Partial Replacement of Cement with Rice Husk And Wood Ash In Concrete

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Abstract– **The construction industry's ever-growing demand for sustainable and cost-effective building materials has led to the exploration of alternative products aimed at reducing cement consumption. In this pursuit, two promising candidates have emerged: wood ash (WA) and rice husk ash (RHA). This study investigates the combined utilization of wood ash and rice husk ash as partial replacements for cement in concrete. Wood ash is maintained at a constant 15% while varying percentages of rice husk ash (5%, 10%, 15%, and 20%) are employed. The primary objective is to assess the impact of this partial cement replacement on the strength properties of concrete. The results obtained from this study provide valuable insights into the feasibility of using wood ash and rice husk ash as sustainable alternatives to traditional cement in concrete production. These findings hold significant potential for the construction industry, offering a path towards greener and more cost-effective construction practices while simultaneously reducing the environmental footprint of building materials.**

Index Terms- **rice husk, wood ash**

1.INTRODUCTION

Concrete, a cornerstone of modern construction, results from precise amalgamation of cement, water, aggregates, and admixtures. Its properties depend on constituent characteristics, offering opportunities for improvement through new materials—natural, recycled, or synthetic. However, the industry faces sustainability challenges due to reliance on virgin materials and cement's substantial carbon emissions during production. Green concrete, incorporating recycled materials, emerges as a sustainable solution, where modified cement plays a pivotal role. This paper explores pozzolanic materials, like volcanic tuff (Pozzolana), historically vital in construction. It elucidates their role in modifying concrete properties, cost control, addressing cement scarcity, and economically disposing of industrial waste, emphasizing concrete's competitive edge in modern construction.

1.1 AIM OF THE STUDY

The aim of the project is the partial replacement of cement by Rice husk ash and Wood ash, by keeping wood ash as fixed (15%) and progressively increasing rice husk content by 0%, 5%, 10%, 15%, 20%.

1.2 SCOPE OF THE STUDY

The study focuses on evaluating the possibility of using rice husk ash and Wood ash to partially substitute the cement in concrete to improve the strength properties of concrete. The scope of the project can be summarized as:

- To carry out preliminary tests on concrete constituents, to determine its properties.
- To perform compressive strength test and flexural strength test on rice husk ash and Wood ash concrete and control mix concrete specimen as per IS code.
- Determination of optimum rice husk ash content and wood ash for the concrete.

2. METHODOLOGY

Methodology consists of the following steps:

1. **Literature Review**:

Extensively reviewed existing literature on sustainable concrete and pozzolanic materials to understand their roles in improving concrete properties and reducing environmental impact.

2. Material Preparation and Testing:

- . Calculated precise quantities of cement, sand, rice husk ash (RHA), and wood ash (WA) based on desired mix proportions for both standard concrete and specimens with ash replacements.
- Procured materials from reliable sources, ensuring they met the necessary quality standards.
- Conducted comprehensive material testing, including assessments of fineness, chemical composition, and specific gravity, to evaluate their suitability for concrete production.

3. Specimen Casting and Testing:

- Casted standard concrete specimens, including cubes (15x15x15 cm) and beams (15x10x10 cm), in accordance with established guidelines.
- Produced additional specimens by substituting a constant 15% of cement with WA and varying levels of RHA (0%, 5%, 10%, 15%, 20%) to investigate the impact of these materials on concrete properties.
- Applied proper curing procedures to all specimens.

- Conducted comprehensive testing, including compressive strength tests for cubes and flexural strength tests for beams after the curing period.

4.Data Analysis:

- Analyzed test results to assess how ash replacement affected concrete properties, encompassing strength, durability, and sustainability.
- Performed statistical analysis to draw meaningful conclusions regarding the efficacy of ash replacements in enhancing concrete performance.

These methodologies provide a systematic and well-structured framework for your research, allowing for a comprehensive investigation of the influence of ash replacement materials on concrete properties and sustainability.

