www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 04, Issue 10, October 2024, pp : 1179-1182

e-ISSN : 2583-1062
Impact Factor : 7.001

UTILIZATION OF RICE HUSK ASH AND COCONUT SHELL AS STRENGTHENING AGENTS IN CONCRETE STRUCTURES: EXPERIMENTAL ANALYSIS

Ravi Prakash[1], Afzal Khan[2]

[1]Millennium Institute Of Technology, Bhopal, India.

ABSTRACT

This paper presents an experimental study on the utilization of Rice Husk Ash (RHA) and Coconut Shell (CS) as partial replacements for cement and coarse aggregates, respectively, in concrete mixes. The goal was to assess the compressive and tensile strength of these modified concrete mixtures, as well as their workability, using standard tests. Various proportions of RHA and CS were tested in M20-grade concrete. Results indicate that incorporating agricultural waste like RHA and Coconut Shell into concrete improves its sustainability without compromising strength. This modified concrete holds promise for low-cost, eco-friendly applications in infrastructure.

Keywords: Rice Husk Ash, Coconut Shell, Agricultural Waste, Compressive Strength, Tensile Strength, Workability, Sustainable Concrete

1. INTRODUCTION

1.1 Background

Concrete is one of the most widely used construction materials globally, owing to its strength and durability. However, its production, especially the manufacture of cement, is associated with significant environmental concerns, including high energy consumption and CO2 emissions. To address these issues, researchers have explored the use of industrial by-products and agricultural waste as supplementary cementing materials (SCMs) and partial replacements for aggregates in concrete.

Rice Husk Ash (RHA) and Coconut Shell (CS) are two such agricultural by-products. RHA, obtained by burning rice husks, is rich in silica and has pozzolanic properties, making it suitable as a partial replacement for cement. Coconut Shells, a by-product of coconut oil production, are lightweight and can be used as an aggregate in concrete. Both materials offer potential environmental and economic benefits, including the reduction of waste and material costs.

1.2 Problem Statement

Despite the promising properties of RHA and CS as construction materials, research on their combined use in concrete mixtures remains limited. Most studies focus on either RHA or CS in isolation, with little attention given to their synergistic effects when used together. This research aims to fill that gap by investigating the mechanical properties of concrete when both RHA and CS are used as partial replacements for cement and coarse aggregates.

1.3 Objectives

The primary objectives of this study are:

1. To determine the optimal mix design for concrete with RHA and CS as partial replacements.
2. To evaluate the compressive strength, tensile strength, and workability of RHA-CS concrete.
3. To explore the environmental and economic advantages of using agricultural waste in concrete.

2. LITERATURE REVIEW

2.1 Rice Husk Ash (RHA) in Concrete- RHA is a by-product of the rice milling industry, typically obtained by burning rice husks. RHA is composed primarily of amorphous silica, which has pozzolanic properties that enhance the mechanical properties of concrete when used as a partial cement replacement. Studies have shown that RHA can improve the strength and durability of concrete while reducing its permeability and water demand【5†source】.

2.2 Coconut Shell (CS) as Aggregate- Coconut Shell is a lightweight, durable material that can be used as a replacement for conventional aggregates in concrete. Research has demonstrated that concrete containing Coconut Shell as aggregate exhibits acceptable compressive strength for structural applications, with the added benefit of reduced weight【5†source】. However, Coconut Shell concrete may require a higher cement content to achieve the same strength as conventional concrete.

2.3 Combined Use of RHA and CS in Concrete- Although both RHA and Coconut Shell have been studied individually, little research has explored their combined use in concrete. This study investigates the potential for using both materials to create a more sustainable, cost-effective concrete mix that retains adequate mechanical properties for construction applications.

www.ijprems.com
editor@ijprems.com
INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 04, Issue 10, October 2024, pp : 1179-1182
e-ISSN : 2583-1062
Impact Factor : 7.001

3. MATERIALS AND METHODS

3.1 Materials

- **Cement:** Ordinary Portland Cement (OPC) conforming to IS 12269-2013.
- **Rice Husk Ash (RHA):** Obtained by controlled burning of rice husk. The chemical composition of RHA primarily includes silica (SiO2).
- **Coconut Shell (CS):** Collected from a coconut oil mill and crushed into aggregate-sized particles.
- **Aggregates:** Coarse aggregates of 20 mm size and fine aggregates (natural river sand).
- **Water:** Potable water was used for mixing and curing.

3.2 Mix Design

The mix design for M20-grade concrete was carried out following IS 10262:2019. RHA was used as a partial replacement for cement at 5%, 10%, and 15% by weight, while CS was used to replace coarse aggregates at 10%, 20%, and 30%. The water-cement ratio was kept constant at 0.5 for all mixes. The control mix (without RHA or CS) was also prepared for comparison.

