubes is given below:

Table 6: **Mix Proportions of RHA Concrete Block**

RHA (%)	Cement (kg)	RHA (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water (litre)
0%	0.82	-	1.81	1.62	0.41
5%	0.779	0.041	1.81	1.62	0.41
10%	0.738	0.082	1.81	1.62	0.41
15%	0.697	0.123	1.81	1.62	0.41

Table 7: Mix Proportion of RHA-Concrete Block

Plastics (%)	Cement (kg)	RHA (kg)	Fine Aggregate (kg)	Plastic (kg)	Coarse Aggregate (kg)	Water (litre)
0%	0.738	0.082	1.81	-	1.62	0.41
2%	0.738	0.082	1.81	0.032	1.588	0.41
4%	0.738	0.082	1.81	0.064	1.556	0.41
6%	0.738	0.082	1.81	0.0972	1.524	0.41

V. MIX PROCEDURE

All of the elements are hand blended in a dry state until a uniform color is attained. The water is then added and stirred for 4minutes to ensure even distribution.

VI. CURING

The blocks were demolded after 24 hours and taken into the curing tank for curing. Blocks were cured for 7, 14 and 28 days.

VII. PROPERTIES OF CONCRETE

1. Fresh Concrete Property

- **Workability (Slump Test):** The slump test is used to measure the consistency or workability of freshly mixed concrete. It indicates the concrete mixture's water quantity, aggregate dispersion, and overall quality.

Figure 2: Slump Test

In this test, the cone is filled with concrete layer by layer with 25tampings each. Then the cone is vertically lifted. The slump test is shown in the figure. As a result, a proper dosage of additional water was added to improve the fluidity and consistency of the mix.

2. Mechanical Properties of Concrete

- **Compressive Strength Test:** The compressive strength test was carried out on both RHA concrete block and RAH plastic concrete specimens of size 190 mm x 100 mm x 100 mm in a compression testing machine of capacity 2000 KN, as per IS 516:1959 Specification. It is shown in the figure below.

Figure 3: Compressive Strength Test of Cube

3. Durability Property of Concrete

- **Water Absorption Test:** The water absorption of concrete cubes is a significant characteristic that reflects the concrete's resistance to water penetration. The concrete blocks were taken from the curing tank after 28 days of curing and allowed to air-dry until they attained a steady weight. The blocks were then placed in an oven and dried for 24 hours at 110°C. After drying, the blocks were removed, cooled, and weighed. These oven-dried blocks were then immersed in a curing tank for 24 hours. After the specified time, the blocks were removed from the tank, weighed again, and the water absorption was calculated based on the change in weight.

