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Experimental Study on Partial Replacement of Fine Aggregate with Rice Husk in Concrete

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A B S T R A C T

This experimental study investigates the effects of partial replacement of fine aggregate with rice husk in concrete, exploring proportions of 0%, 10%, 15%, and 20% rice husk inclusion. The research evaluates the mechanical properties, workability, and durability of the resulting concrete mixtures. Through comprehensive testing, including compressive strength, tensile strength, and water absorption, the study aims to assess the feasibility and potential benefits of utilizing rice husk as a sustainable alternative in concrete production. Findings from this study contribute valuable insights to sustainable construction practices, offering potential solutions for enhancing concrete performance while reducing environmental impact.

Keywords: Experimental study, Partial replacement, Fine aggregate, Rice husk, Concrete, Sustainable construction

1. INTRODUCTION

Recent years have seen a substantial increase in interest in the use of sustainable materials in construction processes as a result of resource efficiency and environmental concerns. The purpose of this experimental investigation is to determine whether it is feasible to substitute some of the fine aggregate in concrete mixtures with rice husk. Because it is lightweight and insulating, rice husk an abundant agricultural byproduct holds potential as a sustainable substitute for building materials. This study attempts to examine the effects of different rice husk inclusion percentages (0%, 10%, 15%, and 20%) on the final concrete's mechanical qualities, workability, and durability. Determining the viability of using rice husk in the manufacturing of concrete which could have positive effects on the environment and the economy requires an understanding of these consequences. The

2. LITERATURE REVIEW

Ghassan Abood Habeeb, Hilmi Bin Mahmud [1] (2010) investigated the properties of rice husk ash (RHA) produced by using a Ferro-cement furnace. The effect of grinding on the particle size and the surface area was first investigated, and then the XRD analysis was conducted to verify the presence of amorphous silica in the ash. RHA concrete gave excellent improvement in strength for 10% replacement (30.8% increment compared to the control mix), and up to 20% of cement could be valuably replaced with RHA without adversely affecting the strength. Increasing RHA fineness enhanced the strength of blended concrete compared to coarser RHA and control OPC mixtures.

Gritsada Sua-iam, Natt Makul[2] (2013) investigated the properties of self-compacting concrete (SCC) mixtures comprising ternary combinations of Type 1 Portland cement (OPC), untreated rice husk ash (RHA), and pulverized fuel ash (FA). The SCC mixtures were produced with a controlled slump flow in the range between 67.5 to 72.5 cm diameter with a constant total powder materials content of 550 kg/m3. RHA and/or FA were used to replace in powder materials with 20 or 40 wt%. The fresh and hardened properties including water requirement, workability, density, compressive strength development and ultrasonic pulse velocity were determined. Self-compacting concrete mixtures formulated using ternary blends exhibited significant improvements in physical properties compared to SCC mixtures containing only RHA or FA.

Rafat Siddique, Geert de Schutter and Albert Noumowec [3] (2008) presented the results of an experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate (regular sand) was partially replaced with waste foundry sand. Fine aggregate was replaced with three percentages (10%, 20%, and 30%) of WFS by weight. Tests were performed for the properties of fresh concrete. Compressive strength, splitting- tensile strength, flexural strength, and modulus of elasticity were determined at 28, 56, 91, and 365 days. Test results indicated a marginal increase in the strength properties of plain concrete by the inclusion of WFS as partial replacement of fine aggregate (sand) and that can be effectively used in making good quality concrete and construction materials.

Yogesh Aggarwal, Paratibha Aggarwal, Rafat Siddique, El-Hadj Kadri and Rachid Bennacer [4] (2010) presented the design of concrete mixes made with waste foundry sand as partial replacement of fine aggregates up to 40%. Various mechanical properties are evaluated (compressive strength, and split tensile strength). Durability of the concrete regarding resistance to chloride penetration, and carbonation is also evaluated. Test results indicate that industrial by-products can produce concrete with sufficient strength and durability to replace normal concrete. Compressive strength, and split-tensile strength, was determined at 28, 90 and 365 days. Comparative strength development of foundry sand mixes in relation to the control mix i.e. mix without foundry sand was observed. Thereby, indicating effective use of foundry sand as an alternate material, as partial replacement of fine aggregates in concrete.

3. METHODOLOGY

- ✓ Selection of Materials: Fine aggregate, rice husk, cement, water.
- ✓ Preparation of Concrete Mixtures: Proportions adjusted for 0%, 10%, 15%, and 20% rice husk inclusion.
- ✓ Mixing Process: Consistent mixing procedures followed for each batch to ensure uniformity.

Testing Procedures:

- ✓ Workability: Slump test conducted to assess the consistency of each mixture.