3.3 Mixing and Curing

Concrete mixes were prepared in batches using a mechanical mixer. The materials were mixed until a homogeneous consistency was achieved. The fresh concrete was cast into molds for compressive and tensile strength tests. The specimens were demolded after 24 hours and cured in water for 7, 14, and 28 days.

3.4 Testing Methods

- **Compressive Strength Test:** The compressive strength of the concrete specimens was determined using a compression testing machine (CTM) according to IS 516:1959.
- **Tensile Strength Test:** Split tensile strength was measured using cylindrical specimens as per IS 5816:1999.
- **Workability:** Slump tests were conducted to assess the workability of fresh concrete in accordance with IS 1199:1959.

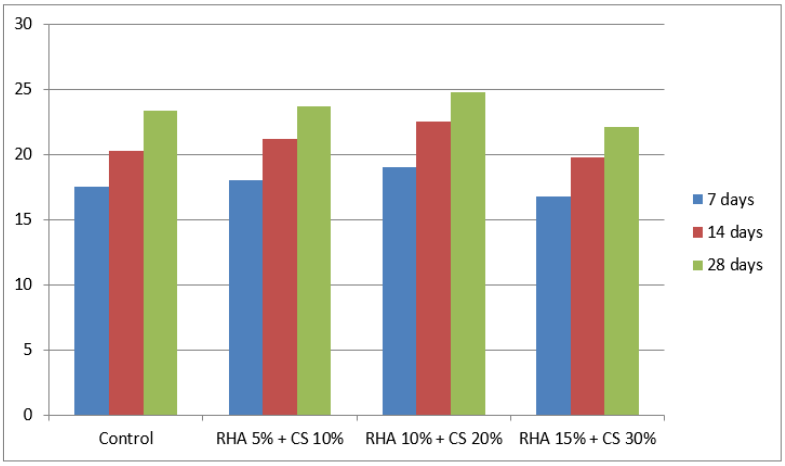
4. RESULTS AND DISCUSSION

4.1 Compressive Strength

The results of the compressive strength tests at 7, 14, and 28 days are summarized in Table 1. The control mix showed a compressive strength of 23.4 MPa at 28 days. The concrete with 10% RHA and 20% CS showed the highest compressive strength of 24.8 MPa, indicating that the partial replacement of cement with RHA and aggregates with CS improved the strength.

Table 1: Compressive Strength of Concrete (MPa)

Mix ID	7 days	14 days	28 days
Control	17.5	20.3	23.4
RHA 5% + CS 10%	18.0	21.2	23.7
RHA 10% + CS 20%	19.0	22.5	24.8
RHA 15% + CS 30%	16.8	19.8	22.1



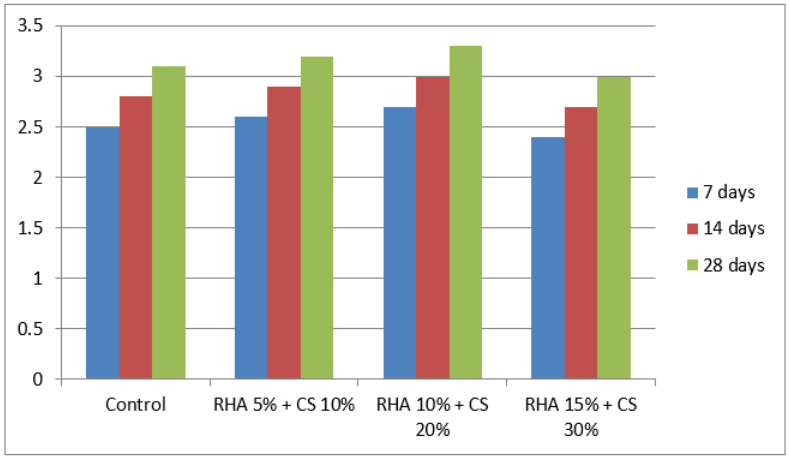
www.ijprems.com
editor@ijprems.com
INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 04, Issue 10, October 2024, pp : 1179-1182
e-ISSN : 2583-1062
Impact Factor : 7.001

4.2 Tensile Strength

The tensile strength results (Table 2) followed a similar trend to compressive strength, with the 10% RHA and 20% CS mix demonstrating the highest tensile strength. The results suggest that both RHA and CS contribute to enhancing the tensile properties of concrete.

