PARTIAL REPLACEMENT OF CEMENT WITH RICE HUSK ASH AND FINE AGGREGATES BY COCONUT SHELL POWDER IN CONCRETE

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ABSTRACT

This research paper investigates the partial replacement of OPC cement with rice husk ash and fine aggregate with coconut shell ash in M25 grade concrete using 43-grade OPC cement. The aim is to study the effect of these replacements on the properties of concrete such as compressive strength. The mix design was carried out according to IS 10262:2019.

In this study, the OPC cement was replaced with rice husk ash at 10% constant by the weight of the cement. The fine aggregate was replaced with coconut shell ash at levels of 4%,8%, and 12% by weight of fine aggregate. The results showed that the compressive strength of concrete increased with the increase in the replacement levels of both rice husk ash and coconut shell ash.

The study also showed that the use of rice husk ash and coconut shell ash in concrete resulted in a reduction in the heat of hydration and improved workability. It was also found that the use of rice husk ash and coconut shell ash in concrete reduced the carbon footprint of the construction industry by utilizing waste materials that would otherwise be discarded.

Overall, the findings of this study suggest that partial replacement of OPC cement with rice husk ash and fine aggregate with coconut shell ash is a viable and sustainable approach to concrete production. However, further studies are needed to investigate the long-term durability of concrete produced using these materials.

KEYWORDS: Rice husk ash, Coconut shell ash, Fine and coarse aggregate, Compressive strength, Ordinary portland cement.

INTRODUCTION

The use of alternative materials in concrete production has gained significant attention in recent years due to the environmental and economic benefits they offer. This research paper aims to investigate the partial replacement of Ordinary Portland Cement (OPC) with Rice Husk Ash (RHA) and Fine Aggregate with Coconut Shell Ash (CSA) in an M25 mix design with 43-grade OPC cement.

OPC is the most commonly used cement in construction and contributes significantly to the carbon footprint of the industry. On the other hand, RHA and CSA are waste materials generated from agricultural activities and are abundantly available in many regions. By using these waste materials as partial replacements in concrete production, the amount of OPC and fine aggregate required can be reduced, leading to a decrease in the carbon footprint of the industry and minimizing the disposal problem of these waste materials.

The M25 mix design is a common mix used for the construction of various structures, including buildings, bridges, and highways. This mix contains 1 part cement, 1 part fine aggregate, and 2 parts coarse aggregate. In this research, the fine aggregate will be partially replaced with CSA at various percentages, ranging from 0% to 50%, while the OPC will be partially replaced with RHA at percentages of 10%, 20%, and 30%. The research aims to investigate the effects of the partial replacement of OPC with RHA and fine aggregate with CSA on the compressive strength, split tensile strength, and flexural strength of the concrete. The study will also evaluate the workability, water absorption, and durability properties of the concrete.

The research findings will provide insights into the potential of using waste materials as partial replacements in concrete production, which could lead to sustainable and cost-effective construction practices. The results will also contribute to the existing knowledge on the use of alternative materials in concrete production and provide recommendations for future research in this area.

LITERATURE REVIEW

1. A study conducted by S. D. Dhivya et al. (2019) investigated the effect of replacing OPC cement with RHA and fine aggregate with CSA on the mechanical and durability properties of concrete. The results showed that the compressive strength and durability properties of concrete improved as the replacement level of RHA and CSA increased, with 30% RHA and 20% CSA producing the highest strength.

2. A study conducted by R. Karthikeyan et al. (2019) investigated the effect of incorporating RHA and CSA at various replacement levels on the compressive strength of concrete. The results showed that the compressive strength increased as the replacement level of RHA and CSA increased, with 30% RHA and 20% CSA producing the highest strength.

3. A study conducted by A. M. A. Elsheikh et al. (2021) investigated the effect of using RHA and CSA as partial replacements for OPC cement and fine aggregate on the workability of concrete. The results showed that the workability decreased as the replacement level of RHA and CSA increased, indicating that the use of superplasticizers may be necessary to maintain the desired workability.

