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A Review on the Effect of Rice Husk Ash Blending On Concrete Properties

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ABSTRACT: This paper presents a review on the use of Rice husk ash (RHA) as a mineral admixture in the concrete. Distinctive outcome from several researches have been demonstrated here, particularly emphasizing on the fresh, hardened and durability properties of concrete when blended with Rice husk ash (RHA). The results shown a substantial enhancement in the mechanical properties of concrete when replaced with RHA. It can be concluded that the optimize percentage of replacement with RHA lies in the range of 5-10 % particularly for compressive strength. However the variation of blending goes up to 5-15% in case of split tensile and water absorption of concrete. Sorptivity & electrical resistance also enhances with age and blending percentage.

Keywords: Blending, Compressive strength, Concrete, Initial & Final setting time, Rice husk ash, Split tensile Strength, Water absorption.

1 Introduction

Concrete is the key material used in various types of construction, from the flooring of a hut to a multi-storied high rise structures. Concrete is one of the versatile heterogeneous materials. With the advent of concrete civil engineering has touched highest peak of technology. Many researchers have done work for increase strength and to improve durability of concrete. Out of the various materials used in the production of concrete, cement plays a major role due its size and adhesive property. So, to produce concrete with improved properties, the mechanism of cement hydration has to be studied properly and better substitutes to it have to be suggested. Different materials known as supplementary cementitious materials (SCMs) are added to concrete to improve its properties. Fly ash, Rice husk ash, silica fume etc are some of the pozzolanic materials which can be used in concrete as partial replacement of cement. Addition of Rice husk ash to concrete has many advantages like high strength, durability and reduction in cement production.

Rice husk has been proven as good pozzolonic material by the various researchers. A pozzolona is a siliceous/ aluminous material which itself has little or no cementitious value and reacts with calcium hydroxide liberated during the hydration of Portland cement (on addition of water) to produce stable, insoluble cementitious compound which imparts strength and impermeability to the mixture [1]. RHA can be used as a replacement of Cement or as an admixture in manufacturing of cheap concrete [2]. Several method have been tried to increase the early initial strength of concrete: finer grinding of the materials [3],[4],[5], accelerated curing [6], and thermal activation [7]. So the use of these materials on a wider scale could be increased if a method were found to increase the rate of pozzolanic reactions so that strength is increased without affecting other properties.

1.1 Formation of Rice husk ash

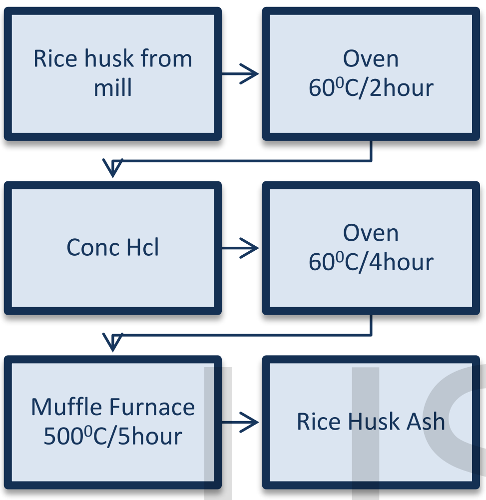

Fig 1.1: Preparation of Rice Husk Ash [8]

Rice hulls are the coatings of seeds, or grains, of rice. The husk protects the seed during the growing season, since it is formed from hard materials, including opaline silica and lignin. The hull is mostly indigestible to humans [9].

Winnowing, used to separate the rice from hulls, is to put the whole rice into a pan and throw it into the air while the wind blows. The light hulls are blown away while the heavy rice fall back into the pan. In 1885 the modern rice hulling machine was invented in Brazil. During the milling processes, the hulls are removed from the raw grain to reveal whole brown rice, which may then sometimes be milled further to remove the bran layer, resulting in white rice. Rice husk are collected from a rice mill. The rice husk are burnt in an annular kiln for obtaining amorphous silica under controlled burning as described in Nair et al [9].