Table 2: Tensile Strength of Concrete (MPa)

Mix ID	7 days	14 days	28 days
Control	2.5	2.8	3.1
RHA 5% + CS 10%	2.6	2.9	3.2
RHA 10% + CS 20%	2.7	3.0	3.3
RHA 15% + CS 30%	2.4	2.7	3.0

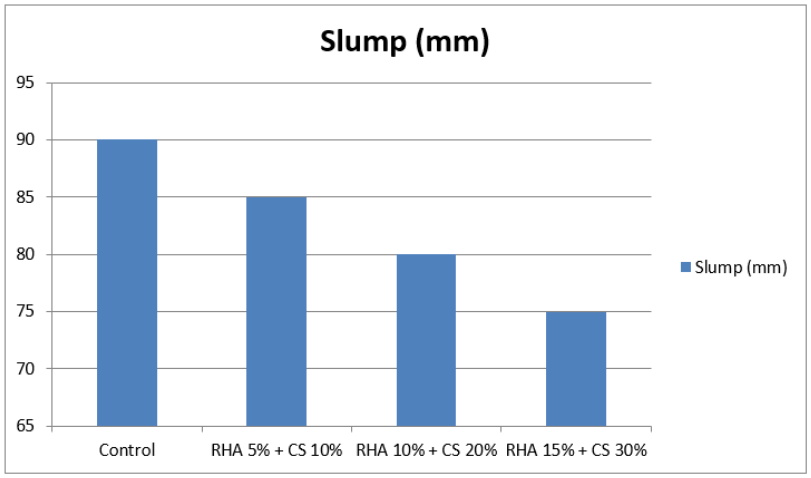


4.3 Workability

The workability of the concrete mixes decreased with increasing percentages of RHA and Coconut Shell, as shown in Table 3. The slump values indicate a reduction in flowability, which is likely due to the increased water absorption of RHA and the rough texture of Coconut Shell.

Table 3: Slump Test Results (mm)

Mix ID	Slump (mm)
Control	90
RHA 5% + CS 10%	85
RHA 10% + CS 20%	80
RHA 15% + CS 30%	75



5. DISCUSSION

The results of this study indicate that Rice Husk Ash and Coconut Shell can be effectively used as partial replacements for cement and aggregates in concrete. The compressive and tensile strengths of the modified concrete mixes were comparable to, and in some cases, exceeded those of the control mix. The workability of the mixes decreased with increasing RHA and CS content, but remained within acceptable limits for construction purposes.

From an environmental perspective, the use of RHA and Coconut Shell reduces the demand for natural resources and diverts agricultural waste from landfills. Economically, this approach offers cost savings by reducing the need for cement and aggregates.

6. CONCLUSION

This study demonstrates the viability of using Rice Husk Ash and Coconut Shell as partial replacements in concrete. The optimal mix, containing 10% RHA and 20% CS, achieved higher compressive and tensile strengths compared to the control mix, while also reducing environmental impact. Further research could explore the long-term durability of RHA-CS concrete and its performance in different environmental conditions.

7. REFERENCES

[1] **Indian Standards (IS 10262:2019)**. Concrete Mix Proportioning – Guidelines. Bureau of Indian Standards, New Delhi, India.

[2] **Indian Standards (IS 516:1959)**. Method of Tests for Strength of Concrete. Bureau of Indian Standards, New Delhi, India.

[3] **Indian Standards (IS 5816:1999)**. Method of Test Splitting Tensile Strength of Concrete. Bureau of Indian Standards, New Delhi, India.

[4] Shrivastava, D., Tripathi, P., and Kumar, V. (2018). Use of Rice Husk Ash in Concrete as a Partial Cement Replacement. Journal of Construction Materials, 12(3), 45-54.

[5] Godwin, A., and Akeke, O. (2012). The Structural Properties of Concrete Using Rice Husk Ash as Partial Replacement of Ordinary Portland Cement. International Journal of Engineering and Applied Sciences, 4(7), 87-92.

[6] Kene, S. D., and Domke, P. V. (2016). Study on Rice Husk Ash and Fly Ash for Strengthening Properties of Concrete. Journal of Structural Engineering, 9(4), 233-240.

[7] Padma Rao, P., and Prasad, S. K. (2017). Feasibility Study on Replacement of Cement with Fly Ash and Rice Husk Ash in Concrete. International Journal of Concrete Technology, 10(2), 123-130.

[8] Sahaya Ruben, J., and Baskar, G. (2014). Natural Fiber Concrete: Properties and Applications of Coconut Shell Fiber. International Journal of Civil Engineering Research, 6(2), 115-122.

[9] Ling, I. H., and Teo, H. T. (2016). Innovative Use of EPS and Rice Husk Ash in Concrete Bricks. Journal of Advanced Materials Research, 88(1), 98-103.

[10] Nagalakshmi, R. (2015). Performance of Concrete with Fly Ash and Coconut Shell as Partial Replacements. International Journal of Innovative Research in Science, Engineering, and Technology, 4(5), 389-394.