Mechanical Properties:

- ✓ Compressive Strength: Testing conducted on cured specimens using standard procedures.
- ✓ Tensile Strength: Determined through appropriate testing methods.
- ✓ Water Absorption: Specimens submerged and weight gain measured over time.
- ✓ Data Analysis: Results compared across different mixtures to determine the effects of rice husk inclusion on concrete properties.
- ✓ Statistical Analysis: Statistical methods employed to analyze and interpret experimental data.
- ✓ Conclusion: Findings summarized to draw conclusions regarding the feasibility and effectiveness of using rice husk as a partial replacement for fine aggregate in concrete.

4. MATERIALS AND MIX PROPORTION

4.1 CEMENT

The cement used was ordinary Portland cement (Ultra Tech cement) of 53 grade, which certifies IS 12269-1987. Physical properties were examined in accordance with IS 4031 (Part II)-1988.

Fig 1: weighing of cement

4.2 AGGREGATE

To get good concrete, the aggregate's size, shape, and grade are crucial considerations. In restricted areas, the elongated and flaky particles will cause obstructing issues. The rebar spacing size will determine the size of the aggregates. The coarse aggregate used in concrete was usually well graded, angular in shape, and smaller than the largest size acceptable for ordinary concrete, which often calls for aggregates no larger than 20 mm. Selecting a coarse aggregate requires careful consideration of gradation. Compared to well-graded coarse aggregate, gap-graded coarse aggregate encourages segregation more.

4.2.1 FINE AGGREGATE

In the current study, the fine aggregate utilized was river sand that was readily available in the area. There was no organic impurity, salt, or clayey debris in the sand. In compliance with IS 2386-1963, tests were conducted on the sand to determine its specific gravity, bulk density, and other characteristics. The fine aggregate met all required standards.

4.2.2 COARSE AGGREGATE

As coarse aggregate, 20mm nominal size machine-crushed angular granite metal was obtained locally. It included no contaminants of any kind, including organic matter, dust, or clay particles. The investigation of coarse aggregate's physical qualities followed IS 2386-1963.

4.3 WATER

Water that is readily available locally is used for mixing and curing; it is drinkable and devoid of harmful concentrations of oils, acids, alkalis, salts, sugar, organic compounds, or other things that could harm steel or concrete.

4.4 RICE HUSK

The rice mill region at Kattumannarkoil, which is close to the MRK Institute of Technology Engineering College, is where the rice husk ash used in this program is brought from.

4.5 MIX PROPOTION

MATERIALS(Kg&lit)	**Mix proportion**				
	0%	**10%**	**15%**	**20%**	**25%**
Cement	2.994	2.994	2.994	2.994	2.994
Coarse aggregate	8.832	8.832	8.832	8.832	8.832
Fine aggregate	4.416	4.416	4.416	4.416	4.416
Rise husk	0	0.441	0.662	0.883	1.1.04

Table 1: mix proportion

5. PREPARATION OF TEST SPECIMEN

5.1 WEIGHING

To within 0.1 percent of the batch's total weight, the amounts of cement, rice husk ash, aggregate size, and water were measured for each batch based on weight.

Fig 2: Weighing both fine and coarse particles

5.2 CONCRETE MIXING

A pan mixer with a revolving function was used to combine the components.Using a trowel, fine aggregate and leftover foundry sand were completely combined in a tray; in a similar manner, the cementitious ingredients were blended. Approximately half of the coarse aggregate, fine aggregate, cement, and then the remaining coarse aggregate were added to the drum in that order. Right before the drum began to rotate, water was added. After all the elements were loaded into the drum, the mixing process lasted for at least two minutes, and it continued until the final concrete had a uniform appearance.

Fig 3: concrete mixing

6. RESULT AND CONCLUSION

6.1 SLUMP CONE TEST

The Slump Cone Test was conducted to assess the workability of concrete mixtures containing varying percentages of rice husk. Each mixture was poured into a slump cone in layers and compacted using a standard tamping rod. After the cone was removed, the slump of the concrete was measured as the difference in height between the original cone and the displaced concrete. This test provided valuable insights into the consistency and flow ability of the mixtures, aiding in understanding how the addition of rice husk affected the workability of the concrete, crucial for ensuring proper handling and placement during construction.

