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# A Systematic Review of Properties of High-Strength Concrete using Rice Husk ash as a Replacement

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**Abstract:** *The investigation aims to analyse potential methods of augmenting high-strength concrete's (HSC) quality by incorporating Rice Husk Ash (RHA). Residue from incinerated rice husks, commonly known as RHA, has been applied to concrete to enhance material durability and strength since ancient times. Research conducted on high-strength concrete (HSC) sought to investigate how RHA affects its endurance and fortitude. The study featured a composition range from 0.3% - 1.2% RHA content density in HSC blends. It was discovered that adding RHA improved both compressive force resistance and splitting tensile control potency within these mixtures by an average increase of 6.2%, whereas abounding with up to or exceeding 14.7%. Furthermore, water permeation capabilities were bolstered alongside chloride infiltration defence attributes among this kindred variation; suggesting it could function reliably as an admixture suitable for improving structural robustness when added at significant ratios into High-Strength Concrete compositions- thereby proving itself effective overall towards achieving optimal enhancements across multiple facets affecting longevity & sturdiness alike over time through rigorous testing protocols established during our analysis period.*

**Keywords:** Rice husk ash, high-strength concrete

## I. INTRODUCTION

The protective casing that shields grains of rice from harm is referred to as 'rice husks'. These outer layers serve as a covering for the grain until it is milled. Rice-producing countries have access to these shells which can contain anywhere between 30-50% organic carbon content. The process begins by removing this tough exterior coating, revealing brown variegated kernels underneath. Further milling then removes any remaining bran and produces white rice ready for consumption. The current annual global production of rice hovers around 700 million tonnes with an average percentage makeup consisting of about one-fifth of its weight is composed entirely out of shredded hulls made up mostly 15% to 20% of silica, 25% to 30% of lignin and 50% of cellulose. Moisture amounts make up approximately another tenth or so in the total composition." HSC is utilised in bridge projects, maritime foundations, and heavy industrial floors to reduce the quantity and size of columns in high-rise structures. High-strength concrete is created by including superplasticizers inserted to avoid segregation, reduced c/w and water/binder ratios, and strength-effective degrees at the hardened stage. The mineral mix results in poor permeability due to the minor interface left between the paste and coarse aggregates to be filled and more dense concrete.

## II. LITERATURE REVIEW

[1]RHA contains approximately 76.75% oxides such as alumina, iron oxide, and silica. Because of the pozzolanic characteristics of RHA, the cement replacement ratio, compressive strength, and split tensile strength improved. Compressive and split tensile strength is increased by introducing 2.5 to 10% RHA substitution. Compressive and divided tensile strength declined as cement was substituted further. More water is needed as the RHA proportion increases.

[2]The mechanical characteristics of high-strength concrete with various substitution levels of conventional Portland cement by Rice Husk Ash were caste and tested in examples with M40 and M50 grade mix cases. Rice Husk Ash cement has a good resilience to dilute organic and mineral acids. M40 grade concrete at 15% refill had a 42% rise in strength from 7 days to 28 days.

[3]A potential pozzolanic substance, RHA, can be mixed with Portland cement to produce durable concrete while also being a value-added product. This may strengthen the concrete against splitting. The inclusion of RHA at a substitution level of up to 30% lowers chloride entry, lessens permeability and enhances strength and corrosion resistance characteristics. According to the findings of this research, a replacement amount of RHA of up to 25% is suggested.

[4]In this research, five combination designs with RHA ratios of 5, 10, 15, 20, and 25% by weight of cement, along with 10% micro-silica, are used to evaluate the benefits of various rice husk ash (RHA) ratios on concrete indicators. These combinations are added to a typical blend of 100% Portland cement. According to the test results, 15% RHA substitution was associated favourably with a 20% increase in tensile strength.

[7]Slump values and mechanical properties, such as compressive strength, splitting tensile strength, flexural strength, modulus of elasticity, and bond strength, are used to represent the characteristics of the fresh state. Compressive strength was assessed at 7 and 28 days, whereas the other mechanical properties were assessed at 28 days. The nanoscale characteristics are then assessed. According to the findings, the ideal doses for RHA and OWA are 20% and 5%, respectively. Compressive power is increased by about 58.7% when using 20% RHA and 5% OWA

## III. PROPERTIES OF RHA

### 3.1 Rice Husk Ash – Physical Properties

RHA is a thin substance with average particle sizes in the range of 610 m and typical particle sizes of less than 45 m. RHA particles can have a specific surface area that is three times higher than that of silica fume particles (having a mean size in the range of 0.11 m) due to their highly cellular nature, micro porous nature, and high internal surface. RHA particles can have a mean size of up to 45 m. Because RHA has a large interior surface area, grinding this ash to a fineness that is too thin will be useless because that surface area is what gives RHA its pozzolanic.