The Rice Husk is burnt under guided or enclosed place to limit the amount of ash that will be blown off. The ash are ground to the required level of fineness and sieved through 600 µm sieve in order to remove any impurity and larger size particles [10].

1.2 Physical properties of RHA

The property of Rice Husk Ash depends on the type of production as well as the process used for its manufacturing. It is in powder form whose particle size is coarser than that of Portland cement. The colour of RHA varies from light to dark grey or brown which is because of the different manufacturing process and is influenced by several parameters. Table 1 shows a brief detail of the physical properties of RHA adopted by Kulkarni et al. (2014) [11].

Table 1.1: Typical physical properties of Rice Husk [11]

S. No	Particular	Properties
1	Colour	Irregular
2	Shape Texture	Non crystalline
3	Mineralogy	<45 micron
4	Odour	Odourless
5	Gravity	2.3
6	Appearance	Very fine

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Fig. 1.2: Rice husk pellets [12]

Fig 1.3: Residual RHA after burning [12]

1.3 Chemical properties of R H A:-

Below Table 1.2 demonstrates a variation of several chemical compositions of RHA adopted by several authors.

Table 1.2: Chemical composition of R H A samples

Authors / Oxides	Ngun et al. [13]	Kad & Vinod [14]	Talsania et al. [15]
SiO_2	91%	86.94%	85.5-95.5%
Al_2O_3	0.1%	0.2%	0.0-2.5%
Fe_2O_3	0.1%	0.1%	0.0-1.5%
CaO	0.4%	0.3-2.2%	0.0-1.0%
MgO	0.9%	0.2-0.6%	0.96%
K_2O	3.3%	2.15-2.30%	-
Na_2O	-	0.1-0.8%	0.0-1.0%
SO_3	-	-	0.42%
LOI	2%	3.15-4.4%	-

2. Initial & Final Setting time

Hossain et al. [16] concluded that Initial setting time was compared with controlled cement i.e. no RHA was added from there we come to know that addition of RHA increase the initial setting time of cement about 100% with addition of 15% of RHA. Increase of initial setting time gives more time of the concrete to properly mixed, compacted and finished. Thus RHA acts as a retarder in the cement paste. Reason behind this increase in initial setting time may be due to the chemical reaction of RHA with water. For final setting time it was seen that up to 6% of RHA, final setting time increases proportionately, beyond that final setting time increases at a very slow rate with RHA.

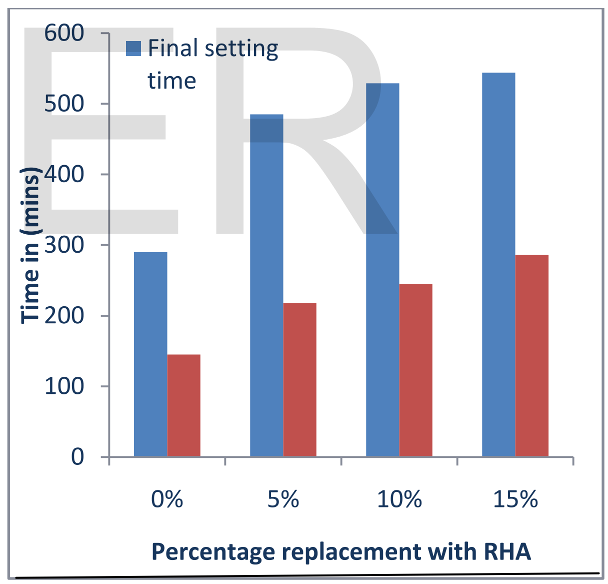

Fig 2.1: Results for Initial and Final setting time with RHA replacement [16]

The initial and final setting times increases with increase in rice husk ash content. The chemical analysis done on rice husk ash revealed that high amount of silica in RHA imparts workability to the concrete [17].