The slump value is 55mm for water cement ratio of 0.45

Table 2: slump cone test

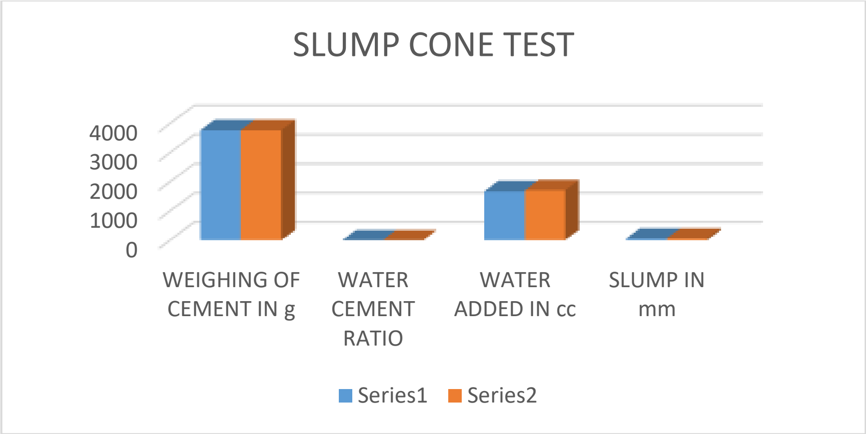

Fig 4: slump cone test

6.2 COMPACTION FACTOR TEST

The workability of concrete mixes containing different amounts of rice husk was assessed using the Compaction Factor Test. Using a conventional tamping rod, each mixture was compressed in this test by placing it in a standard compaction factor apparatus. After lifting the equipment, the volume of the concrete before and after compaction was compared to determine the degree of compaction that had been achieved. This test revealed information about the concrete mixes' capacity for self-compaction, demonstrating their applicability for real-world building uses. In order to ensure appropriate consolidation and density of the concrete, which in turn influences its strength and durability properties, it was imperative to comprehend the compaction factor.

S.NO	W/C RATIO	EMPTY WEIGHT OF CYLINDER IN g	WEIGHT OF CEMENT IN g	WEIGHT OF PARTIALLY COMPACTED CONCRETE IN g (W_P)	WEIGHT OF FULLY COMPACTED CONCRETE IN g (W_F)	COMPACTION FACTOR (W_P/W_F)
1	0.45	5600	3722	10610	12700	0.85
2	0.46	5600	3722	11910	13350	0.86

The compaction factor is 0.85 for water cement ratio of 0.45

Table 3: compaction factor test

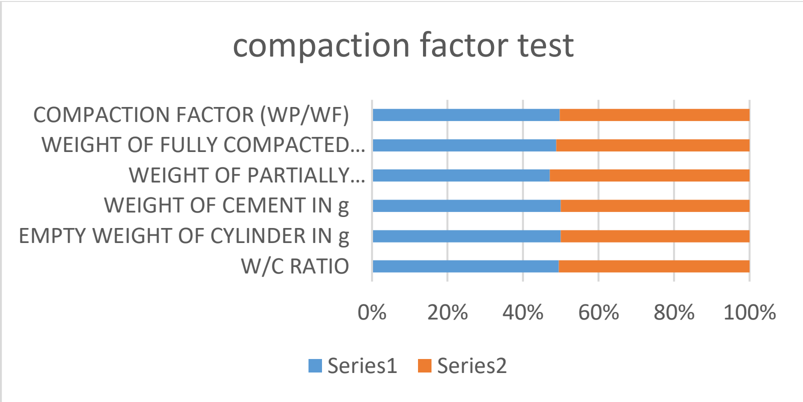

Fig 5: compaction factor test

6.3 CONCLUSION

To sum up, this experimental investigation examined the viability of using different proportions of rice husk in place of fine aggregate in concrete compositions. The results show that concrete with mechanical qualities similar to the control mix (0% rice husk) could be produced with up to 15% replacement. Nonetheless, a minor reduction in compressive strength was noted at 20% replacement. However, it was shown that adding rice husk could improve the sustainability of concrete production without compromising acceptable performance standards. Additional mix percentage optimization and fine-tuning could yield even higher benefits, opening the door for ecologically friendly building techniques and advancing the more general objective of sustainable infrastructure development.

References

1) G. Lalitha Devi, et.al, "Experimental analysis of the use of steel slag as cement" Journals of mechanical and civil engineering, January (2019).

2) Nisha Ali, et.al, "Rise husk a potential partial course aggregate replacement in concrete "International journal of science, environment and technology on January (2020).

3) Pushpa Poudyal', et.al, "The suitability of rice husk as an alternative to sand in concrete production was studied here." Journal of mechanical and civil engineering on (2016).

4) Rupesh Malik, et.al, "Experimental study on strength characteristics on M20 concrete with partial replacement of cement with fly ash and coarse aggregate with Rise husk," International journal of scientific & engineering research on January (2012).

5) K. Sathish Kumar, et.al, "Rise Husk as partial replacement of coarse aggregate in concrete," IOSR journal of mechanical and civil engineering, on December (2014).

6) Tomas U, et.al, "The experimental study aimed to analyze the effect of rice husks as fine aggregate to find solutions regarding the disposal to landfills of waste materials and save the environment." Journal of civil engineering on (2013).