Figure 4: Water Absorption Test

VIII. RESUTL AND DISCUSSION

1. Workability of Concrete

Table 8: Slump Test Value

Slump value	27 mm

2. Compressive Strength

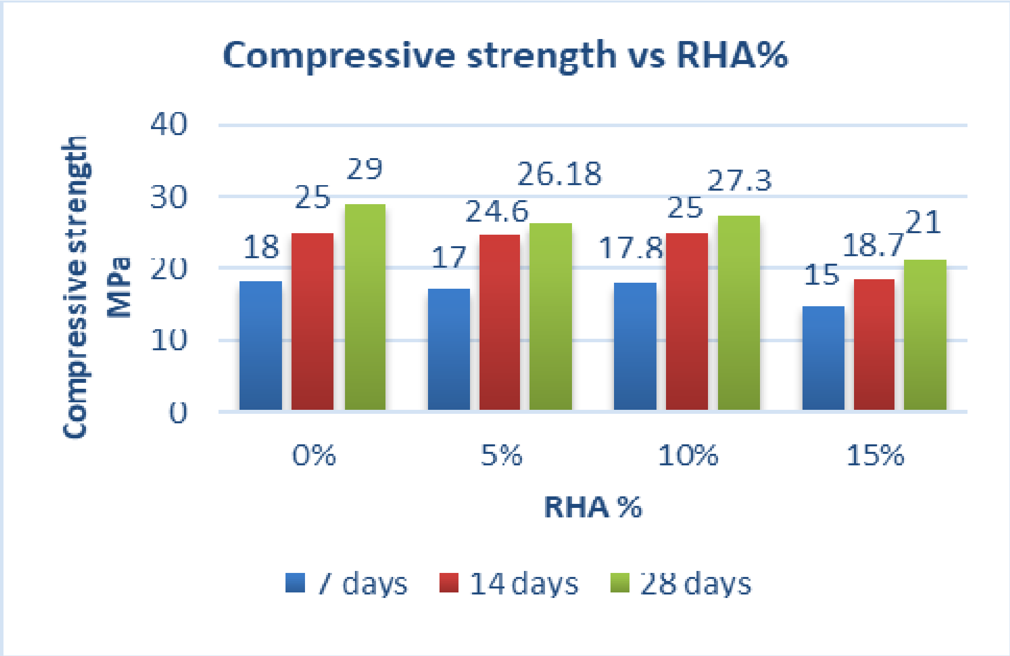

Figure 5: Compressive Strength of RHA Concrete Blocks

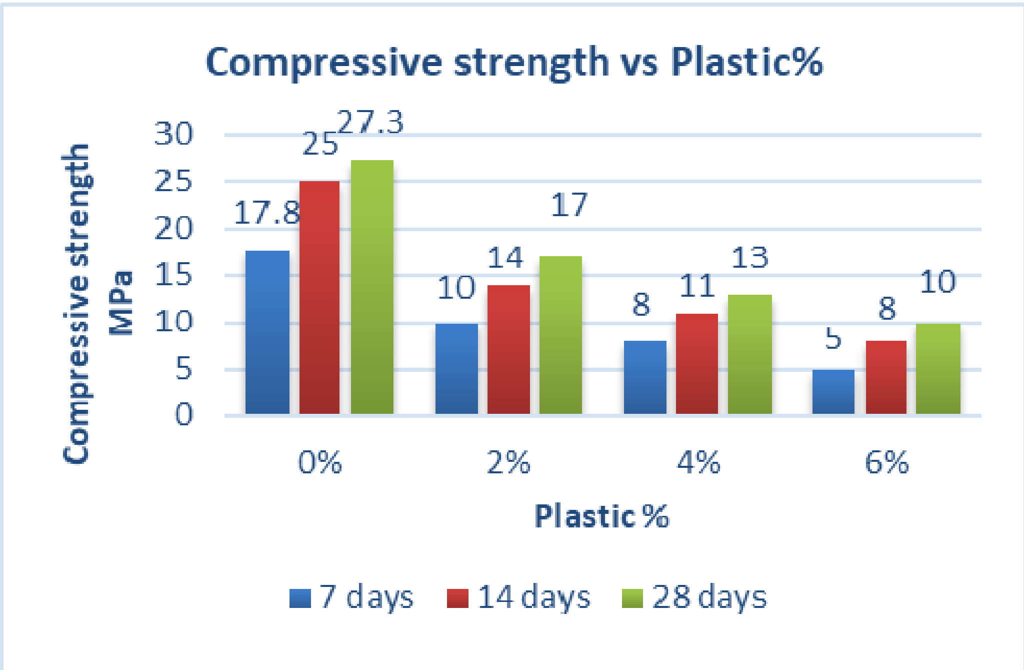

Figure 6: Compressive Strength of RHA-Plastic Concrete Blocks.