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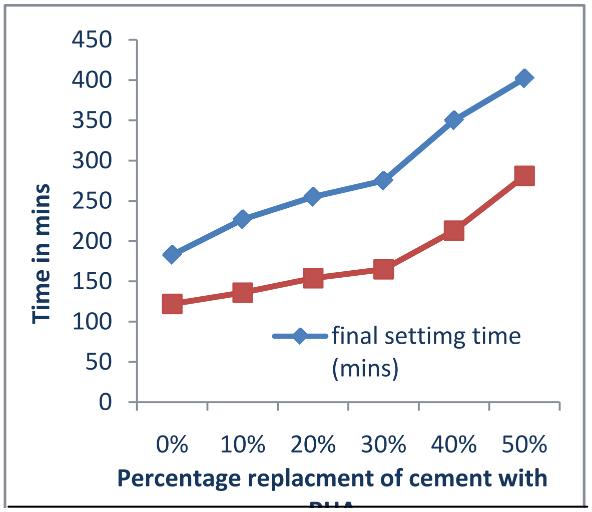

Fig 2.2: Initial and final setting time with replacement [17]

3 Properties of Hardened concrete

3.1 Compressive strength

Saraswathy & Wonsong [18] presented in his paper that the compressive strength increases with blending percentage and with age. Rice husk ash blended concretes showed higher compressive strength than control concretes beyond 5% replacement levels. Upto 20% replacement level of rice husk ash there was no decrease in compressive strength observed, when compared to conventional OPC concrete. Nehdi et al. [22] also found the same observation in compressive strength increment. Likewise Obilade [10] studied that compressive strength decreases as the percentage of blending increases at both 7 & 28 days, the optimum value achieved was at 5% RHA. Further research by Habeeb & Mahmud [19] stated that there was good enhancement in concrete 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. Similarly, Rao et al [20] investigated that at early ages there was reduction in compressive strength at all level of replacement but at later ages 5% replacement yielded optimum value and replacement of 10% RHA was comparable to control value.

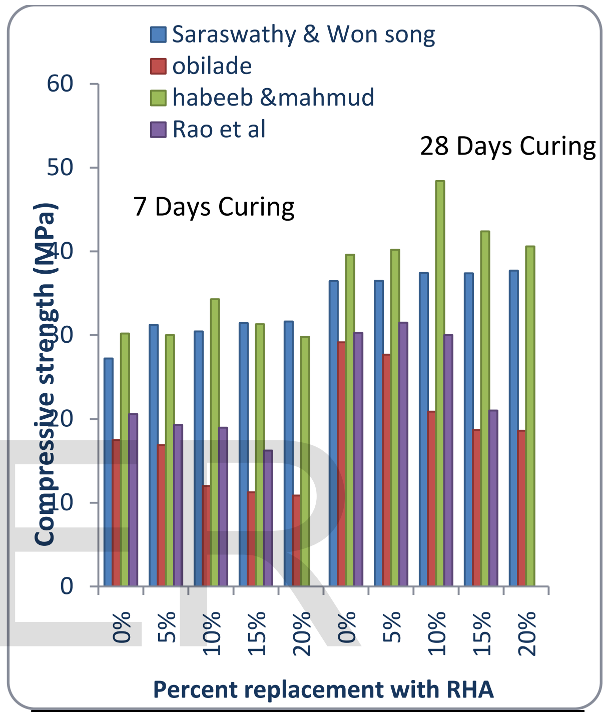

Fig 3.1: Comparison of Compressive strength at 7 & 28 days of different research

3.2 Splitting tensile strength

Sarawathy & wonsong [18] studied that 15% replacement of RHA gave optimum value and other replacement was comparable to control mix. Likewise Hossain et al [16] presented in his paper that gain in Split tensile strength was low in comparison to control value and the optimum value achieved was at 5% replacement of RHA.

