Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 06, June -2018

EFFECT OF RICE HUSK ASH (RHA) AS A PARTIAL REPLACEMENT OF CEMENT IN CONCRETE AND MORTAR

Syed Hissan[1], Muhammad Umar[1], Muhammad Irshad Khan[1], Muhammad Tahir Khan[1]

[1]*M.Sc. Scholar, Department of Civil Engineering, University of Engineering & Technology Peshawar, Pakistan*

Abstract:- *This research work investigates the effect of Rice husk ash (RHA) when used as a partial replacement of ordinary Portland cement in concrete and mortar sample. Before using RHA as a partial substituent of cement, EDX and XRD analysis were conducted on RHA sample. Slump cone test was performed for various replacement level of cement i.e 0%, 10%, 15%, 20% with RHA on concrete. The test result showed reduction in workability as the percentage replacement of Ordinary Portland cement (OPC) with Rice hush Ash (RHA) increased. Moreover, Compression tests results carried out on mortar specimens showed reduction in strength with the increase in amount of RHA.*

Key words*: RHA, EDX, XRD, Workability, Compression test*

1. Introduction

Concrete is the one of the most widely used material in construction industries; Ordinary Portland cement (OPC) is a main binding material used in preparation of concrete. In order to fulfill the needs of construction industries, in recent years the annual cement production of world has grown from 1 billion tons to about 1.7 billion tons [1]. The production of cement is not only costly but also emits greenhouse gases to environment particularly CO_2 [2]. Cement factories released up to 1.25 tons of CO_2 for the production of each ton of cement, and leads to environmental degradation and pollutions problems [3]. For this reason researchers have been working on cheap and easily available materials like agricultural and industrial wastes which can be used as a cement replacement in concrete [4]. One of the most promising materials is the rice husk ash (RHA) which can be obtained by burning rice husk at controlled temperature.

Rice husk is an agricultural waste, obtained during milling of paddy which comes from the field. During milling process 78 % of weight is received as rice, beans and broken rice while remaining 22% is received as rice husk. Upon burning, rice husk contains about 75% of volatile matters and 25% of the weight converted in to ash. RHA obtained after burning contains about 85% to 90% of silica [5]. However, the chemical composition of rice husk is found to be different from one sample to another depending upon geographical conditions type of paddy, and climate etc. [6].

The objective of this work is to examine the effect of rice husk ash on the strength of mortar specimens by using variable amount of RHA as a partial replacement of ordinary Portland cement. Moreover, slump cone test was carried out to investigate the effect of RHA on workability of concrete.

2. Methodology

2.2.1 Cement

Ordinary Portland cement manufactured by Cherat cement factory, meeting the requirements of ASTM C150 was used in this study.

2.2.2 Sand

Fine aggregates used in this work were obtained from local quarries. Fineness modules of 2.38 was computed for sand by following ASTM standard procedure.

2.2.2 Coarse aggregate

The coarse aggregate used in this research work were collected from local resources. It had a maximum aggregate size of 19mm and bulk density of 1557kg/m^3.

2.2.3 Rice husk ash

Rice husk ash from Khyber Pakhtunkhwa (KPK), Pakistan was selected for this research work. Rice husk was burnt for three hours in a controlled atmosphere. After burning, it was grinded in a ball mill for about 120 minutes. The chemical composition of RHA was computed by using Energy Dispersive X-rays analysis (EDX). EDX results showed up to 88% of silica in RHA. Other ingredients like alumina, iron oxide, calcium oxide, magnesium oxide Sulfur trioxide and potassium oxide were also present in very small quantities as shown in figure 3.