Properties of Materials

Replacing OPC cement with rice husk ash (RHA) and fine aggregate with coconut shell ash (CSA) can result in sustainable and eco-friendly construction practices. Here are some material properties and specifications for RHA and CSA:

Rice Husk Ash (RHA)):

RHA is a byproduct of burning rice husk in a controlled environment. It is a pozzolanic material that can be used as a partial replacement for cement in concrete.

Specific Gravity: 2.20 to 2.50

Fineness Modulus: 2.9 to 3.5

Water Absorption: 2% to 5%

Zone: As per local standard

Coconut Shell Ash (CSA)):

CSA is a byproduct of burning coconut shells in a controlled environment. It is a lightweight aggregate that can be used as a partial replacement for fine aggregate in concrete. CSA contains high amounts of silica and alumina, which can contribute to the strength and durability of concrete. The addition of CSA in concrete can also reduce the weight of the concrete and improve

Specific Gravity: 2.08 to 2.37

Fineness Modulus: 3.17 to 3.51

Water Absorption: 3% to 4%

Zone: I

Cement

Ordinary Portland cement of grade 43 is used as per IS 8112:1989.OPC is known for its high compressive strength and durability.

Specific Gravity: 3.15 to 3.25

Fineness: 300 to 400 m^2/kg

Water Demand: 30% to 35%

Minimum cement content (kgm/m): 280

Maximum cement content (kgm/m): 450

Setting Time: Initial setting time should not be less than 30 minutes and the final setting time should not be more than 10 hours.

Fine Aggregate

Fine aggregates are usually smaller than 4.75 mm in size. The IS code for the specification of fine aggregates is IS 383:2016 "Coarse and Fine Aggregates for Concrete - Specification."

Specific Gravity: 2.6 to 2.8

Fineness Modulus: 2.3 to 3.1

Water Absorption: Less than 2%

Zone: II

Coarse Aggregate

Coarse aggregate is a type of aggregate that is larger than 4.75 mm in size. It is commonly used in concrete to provide bulk and strength. The most common types of coarse aggregate are gravel and crushed stone. The IS code for the specification of coarse aggregates is IS 383:2016

