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Performance the energy dispersive x-ray analysis & x-ray diffraction analysis for R-husk ash

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Abstract
A large portion of the husk created during rice processing is either burned or disposed of as waste in most rice-producing nations. One of the most abundant yet underutilized biomass resources is rice husks, which make them a perfect fuel for producing energy. The author of this communication conducted X-ray diffraction experiments on rice husk ash (RHA) concrete samples heated at 500 °C and 1000 °C. The results were compared, and it was found that the specimen's inner surface exhibits an additional compound at 500 °C. The additional chemical compounds formed at lower temperatures were not present at 1000 °C on the outer and inner surfaces of the sample, according to X-ray diffraction studies of samples exposed to this temperature. This could be the cause of the specimens' poor strengths. These experiments show how RHA can improve concrete's durability qualities and help produce high-strength concrete at a reasonable cost by utilizing waste resources.

Keywords: X-ray diffraction, rice husk ash, compressive strength, durability, sustainable construction

1. Introduction

One percent of the earth's surface is made up by rice, which provides billions of people with their main food source. An estimated 600 million tons of rice paddies are produced annually worldwide. The ash has a very high exterior surface area, is lightweight, extremely porous, and contains 92% to 95% silica (SiO_2). Numerous industrial uses benefit from the ash's insulating and absorbent qualities, and it has been the focus of numerous studies. The feasibility of rice husk power or cogeneration facilities is significantly increased if a long-term sustainable market and price for rice husk ash (RHA) can be developed. In addition to durability's socioeconomic effects, there is a direct correlation between durability and the environment. We save precious natural resources by prolonging the life cycle of building materials. Concerns with the usage of RHA concrete in concrete structure design extend beyond structural stability to include durability. Mauro M. Tashima *et al.* (1985) [2] investigated the effects of varying RHA concrete grades on the material's physico-mechanical characteristics. Rice husk ashes (RHAs) were used by numerous researchers to explain a number of important characteristics of high strength concrete. RHAs were acquired from two sources: Vietnam and India. They were employed in high-strength concrete with different components to partially replace cement binder. Important concrete characteristics, such as slump, density, compressive strength, and resistance to water and chloride permeability, were examined in comparison between samples that used two different types of RHAs and those that did not. The impact of using RHA as a 10%-30% cement substitute was investigated by Muhammad Shoaib Ismail *et al.* in 1996 [5]. According to Moayad N. Al-Khalaf *et al.* (1984) [6], rice husk ash was made into a pozzolana using a unique process that ensured the end product met engineering specifications for both physical and chemical characteristics while the silica remained amorphous with a small amount of unburned carbon. RHA has been utilized as a highly reactive pozzolanic material to enhance the microstructure of the interfacial transition zone (ITZ) between the aggregate and cement paste in high-performance concrete, according to Bui D., Hu J. *et al.* (2005) [7]. The durability and resilience of a new type of high-performance concrete reinforced with rice husk ash (RHA) were evaluated by Bahri *et al.* (2019) [1]. A study published in the IOP Conference Series: Materials Science and Engineering found that RHA increased compressive strength and elastic modulus while decreasing chloride penetration into HSHPC.

They found that RHA has strong pozzolanic capabilities through pore refinement and the production of calcium silicate hydrate (C-S-H) gel, which would improve the strength and durability of building materials. A study by Dharmaraj *et al*. (2023) [3] investigated the feasibility of producing HPC from rice husk ash. Their results, which were published in Materials Today: Proceedings, show that RHA may significantly increase concrete's resistance to split tensile stress and compression. The study showed that using RHA in place of some of the cement improved the bonding in the concrete, making it stronger, more sustainable, and requiring less cement. The study emphasized RHA in its discussion of more environmentally friendly substitutes for conventional concrete additives. Faried *et al*. (2021) [4] focused on the effects of nano rice husk ash (NRHA) on ultra-high-performance concrete (UHPC) at varying levels of burning. According to their research, which was published in Construction and Building Materials, NRHA could improve the microstructure density and mechanical performance of UHPC. They came to the conclusion that NRHA was advantageous for UHPC, particularly when it was observed during combustion. Their research revealed improved durability indicators such resistance to sulfate and chloride ion attacks, as well as greater compressive strength with decreased porosity. The results connected the NRHA's pozzolanic reactivity and nanoscale particle size to the UHPC improvement properties. The use of rice husk ash (RHA) as an SCM in sustainable high strength concrete was investigated by Hasan *et al*. in 2022 [8]. The authors of a study that was published in Materials discovered that adding RHA improved compressive strength while decreasing water absorption and durability. In order to increase sustainability without sacrificing structural performance, the authors emphasized how partially substituting rice husk ash for OPC can reduce the carbon footprint associated with cement-based building. In their 2020 study, Hu, He, and Zhang examined the environmentally friendly and performance-enhancing uses of rice husk ash in cement-based products. They conducted a thorough life-cycle assessment and performance evaluation for their study, which was published in the Journal of Cleaner Production. The study found that RHA reduced mechanical strength, permeability, and long-term durability while also significantly reducing the environmental effect of cement manufacture. According to the authors, RHA promoted sustainable building practices and enhanced the qualities of concrete. Ahmadi M. A. *et al*. investigated the evolution of mechanical properties up to 180 days of self-compaction and regular concretes with rice-husk ash (RHA). They found that 20% RHA concrete has a beneficial impact on mechanical properties at ages after 60. They also found that two different percentages of cement replacement by RHA were 10% and 20%, as well as two different water/cementicious material ratios of 0.40 and 0.35. Prior research has only been conducted on regular concretes that contain fly ash and silica fume. There aren't many studies on RHA concretes. The majority of RHA concrete studies take into account replacement percentages of 0, 5, 10, 15, and 20. Numerous investigations have been conducted on the aforementioned substances, such as fly ash, metakaoline, etc. Nevertheless, there is little research on rice husk ash concrete, a possible mineral addition for concrete. A study on RHA concretes was required due to the disposal of RHA and environmental issues. The research did, however, also reveal that there had been relatively few prior investigations into the fire resistance of RHA concrete. Hence, in the present study the basic properties like strength, durability, fire resistance and other aspects of the RHA concretes were proposed for investigation. Therefore, in this communication the X-ray diffraction studies on RHA concrete samples heated at 300 °C and 1000 °C were compared.