Figure 1: Rice husk

Figure2: Rice husk ash

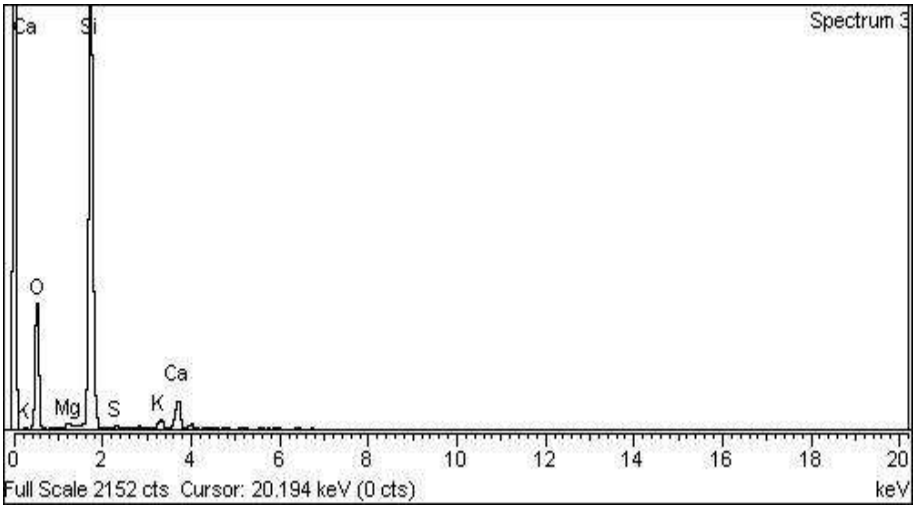

Figure 3: EDX Result of RHA

2.2.4 X-ray diffraction analysis

To confirm the mineralogical phase (crystalline or amorphous), X ray diffraction analysis was carried out on RHA sample by using x-ray diffractometer. Figure 4 is showing the XRD analysis performed on RHA sample. As no obvious sharp peaks were detected in XRD pattern of RHA which indicates that silica of RHA is mainly in amorphous form.

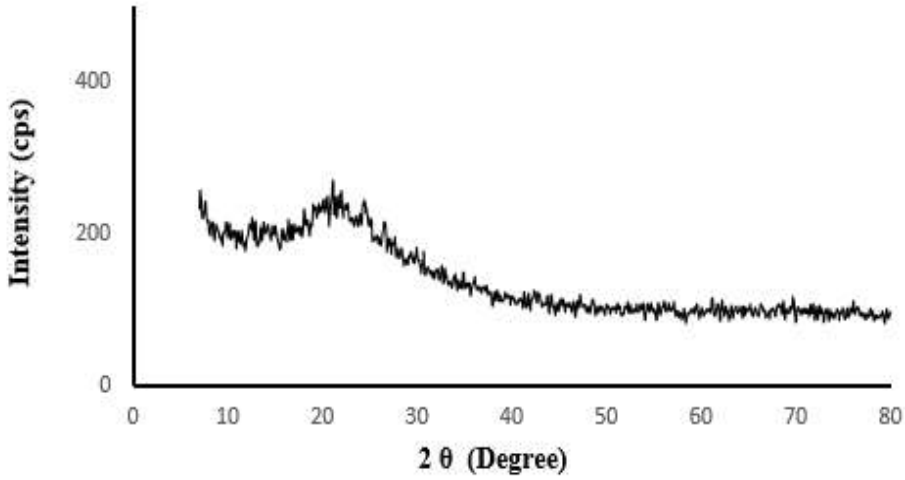

Figure 4: XRD of RHA

2.2.5 Compression Test

ASTM C-109 requirement were followed in preparation of mortar sample. Mortars were prepared in standard proportion of 1:2.75 with addition of 0.48 water to cement ratio. RHA was used at variable level i.e 0%, 10%, 15% and 20% as a replacement of cement. The mortar sample were tested under Universal testing machine after 7, 14 and 28 days of moist curing.

Figure 5: Compression Test on mortar

2.2.6 Slump test

To measure workability of concrete slump test was performed according to ASTM C143 on control concrete and RHA concrete with 10%, 15% and 20% replacement of cement with RHA by weight. In this slump cone was filled from concrete in three layers, each layer was stroked 25 times with the help of standard diameter steel rod (16mm) with round ends. After slump cone was completely filled with concrete, the cone was lifted vertically and slump value of concrete mixture was computed with the help of scale as shown in figure 6.

Figure 6: Slump cone test

3. Results and discussion

3.1 Compression Test

The strength results obtained for mortar specimens after 7, 14 and 28 of curing are shown in figure 7. It is clear from compression test results that strength decreases with the increase in RHA amount. It can be observed from the figure 7 that the strength difference between control mortars and RHA mortars are much higher during early ages i.e 7 and 14 days as compared to 28 days strength. For 20% usage of RHA as a partial replacement of cement, the 7 and 14 days strength reduction was up to 49% and 41%. However this strength reduction difference was much lesser at 28th day and 22% reduction in strength was recorded for mortar that was incorporated with 20% of RHA.