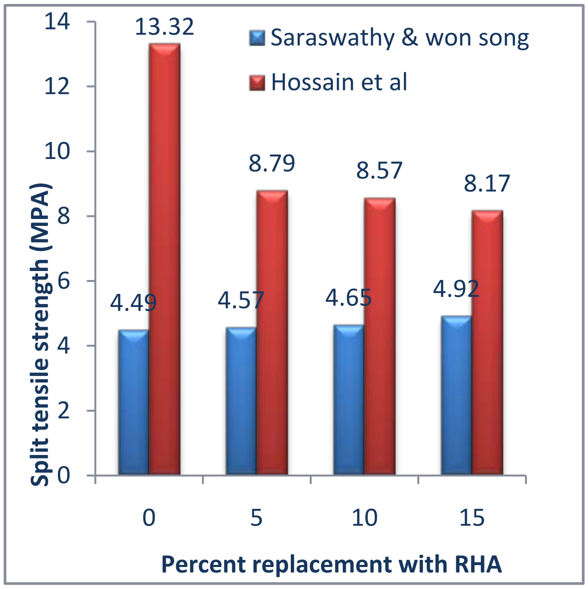

Fig 3.2: Split tensile strength of rice husk ash replaced concrete after 28 days of curing

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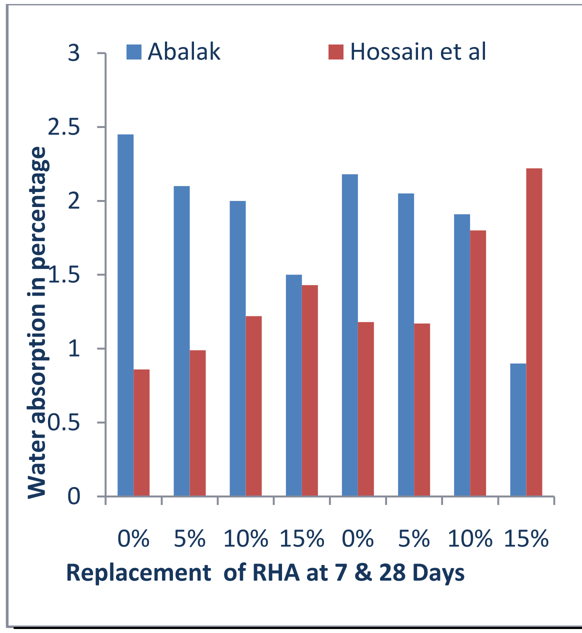

Fig 4.1: Water absorption at 7 & 28 days of curing

4 Durability

4.1 Water absorption

Percentage of water absorption is a measure of the pore volume or porosity in hardened concrete, which is occupied by water in saturated condition. According to Abalak [21] RHA blending with cement produced reduction in absorbed water up to 15% blending at all ages. Further research by Hossain et al [16] concluded that there was increment in absorbed water as the percentage of blending increases up to 15%.

4.2 Sorptivity

Sorptivity is a measure of the capillary forces exerted by the pore structure causing fluids to be drawn into the body of the material [23],[24].The results of sorptivity test in fig 4.2 show that specimens containing RHA had sorptivity values higher than control. The sorptivity of the specimens reduces at lower w/b ratio mixes and RHA content, but it increases as the percentage blending with RHA is enhanced. At 90 days curing, the permeability further reduced resulting in reductions in sorptivity recorded as compared to 28 days. From fig.4.2 it is also clear that at 28 days, as the RHA content increased, the permeability of the concrete increased above the control due to the hygroscopic nature of the RHA. Therefore it is concluded that Sorptivity decrease with age and with increase in percentage blending with RHA.