3.TESTS CONDUCTED

3.1 TEST ON CEMENT

1. **Specific Gravity of Cement**

The specific gravity is normally defined as the ratio between the weight of a given volume of material and weight of and equal volume of water. The Portland cement have a specific gravity of around 3.15 and for Portland Pozzolana cement, the value come near to 2.90. Specific gravity test for cement is carried out using Le Chatelier flask apparatus.

2. **Consistency Test**: The Vicat test, also referred to as the consistency test, aims to determine the water content necessary to create a standard consistency cement paste. In this test, a Vicat plunger is used to measure how far it penetrates into the cement paste under specific conditions. The consistency of the cement paste serves as an indicator of its workability and its capacity to form a cohesive blend when mixed with aggregates. This property has a direct impact on various aspects, including how easy it is to handle and place the concrete. An appropriately consistent cement paste ensures the even distribution of water and aggregates, ultimately resulting in a robust and long-lasting concrete mixture.

3. **Fineness of cement:** Fineness of cement is measured by sieving cement on standard sieve. The proportion of cement of which the cement particle sizes are greater than 90 microns is determined.

4. **Setting Time Test**: The setting time of cement is a vital characteristic that dictates the duration during which cement paste transitions from a flexible, workable state to a solid, firm state. This assessment is carried out using either a Vicat apparatus or Gillmore needles and involves monitoring the time when the initial and final setting phases take place. The initial setting time denotes when the cement paste loses its malleability, rendering it unsuitable for further handling. On the other hand, the final setting time signifies the point at which the cement paste attains its ultimate hardness and can bear loads. A comprehension of cement's setting time is essential to ensure that construction tasks like placement, finishing, and curing are executed within the designated timeframe.

3.2 TEST ON AGGREGATE

Specific Gravity Test: The specific gravity of an aggregate reflects how dense it is compared to water. This measurement involves assessing the weight of a specific volume of the aggregate in relation to the weight of an equal volume of water. Typically, the specific gravity of both fine and coarse aggregates is determined using either the displacement method or the pycnometer method. The outcomes of this test offer essential insights into the aggregate's characteristics, such as its porosity, permeability, and capacity to absorb moisture.

Sieve Analysis And fineness Modulus: The fineness modulus of sand serves as an indicator that reveals the average particle size within the sand. This value is determined through a sieve analysis using a specific set of standard sieves. To calculate it, we sum up and then subtract 100 from the cumulative percentage of material retained on each sieve. Fine aggregate, in this context, refers to aggregate material that passes through a 4.75 mm sieve. To compute the fineness modulus of fine aggregate, we require a series of sieve sizes, including 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm, 0.15mm, and 0.075mm.

3.5 TEST ON CUBE

Compressive Strength Test: The compressive strength test on concrete cubes is a crucial evaluation to determine the concrete's ability to withstand axial loads. It involves casting standard 15x15x15 cm concrete cubes and subjecting them to a compressive force until failure occurs. The test measures the maximum load-bearing capacity of the cube, expressed in megapascals (MPa), and it provides insights into the concrete's durability and structural integrity. This information is essential for assessing the concrete's suitability for various construction applications and ensuring it meets the required strength standards, ensuring the safety and reliability of the built structures.

Flexural Strength Test: The flexural strength test on concrete beams is a critical assessment that determines the material's capacity to resist bending and cracking under applied loads. In this test, standard 15x10x10 cm concrete beams are subjected to a bending force until they fracture. It quantifies the maximum stress or load at which the beam can withstand deformation. This data is crucial for assessing the concrete's structural performance, particularly in applications where it must endure bending stresses, such as in beams and slabs. Understanding the flexural strength helps ensure that concrete structures can safely support varying loads and remain resilient in real-world construction scenarios.