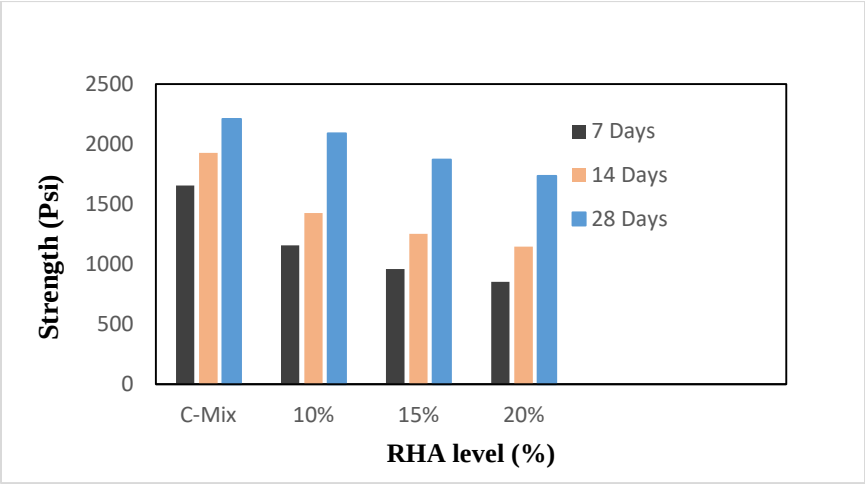

Figure 7: Compression test results of mortar

3.2 Slump test

Table 1 and figure 8 is showing the slump data recorded for control concrete mix and RHA concrete mixes. Significant amount of reduction in slump values were recorded when RHA was added by weight as a partial replacement ordinary Portland cement in concrete mixtures. The slump value recorded in control concrete mixture was 86mm. however, addition of 10%,15% and 20% replacement of cement with RHA showed 68mm,57mm and 51mm of slumps respectively.

Table 1: Slump data of concrete mixtures

Mixture	RHA Replacement (%)	Slump Height (mm)
Control Mix	0	86
RHA-10	10	68
RHA-15	15	57
RHA-20	20	51

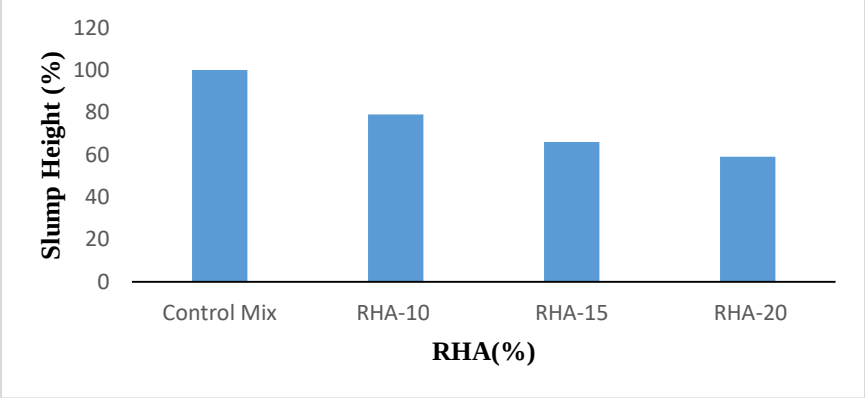

Figure 8: Slump of concrete mixtures for varying percentage of RHA

4. Conclusion

1-Higher amount of silica presence in RHA makes it an effective pozzolanic material.
2-Burning Rice husk under control temperature (700^{o}C) can produce silica in amorphous form.
3- Workability of concrete was reduced up to 41% by 20% addition of RHA as a partial replacement of cement due to higher surface area of RHA.
4- Compression strength of mortar reduced up to 22% by 20% addition of RHA.

5. References

1. Gartner, Ellis. "Industrially interesting approaches to “low-CO2” cements." *Cement and Concrete research* 34.9 (2004): 1489-1498.
2. Mehta, P. Kumar. "Greening of the concrete industry for sustainable development." *Concrete international* 24.7 (2002): 23-28.
3. Muga, Helen, et al. "Development of appropriate and sustainable construction materials." *Civil and Environmental Engineering Sustainable Futures Institute, Michigan Technology University* (2005).
4. Khan, Rawaid, et al. "Reduction in environmental problems using rice-husk ash in concrete." *Construction and Building Materials* 30 (2012): 360-365.
5. http://www.ricehuskash.com
6. Chandrasekhar, S. A. T. H. Y., et al. "Review processing, properties and applications of reactive silica from rice husk—an overview." *Journal of materials science* 38.15 (2003): 3159-3168.