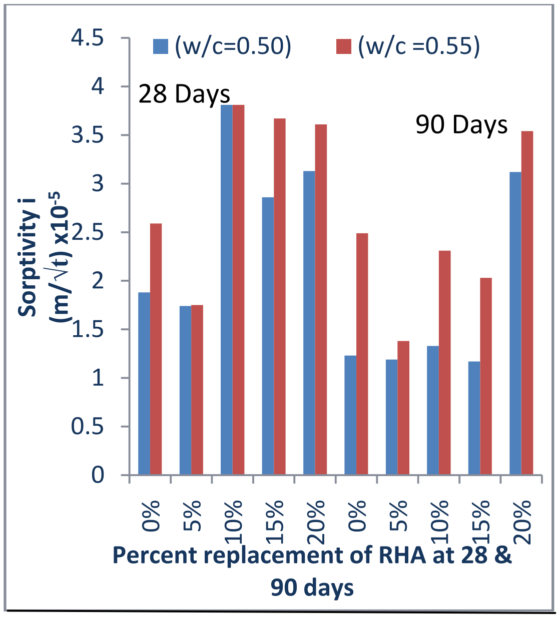

Fig 4.2: Sorpivity at 28 & 90 days of Curing.

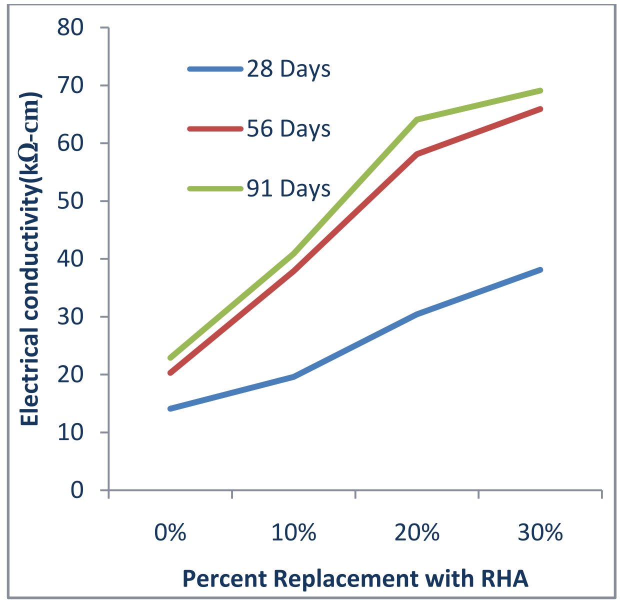

Fig 4.3: Electrical resistance of concrete at 28, 56 & 91 days of curing

4.3 Electrical resistance of concrete

Durability of concrete can also be measured by electrical resistivity of concrete. The conduction of ions of the hydration solution in the pores causes corrosion. With denser concrete and lower w/b ratio, the electrical resistance will increase. Lung et al. [25] studied that with increase in percentage blending with RHA up to 30% there is increase in electrical resistivity of concrete at (w/b) ratio 0.35 as shown in fig.4.3. This study, also suggest that the pozzolanic reaction due to the addition of RHA reduces the volume of capillary pores and enhances the impermeability of concrete. Moreover electrical resistance increases with concrete age through pozzolanic reaction of ground RHA. So, the pozzolanic reaction is not expected to be significant in early age and the electrical resistance is low.

Conclusion

Based on the review, it is quite clear that mineral admixture like Rice husk ash has proved to be the most promising blending material to provide a good quality concrete. The following generalized conclusions can be drawn on the properties of fresh, hardened and durability of concrete.

I. Rice husk ash is considered as a highly reactive pozzolanic material which provides an increased cohesiveness in concrete due to its high fineness modulus which consequently results into a high amount of water requirement to maintain the desired workability. However, the requirement of water may be offset by adding plasticizer.

II. The initial and final setting time of concrete with Rice husk ash (RHA) greatly depends on the particle size, specific surface area and replacement level.

III. The compressive strength of concrete increases with the increase in replacement level of Rice husk ash in a range of 5-10 % below which no significant change in compressive strength can be expected. Rather, a decreasing trend in compressive strength is anticipated if the replacement level is going beyond 15 %..

IV. The split tensile strength of concrete shows an increasing tendency up to a limit of 5 - 15 %. It can be said that the split tensile strength decreases with increasing w/c ratio followed by an increase in Rice husk ash replacement.

V. Interms of durability, water absorption and sorptivity increases as the blending percentage enhances upto 15%. Electrical resistance of concrete showed a increasing trend with age and with increment in percentage blending.

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