2. Objectives

- To Performance the Energy Dispersive X-Ray Analysis & X-Ray Diffraction Analysis for R-Husk Ash
- To investigate R-husk ash's energy dispersive x-ray analysis and x-ray diffraction analysis.

3. Experimental

Rice Husk Ash: India provided the rice husk ash used in this experimental investigation. Tables 1, 2, and 3 provide the general parameters, physical characteristics, and chemical composition of the RHA used in this investigation, which was provided by the supplier.

Table 1: Characteristics of rice husk ash

Silica	90% minimum
Humidity	2% maximum
Mean Particle Size	25 microns
Loss on Ignition at 800 °C	4% maximum

Table 2: The rice husk's physical characteristics

Physical State	Solid-Non Hazardous
Particle Size	25 microns-mean
Odour	Odourless
Specific Gravity	2.3

Table 3: Rice husk ash's chemical characteristics

SiO_2	93.80%
AI_2O_3	0.74%
Fe_2O_3	0.30%
TiO_2	0.10%
CaO	0.89%
MgO	0.32%
Na_2O	0.28%
K_2O	0.12%
Loi	3.37%

4. Results and Discussion

4.1 X-Ray Diffraction Analysis (XRD)

In this case, XRD proved that RHA does in fact contain silica. Created amorphous phases for RHA at lower temperatures, 500-700 °C. Burning RHA at high temperatures transforms amorphous silica into crystalline silica. There is evidence in the literature that cristobalite or tridymite could have been formed when RHA is burned at temperatures of 700 °C or higher. The several phases that formed on RHA were identified by XRD studies. Figure 1 shows that at 1000 °C, RHA reacts very strongly; in this case, practically all of the silica is in an amorphous form, which greatly increases the strength. A single diffuse broad band was formed during XRD examination of RHA burnt at 700 °C, confirming the existence of amorphous silica. When RHA is mixed with a high-strength concrete matrix, the cementitious reactions will be affected by the high levels of amorphous silica. In addition, cement mortar stability is greatly enhanced by the CSH gels. The hydrolysis product of OPC seems to consist mostly of CSH gels and $Ca(OH)_2$. Hydrolysis improves the stiffness of RHA by reacting the crystalline silica with the $Ca(OH)_2$, which in turn generates more CSH gels. The concentration of various quartz crystalline forms influences the generation of extra CSH gels. Crystalline quartz produced at temperatures below 1472 degrees Celsius must thus be the most reactive and suitable ingredient for cement.

