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Improving the strength for Pervious Concrete with Rice Husk and Coconut Husk

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Abstract - Sustainable construction practices have led to the development of eco-friendly materials that reduce environmental impact while maintaining structural integrity. This study explores the use of coconut husk ash (CHA) and rice husk ash (RHA) as partial replacements for cement in the production of pervious concrete paver blocks. The objective is to enhance permeability, reduce cement consumption, and improve mechanical properties while promoting waste utilization.

Experimental investigations were conducted by replacing cement with varying percentages of CHA and RHA (5%, 10%, and 15%) in different mix proportions. Key parameters such as compressive strength, water permeability, porosity, and durability were assessed. The results indicate that an optimal blend of CHA and RHA improves the paver blocks' performance while ensuring sufficient strength for pedestrian and light traffic applications. Furthermore, the integration of agro-waste materials contributes to cost-effectiveness and sustainability, making it a viable alternative for eco-friendly pavement solutions.

This research demonstrates that incorporating coconut and rice husk ash in pervious concrete paver blocks can significantly reduce the carbon footprint of construction materials, promote sustainable waste management, and enhance urban water drainage systems.

Key Words **:** Pervious concrete, paver blocks, coconut husk ash, rice husk ash, sustainable construction, waste utilization, permeability, eco-friendly materials.

1. INTRODUCTION

Pervious concrete is a composite material consisting of coarse aggregate, Portland Cement, and water. It is different from conventional concrete in that it contains no fines in the initial mixture, recognizing however, that fines are introduced during the compaction process. One of the disadvantages of concrete is the high self-weight of concrete. Density concrete is in the order of 2200 to 2600 kg/m^3. This heavy self-weight will make it to some extent an uneconomical structural material. Attempts have been made in the past to reduce the self- weight of concrete to increase the efficiency of concrete as a structural material. The light weight concrete density varies from 300 to 1850 kg/m^3. Light weight concrete has become more popular in recent years and have more advantages over the conventional concrete. Pervious concrete is nothing but no fines concrete, which is also known as porous, gap graded or permeable concrete mainly consists of normal Portland cement, CA, water. In which fine aggregate are not existent or present in very small amount i.e.< 10% by weight of the total aggregates.

2. Methodology

a. Materials Selection and Preparation

- **Cement :** Use Ordinary Portland Cement (OPC) of suitable grade (e.g., OPC 43 or 53).
- **Aggregates :** Select well-graded coarse aggregates (typically 10 mm and 20 mm sizes) without fine aggregates (sand).
- **Coconut Husk Ash (CHA) :** Collect, dry, and burn coconut husk to obtain ash. Sieve it through a 75-micron sieve.
- **Rice Husk Ash (RHA) :** Collect and burn rice husk at a controlled temperature (600–700°C) for 3–5 hours to get amorphous silica. Sieve through a 75-micron sieve.
- **Water :** Use potable water for the concrete mix.

b. Mix Proportioning

- Design a control mix without CHA and RHA for comparison.
- Prepare multiple mixes by partially replacing cement with different percentages (e.g., 5%, 10%, 15%) of CHA and RHA.
- Maintain a constant water-cement ratio (w/c), typically between 0.3 and 0.4 for pervious concrete.

c. Mixing and Casting

- Dry mix cement, CHA, RHA, and aggregates uniformly.
- Gradually add water and mix thoroughly until achieving a uniform consistency.

- Pour the mix into paver block molds and compact properly.

d. Curing

- Cure specimens using water curing for 7, 14, and 28 days.
- Perform air curing for a set of samples to analyze its effect on strength and permeability.

e. Testing of Paver Blocks

- **Mechanical Properties**
  - ✓ **Compressive Strength Test :** As per IS 15658:2006/ASTM C39, test cubes at 7, 14, and 28 days.
  - ✓ **Flexural Strength Test :** Evaluate load-bearing capacity using a three-point bending test.
- **Permeability and Porosity Tests**
  - ✓ **Constant Head Permeability Test:** Measure the rate of water flow through the concrete.
  - ✓ **Porosity Test:** Determine void percentage using weight difference before and after water saturation.
- **Durability Tests**
  - ✓ **Water Absorption Test:** Assess moisture retention as per IS 2185.
  - ✓ **Abrasion Resistance Test:** Evaluate surface wear using the Los Angeles Abrasion Test.
  - ✓ **Acid Resistance Test:** Immerse samples in H2SO4 or HCl and measure mass loss over time.

f. Data Analysis and Interpretation

- Compare results of CHA and RHA-based paver blocks with conventional paver blocks.
- Determine the optimum replacement percentage balancing strength and permeability.
- Analyze trends in strength reduction or enhancement based on ash content.