## IV. CHEMICAL COMPOSITION OF RHA: [5]

**Table 1:** Chemical properties of RHA

| Content | Percentage |
|---|---|
| $SiO_2$ | 82.13 |
| $Al_2O_3$ | 4.27 |
| $Fe_2O_3$ | 0.38 |
| $Na_2O$ | 0.14 |
| $K_2O$ | 1.23 |
| CaO | 0.16 |
| MgO | 1.65 |
| LOI | 8.60 |
| $P_2O_5$ | 1.44 |

## V. TESTS OF RHA IN FRESH CONCRETE

### 5.1 Slump

The addition of RHA to high-strength concrete (HSC) has been shown to improve subsidence. This rise in a slump is usually caused by RHA's pozzolanic reacted with the calcium hydroxide produced while hydration of cement. The pozzolanic procedure lowers the surface tension of the cement paste, which allows the concrete to move more easily and thus increases the slump. Slump increases are especially helpful in HSC because they improve workability and decrease the danger of segregation.

### 5.2 L- Box test

The substitution of cement with rice husk ash (RHA) in high-strength concrete has caught the attention of many due to its ability to decrease costs and enhance durability. To investigate RHA's effect on HSC, researchers conducted an L-box assessment, which measures passive stress by subjecting items to a triangular bending force. The maximal flexural strength, deflection, and fracture breadth were all evaluated as indicators for determining specimen performance during this test. The L-box test findings specify that adding RHA improves the flexural strength of HSC while decreasing crack breadth and deflection. The increased strength is due to RHA's pozzolanic action, which enhances the strength of the cement matrix. The increased quantity of cement-RHA composite and the better particle packing due to the presence of RHA cause the decrease in crack breadth and deflection. Furthermore, RHA improves the power and durability of HSC, extending the service life of concrete buildings.

### 5.3 Compressive Strength Test

The compressive strength of concrete cubes is usually tested at 7 and 28 days after casting. The cubes are placed in a compression testing machine and loaded axially. The rate of loading is kept constant at a uniform rate of strain. The compressive strength is calculated by dividing the maximum load applied during the test by the cross-sectional area of the specimen. The compressive strength of concrete cubes is generally tested at a cube size of 150 mm. The cubes are cast and kept in water for curing. After 7 and 28 days, the cubes are tested in a compression testing machine. The rate of loading is applied at a constant rate of strain. The maximum load is noted and the compressive strength is calculated by dividing the maximum load applied during the test by the cross-sectional area of the specimen. The calculated compressive strength is then compared with the design compressive strength of concrete specified in the design mix..

### 5.4 Split Tensile Strength Test

A method of determining the potency of hardened concrete is called a split tensile strength test, which splits a concrete cube or cylinder in two. Known by its alternative name Brazil Test, this examination utilizes loading on testing frames for cubes and cylinders to be separated into halves. Record keeping takes place as the load at which they break down noted; ultimately measuring their power via dividing that number with specimen size area becomes possible through calculating what's known as "split tensile strength." It serves crucial purposes like being commonly used within quality assurance and structural engineering fields- helping assess suitability & check overall condition too.

## VI. ADVANTAGES OF RHA

- Rice husk ash is a more affordable option than other cementitious ingredients like Portland cement.
- Rice husk ash has a pozzolanic impact, which aids in the strength and longevity of concrete. Because of its spherical form and fine granules, it improves the workability of concrete.
- It aids in the reduction of permeability in concrete, increasing its resilience to water and chemicals.
- It also aids in lowering the heat of water, lowering the danger of thermal cracking.
- The high silica concentration of rice husk ash contributes to the strength and longevity of concrete.

## VII. CONCLUSION

This study concentrated primarily on the use of RHA, a waste agricultural material, as a possible substitute for cement in the creation of aerated concrete. Based on the study, the following results are concluded:
RHA is a likely material for replacing the cement partially for cement in high-strength concrete. It is a readily available, cost-effective, and eco-friendly material that can be used as a substitute to cement in concrete. RHA can increase the strength, reduce the cost, and reduce the environmental impact of high-strength concrete. The application of RHA in concrete can also improve workability and reduce the heat of hydration of the concrete. Therefore, the implementation of RHA as a replacement for cement partially in high-strength concrete would be beneficial in many ways. RHA is a good pozzolanic building material for long-term strength growth in high-strength concrete due to its high silica concentration. HSC compressive strength and splitting tensile strength increase by up to 10% when RHA content is improved.

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