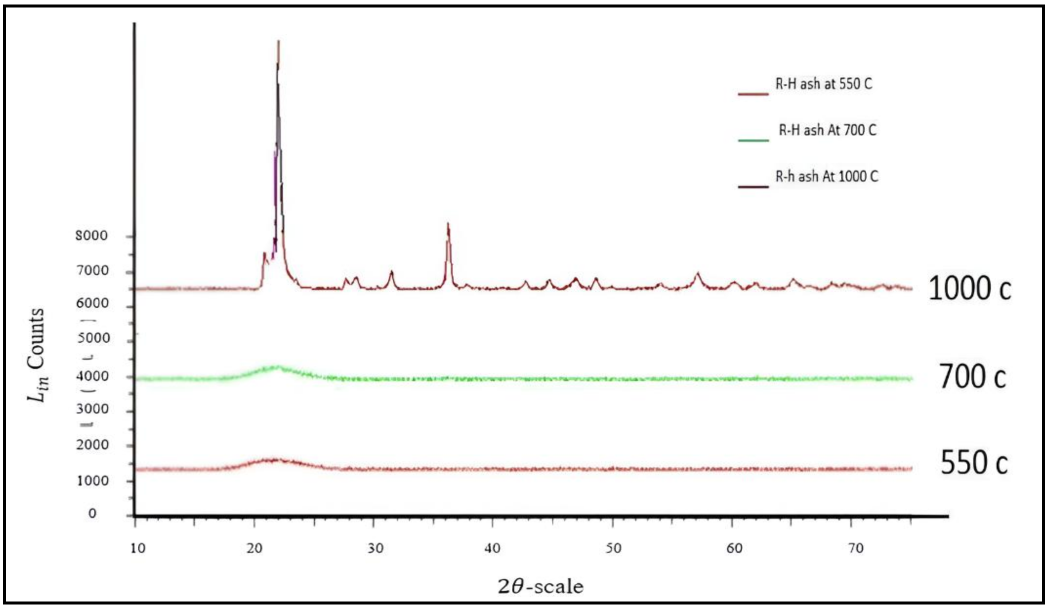

Fig 1: The XRD analysis of several RHAs burnt at different temperatures

Table 4: The maximum amorphous silica and crystalline values found in XRD analyses of several RRHAs burnt at different temperatures

Regulated & Unregulated RHA	Impulse
Amorphous silica in RHA at 550 °C	1524
Amorphous silica in RHA at 700 °C	4450
Amorphous silica in RHA at 1000 °C	19557

4.2 Energy-Dispersive X-Ray Analysis (EDX)

Tests for elemental analysis of RHA burned at temperatures ranging from 550 to 1000 ℃ were conducted in a central lab using EDX on specimens of RHA. Based on the molecular formula derived from the EDX, the existence of% oxide was determined by the chemical characteristics of RHA analysis. Results, including chemical composition, are previously described in Table 5. This includes both RHA specimens treated at 550 and 1000 ℃. Regardless of the temperatures at which they were burned, all RHA specimens consisted mostly of silica. Silica content is marginally greater in RHA specimens fumed at lower temperatures (550 ℃ vs. 1000 ℃) than in RHA specimens burnt at higher temperatures. Cementitious materials are defined by ASTM C 618 as those containing at least 70% of the following elements: "Al_2O_3, SiO_2, and Fe_2O_3". The total "silica, alumina, and iron values" in Table 5 were found to be 20.33 and 96%, respectively, for RHA burnt at 550 and 1000 ℃. Research on RHA indicated that it might be a useful cementitious material according to ASTM criteria.

Table 5: Mass% of Oxides in RHA

Elements	Mass%		
	OPC	Grey RHA	White RHA
$Si(O_2)$	20.33	96.5	96.0
Al_2O3	5.46	0.50	0.40
CaO	63.29	0.41	0.09
Fe_2O_3	4.58	0.08	0.08

4.3 Workability

The results of the collapse or compaction factor tests were lower when RHA was used in place of regular Portland cement. It follows that RHA-containing mixes will want more water than non-RHA-containing mixes in order to achieve the necessary workability. The need for water increased in direct proportion to the percentage of RHA. Particle size, surface area, or shape could all have a role in the increased water need. This was anticipated since, as the quality of the concrete increases, its thickness decreases. To keep the surface particles hydrated in more porous concrete, more water is required. Because of its high specific surface area and water-absorbing properties, RHA decreases workability.

Table 6: Slumps of RHA substitute mixes

RHA Specimens	0%	5%	10%	15%	20%
Slump (mm)	39.6	36.6	34.2	32.8	28.7

5. Conclusion

The study found that concrete's mechanical and durability properties are improved when up to 10% RHA is used in place of ordinary Portland cement. The concrete specimens showed the best compressive and split tensile strengths with the lowest porosity (a measure of water absorption) during all curing durations, suggesting greater structural performance and longevity with this level of RHA replacement. Comparing X-ray diffraction studies of rice husk ash (RHA) concrete samples heated at 500 °C and 1000 °C, it was found that at 500 °C, the specimen's inner surface exhibits an additional compound, Copper Iron Lead Telluride $Cu_3FePbTe_4$ along with SiO_2, $AI_5Fe_2ZnO_4$ which were also present on the surface and may be the cause of the concrete's increased strength at 500 °C. The additional chemical compounds generated at lower temperatures were not present on the exterior and inner surfaces of the sample at 1000 °C , according to X-ray diffraction tests of samples exposed to this temperature. This could be the cause of the specimens' weak strengths. The compound name was displayed on the exterior of the heated specimen at 1000 °C. The study concludes that 10% RHA replacement is the ideal dosage for concrete because it balances improved strengths and durability qualities without sacrificing the cementitious qualities of the mix, making it sustainable and efficient for partial cement replacement.

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