3. RESULT

Water Absorption test results for Control mix after curing for 7, 14, 28 days :

Duration	Water Absorption (%)
7 Days	9.8
14 Days	11.6
28 Days	14.9

Table 1 : Water Absorption (%) after 7, 14, 28 days

Water Absorption test results for pervious concrete with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 5% (89 grams) after curing for 7, 14, 28 days :

Duration	Water Absorption (RHA) (%)	Water Absorption (CCA) (%)
7 Days	8.75	10
14 Days	12.83	9.12
28 Days	12.83	9.48

Table 2 : Water Absorption (%) with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 5% after curing for 7, 14, 28 days

Water Absorption test results for pervious concrete with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 10% (177 grams) after curing for 7, 14, 28 days :

Duration	Water Absorption (RHA) (%)	Water Absorption (CCA) (%)
7 Days	7.14	10.34
14 Days	15.87	15.17
28 Days	15.87	17.48

Table 3 : Water Absorption (%) with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 10% after curing for 7, 14, 28 days

Water Absorption test results for pervious concrete with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 15% (266 grams) after curing for 7, 14, 28 days :

Duration	Water Absorption (RHA) (%)	Water Absorption (CCA) (%)
7 Days	7.14	10.34
14 Days	15.87	15.17
28 Days	15.87	17.48

Table 4 : Water Absorption (%) with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 15% after curing for 7, 14, 28 days

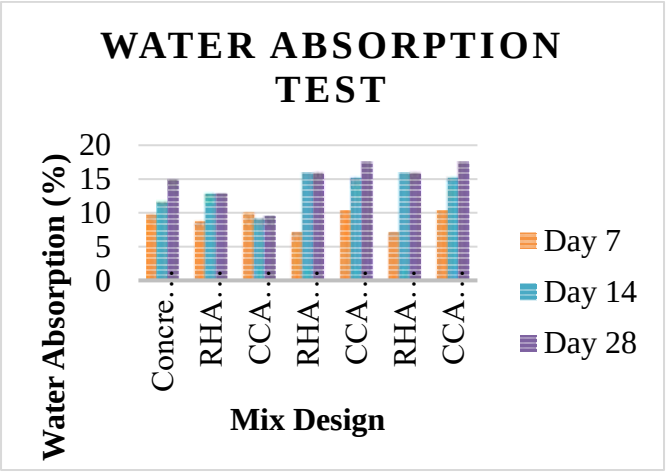

Figure 1 : Water Absorption Test Result

5.2 COMPRESSIVE STRENGTH TEST

Compressive Strength test results for Control mix after curing for 7, 14, 28 days:

Duration	Water Absorption (%)
7 Days	3.2
14 Days	3.6
28 Days	4.1

Table 5 : Compressive Strength (MPa) after 7, 14, 28 days

Compressive Strength test results for pervious concrete with rice husk ash (RHA) & coconut husk ash (CHA) at 5%, 10%, and 15% after curing for 7 days:

Duration	Water Absorption (RHA) (%)	Water Absorption (CCA) (%)
7 Days	2.48	3.10
14 Days	1.24	2.89
28 Days	1.05	1.36

Table 6 : Compressive Strength (MPa) with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 5% after curing for 7, 14, 28 days

Duration	Water Absorption (RHA) (%)	Water Absorption (CCA) (%)
7 Days	2.48	3.42
14 Days	1.62	2.90
28 Days	1.48	1.86

Table 7 : Compressive Strength (MPa) with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 10% after curing for 7, 14, 28 days

Duration	Water Absorption (RHA) (%)	Water Absorption (CCA) (%)
7 Days	2.74	3.70

14 Days	2.03	3.72
28 Days	1.48	2.72

Table 8 : Compressive Strength (MPa) with Rice Husk Ash (RHA) & Coconut Charcoal Ash (CCA) at 15% after curing for 7, 14, 28 days

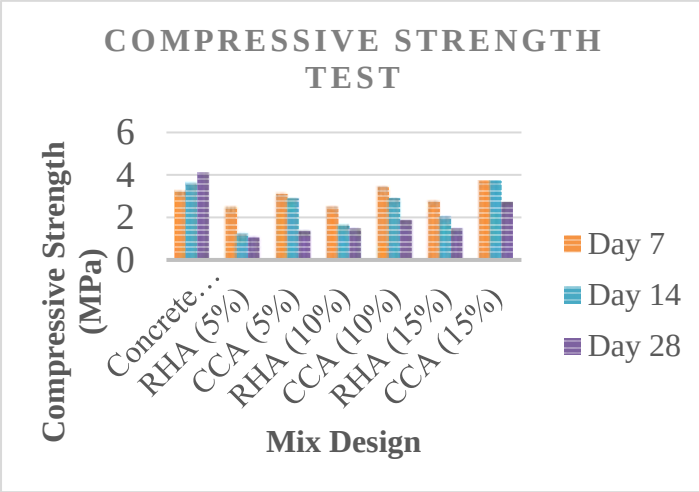

Figure 2 : Compressive Strength Test Result

4. CONCLUSIONS

- ❖ Summarize findings on strength, durability, and permeability.
- ❖ Suggest practical applications for eco-friendly pervious concrete paver blocks

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