3. Water Absorption

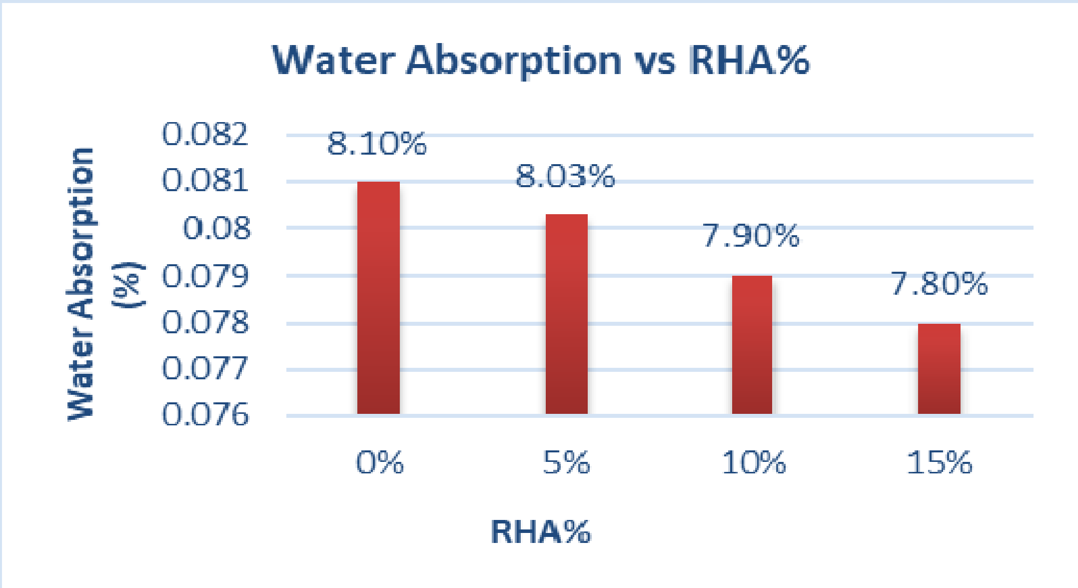

Figure 7: Water Absorption of RHA Concrete Blocks

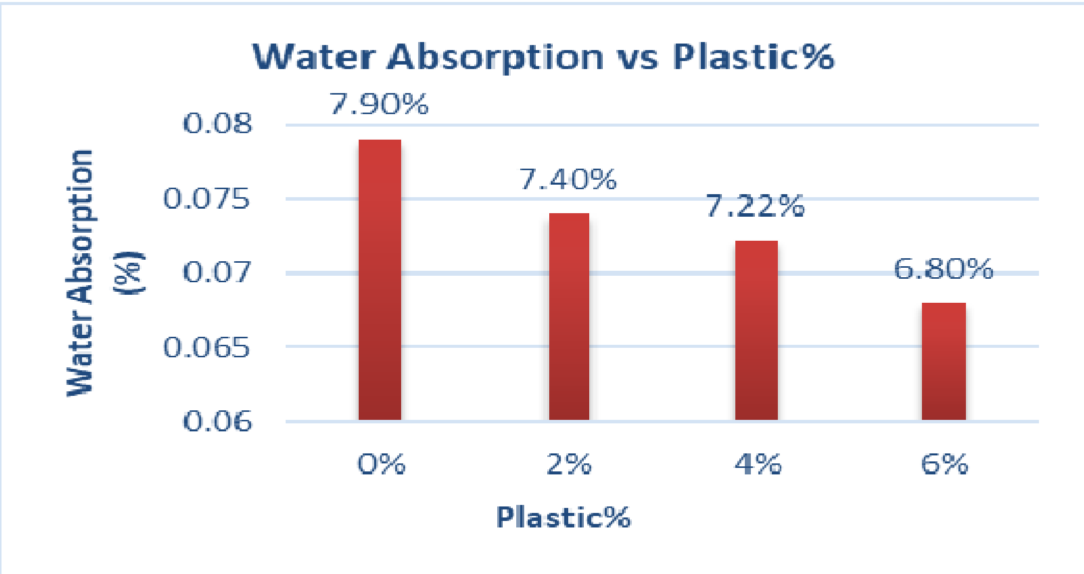

Figure 8: Water Absorption of RHA-Plastic Concrete Blocks

IX. CONCLUSION

1. The average compressive strength of partially replaced cement by Rice husk ash for M-25 mix for proportions of 0%, 5%, 10% and 15% are 29Mpa, 26.18Mpa, 27.3Mpa and 21Mpa respectively at 28th day of curing.
2. The average compressive strength reduced marginally with the 10% replacement of cement by RHA in comparison to conventional blocks, and it was 27.3MPa at 28th day.

3. The average compressive strength of blocks with Optimum use of rice husk ash along with the replacement of coarse aggregate by shredded plastic with the 2%, 4% and 6% are 17Mpa, 13Mpa and 10Mpa at 28th day of curing respectively.
4. The compressive strength of RHA-Plastic Concrete Blocks has been remarkably reduced with the replacement of coarse aggregate by shredded plastic.
5. The water absorption of RHA Concrete blocks decreases as the percentage replacement of RHA increases. And the water absorption of RHA-plastic Concrete blocks also decreases with the increase in the percentage replacement of Shredded plastic.

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