Chemical Compositions of Ground and Unground Rice Husk Ash Produced by Uncontrolled Burning

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1 Introduction

With the rapid increase in infrastructural development, there is also an increase in the production of cement. But, cement production leads to environmental pollution due to the emissions of greenhouse gases [1]. So, many researchers are exploring different substitutes for cement. Rice husk ash (RHA) is the ash that is left over after burning rice husk. This rice husk ash possesses high silica content, making it one of the potential pozzolanic material for cement replacement [2]. Additionally, by incorporating RHA into cement, environmental issues caused by the disposal of rice husk waste will be reduced [3].

Amorphous silica contained in RHA contributes to the pozzolanic reaction in cement. C-S-H gel is created when the reactive silica in RHA combines with the calcium hydroxide created during the cement hydration. It undergoes reaction with calcium hydroxide in cement to form silica gel. RHA's pozzolanic activity has an impact on the characteristics of concrete [4–6].

The majority of the research focused on controlled burning and ground RHA after Mehta's investigation in the early 1970s, which claimed that highly reactive RHA can be produced through controlled combustion and that the pozzolanic activity of the RHA depends on its fineness and the temperature in which it is burned. [7]. Many researchers have investigated the usage of RHA as a pozzolanic material [8–10].

While most researchers are focused on the controlled burning of RHA, few have studied the uncontrolled burnt RHA [4, 11–13]. But, no literature is available in the comparative study of ground and unground RHA produced by uncontrolled burning. Ground RHA is ash that is grounded to fine ashes along with the unburnt carbon particles. Unground RHA is ash that is directly sieved without grinding. This paper

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gives a comparative study on the amorphous nature and the chemical compositions of ground and unground RHA produced by uncontrolled burning.

2 Materials and Methods

2.1 Materials

Rice husks, collected from a local rice mill in Imphal, Manipur, were washed with water to remove unwanted particles and sundried for 48 h. Then, they were burnt in an uncontrolled condition using a local earthen furnace (Fig. 1). Two types of RHA were prepared (Fig. 2):

(a) Ground RHA: The ash was ground for 10 min and sieved through 90-micron sieve.
(b) Unground RHA: The ash was sieved directly through 90 microns sieve without grinding.

Fig. 1 **a** Burning of rice husk in a local earthen furnace **b** RHA left after burning

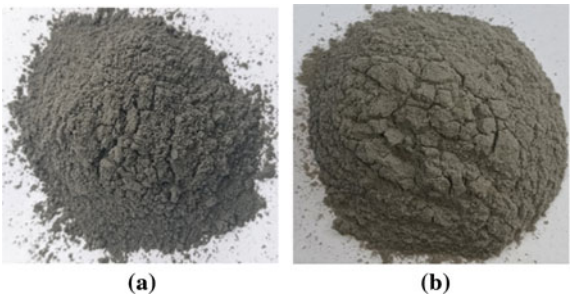

Fig. 2 **a** Ground RHA **b** unground RHA

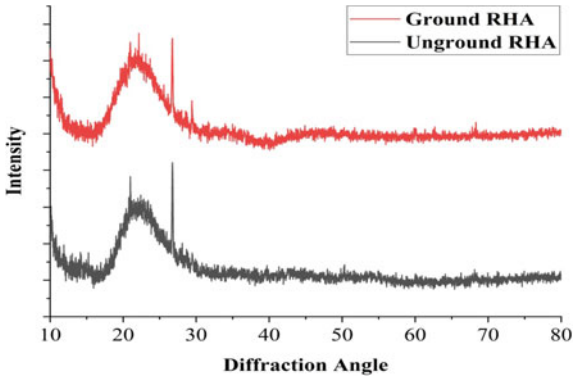

Fig. 3 XRD pattern of ground and unground RHA

2.2 Methods

2.2.1 XRD and EDX Analysis

XRD test was done to analyze the crystalline and amorphous nature of RHA. XRD analysis was done with a 2-theta angle limit of 10–60. EDX analysis was done to understand the elemental compositions of the two samples of RHA.

3 Results and Discussion

3.1 Nature of the Samples

The XRD plot of the two rice husk ash samples was observed (Fig. 3). The diffraction patterns were almost similar between them. Board peaks spanning a 2-theta angle range of 18–25 indicate that the RHA samples have a high amount of silica which are amorphous in nature.

3.2 Chemical Compositions

EDX analysis of the two RHA samples was done. The analysis showed that both of them have high silicon content which agreed with the XRD results indicating the content of high amount of silicon compound (Figs. 4 and 5).

The chemical compositions of ground RHA and unground RHA done by using EDX analysis were given in Table 1.

It was observed that unground RHA have higher amount of silicon than the ground RHA, which might help in the development of strength in concrete. On the other hand,

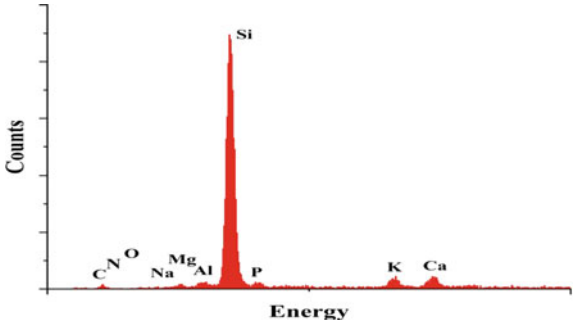

Fig. 4 EDX analysis of ground RHA

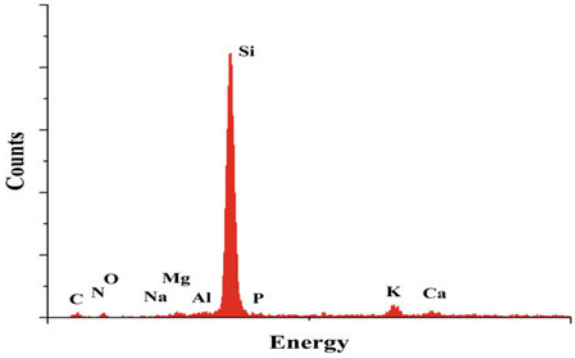

Fig. 5 EDX analysis of unground RHA

Table 1 Chemical compositions of ground RHA and unground RHA

Chemical compositions	Ground RHA (%)	Unground RHA (%)
Si	66.26	73.64
Al	0.79	1.32%
O	4.17	4.80
C	17.16	2.35
K	5.77	6.59
Na	0.13	0.00
N	0.86	0.00
Ca	2.51	7.02
Mg	0.75	0.81
P	1.59	3.47

ground RHA have higher amount of carbon content due to the mixing of unburnt carbon particles while grinding. This might negatively affect the strength of concrete.

4 Conclusion

This comparative study revealed that both of the ground and unground rice husk ashes produced by open burning have high amount of amorphous silica. Additionally, it was found that unground rice husk ash has a larger silicon concentration than ground rice husk ash, which indicates a higher silica percentage. Both the unground and ground rice husk ashes might be suitable for partial cement replacement. Unground RHA might be more favorable compare to ground RHA for partial replacement of cement due to higher silicon compound.

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