RESULTS AND DISCUSSIONS

1. CONSISTENCY TEST

Table 1. Consistency Values

TRIAL	CEMENT (gm)	WATER%	PENETRATION IN mm
1	250	28 (70ml)	33
2	250	30 (75ml)	15
3	250	32 (80ml)	6
4	250	34 (85ml)	5

Consistency test = 32

2. SPECIFIC GRAVITY OF CEMENT

Specific Gravity of cement = 3.01

3. SETTING TIME TEST

Initial setting time = 35 minutes
Final setting time = 10 hours

4. FINENESS OF CEMENT

Fineness of cement = 5.2%

5. SPECIFIC GRAVITY TEST ON FINE AGGREGATE

Apparent specific gravity = (Weight of dry sample/Weight of equal volume of water)
=D/C-(A-B)
=2.711

5. FINENESS MODULUS OF FINE AGGREGATE

SIEVE	WEIGHT RETAINED	% WEIGHT	CUMULATIVE % WEIGHT	CUMULATIVE % FINE
4.75	0.030	3	3	97
2.36	0.056	5.6	8.6	91.4
1.18	0.150	15	23.6	76.4
0.6	0.340	34	57.6	42.4
0.3	0.364	36.4	94	6
0.15	0.050	5	99	1
0.075	0.010	1	100	0
			385.8	

Fineness modulus=385.8/100 =3.858

6.SPECIFIC GRAVITY TEST ON COARSE AGGREGATE

Apparent specific gravity = (Weight of dry sample/Weight of equal volume of water)
=D/C-(A-B)
= 2.64

7.FINENESS MODULUS OF COARSE AGGREGATE

SIEVE	WEIGHT RETAINED	% WEIGHT	CUMULATIVE % WEIGHT	CUMULATIVE % FINE
80	0	0	0	100
40	0	0	0	100
20	1.696	56.533	56.33	43.467
10	1.27	42.33	8.866	1.134
4.75	0.022	0.733	99.399	0.401
2.36	0.012	0.4	99.99	0.001
1.18	0	0	100	100
0.6	0	0	100	100
0.3	0	0	100	100

0.15	0	0	100	100
Pan	0	0	100	100
			754.78	

Fineness modulus=754.78/100 =7.54

8. COMPRESSION TEST ON INTERLOCKING BRICKS

Table 3. compression test value

MIX	STRENGTH(N/mm^2)	
	7 DAYS	**28 DAYS**
Control Mix	16.2	25.2
0% RHA,15%WA	19.73	30.02
5% RHA ,15%WA	24.02	32.55
10% RHA,145%WA	22.14	29.42
15%RHA ,15%WA	21.05	25.88
20%RHA,15%WA	18.45	23.66

8. FLEXURAL TEST ON BEAM

Table 4. Flexural test value

MIX	STRENGTH(N/mm^2)	
	7 DAYS	28 DAYS
Control Mix	6.5	8.3
5% RHA,15%WA	5.91	7.42

CONCLUSION

In light of the pressing need to address the environmental concerns associated with traditional cement production and waste disposal, this experimental study focused on exploring alternative materials for concrete. Concrete, being a heterogeneous material, relies on various components like cement, fine aggregate, coarse aggregate, and water. The aim was to mitigate the high CO2 emissions tied to cement manufacturing and the environmental impact of agricultural and food waste disposal.

Through a series of limited experiments, several key conclusions were drawn:

- The highest compressive strength in concrete was achieved when substituting 5% of cement with Rice Husk Ash (RHA). However, as the percentage of RHA replacement increased while maintaining Wood Ash (WA) at 15%, compressive strength gradually decreased.
- A concrete mix comprising 5% RHA and 15% WA demonstrated superior compressive strength at 7 days.
- It was observed that the flexural strength of concrete, where cement was partially replaced by RHA and WA, was lower at both 7 and 28 days compared to the control mix.
- The addition of 15% WA to concrete without RHA resulted in reduced compressive strength when contrasted with the mix containing 15% WA and 5% RHA. Combining WA with RHA, however, improved the mechanical properties of the concrete.
- RHA, with its high silica content, proved to be an effective supplementary cementitious material and pozzolanic admixture, significantly enhancing compressive strength.
- The inclusion of both RHA and WA in concrete mixes showed improvements in properties like compressive strength and competitive results in flexural strength compared to the control mix.

These findings underscore the potential of incorporating Rice Husk Ash and Wood Ash in concrete production as a promising avenue for both environmental sustainability and mechanical performance enhancement.

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