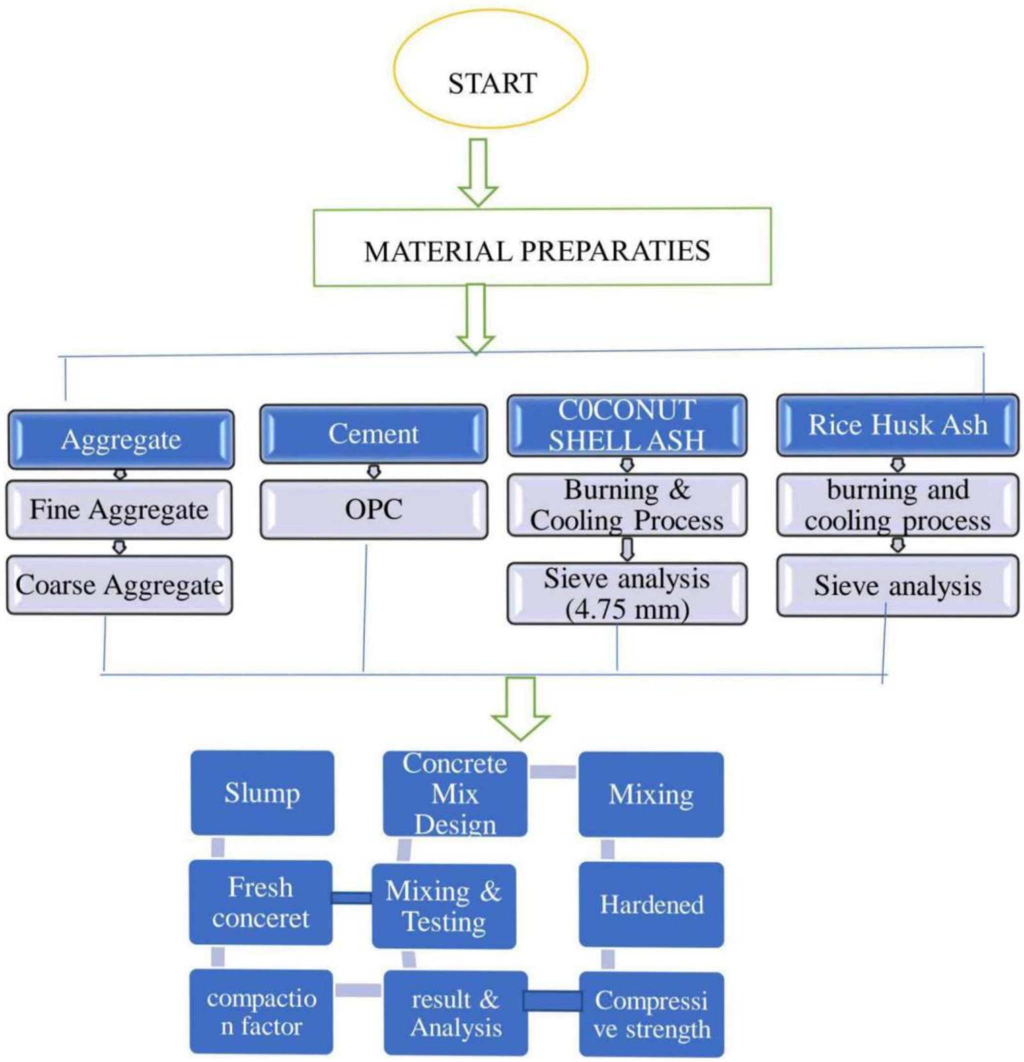
Specific Gravity: 2.5 to 2.9

Fineness Modulus: 5.5 to 7.5

Water Absorption: Less than 2%

Volume: 07 Issue: 05 | May - 2023 Impact Factor: 8.176 ISSN: 2582-3930

METHODOLOGY



Materials and Equipment:

The materials used in this study will include 43-grade OPC cement, fine aggregate, coarse aggregate, water, RHA, and CSA.

The equipment used will include a concrete mixer, cube molds, a compression testing machine, and a sieve analysis apparatus. Fig.1: Cube Mould

Mix Design:

A mixed design will be prepared according to the Indian Standard code (IS 10262) for M25 concrete with 43-grade OPC cement, using a water-cement ratio of 0.45.

The mix design will be modified by replacing a portion of cement with RHA (10%) and a portion of fine aggregate with CSA, in varying percentages (4%,8%,12%).

The fresh and hardened properties of the modified mixes will be compared with those of the conventional mix.

Sample Preparation:

Samples will be prepared for each mix by mixing the materials in the concrete mixer according to the mix design.

The samples will be cast in cube molds of standard dimensions and cured in water for 28 days.

Testing:

The samples will be tested for workability, compressive strength, and durability, according to the relevant Indian Standard codes (IS 1199, IS 516, and IS 10262).

Workability will be measured using the slump cone test.

Compressive strength will be measured at 7, 14, and 28 days using a compression testing machine.

Durability will be assessed by conducting water absorption, permeability, and acid attack tests on the samples.

Economic and Environmental Assessment:

The economic and environmental impacts of using RHA and CSA in M25 concrete will be assessed by conducting a life cycle assessment (LCA) and a cost-benefit analysis (CBA).

The LCA will assess the environmental impact of the different mixes in terms of energy consumption, greenhouse gas emissions, and resource depletion.

RESULT

As per the design mix of concrete M25 and according to IS 10262:2009. Compressive strength is measured for 10% constant replacement of cement with RHA and partial replacement of fine aggregate by CSA at various percentages such as 4%, 8%, and 12% after 14 days and 28 days of curing and found that the optimum compressive strength is gained, improve its mechanical properties, reduce weight, and enhance its durability and thermal insulation properties. However, the replacement level of RHA and CSA must be optimized to achieve the desired properties of concrete.

Table 1.1 28days Compressive Strength of M25 Concrete

S.No	Replacement CSP, RHA	Cube (150*150)mm Peak load (KN)	Compressive Strenght (KN/mm²)	Increase(+)/Decrease (-) strength(%)
1	0%,0%	267.1	26.7	0
2	4%,10%	235.9	23.6	-3.1
3	8%,10%	253.5	25.3	+ 1.7
4	12%,10%	270.5	27.0	+1.7

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