Effect of Fineness of Rice Husk Ash on Properties of Concrete

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Abstract- *:This paper presents an investigation of the effects of different particle sizes of Rice Husk Ash (RHA) on the physical properties of concrete which are workability and strength. However, the burnt RHA need to be ground before mixing it with other materials. This study is based on experimental programme. For laboratory tests, concrete mix proportions sample were introduced with RHA. There are five types of RHA particle sizes used; 25 microns, 40 microns, 53 microns, 63 microns and 75 microns. Concrete will be evaluated for compressive strength and workability. It is found that increase in the fineness decreases the workability but increases the strength of concrete. This research shows that RHA has the potential to be utilized as an alternative material to cement in concrete. It will also investigate that RHA particle size does effect the workability, compressive strength of concrete.*

Keywords-RHA, Ordinary Portland Cement, Workability, Compressive strength, RHA Particle Size

I. INTRODUCTION

Cement is a material with cohesive and adhesive properties when mixed with water, which makes it capable of bonding material fragments into a compact whole (Neville, 1996). Cements are classified as calcium silicate and calcium aluminate cement. Calcium silicate cement is further classified into Portland and Slag, while calcium aluminate is classified into High alumina and Pozzolona cement (Jackson and Dhir, 1991). Rice husk has recently been recognized as pozzolona.

High production cost of cement causes high cost in concrete construction industry. By applying supplementary cementitious material (SCM) concept, cement usage can be minimized or reduced while the strength and durability of the concrete can be improvised compared to the conventional concrete. In addition it reduces the concrete production cost as well as the negative impact on the environmental. So far, RHA has not been utilized yet in the construction industry. The reason for not utilizing this material may probably be due to lack of understanding on the effect of RHA on concrete characteristic. Many researchers have already published the characteristic of RHA concrete on strength and durability. However, only few researchers have been found to write on the effects of RHA particle sizes on these characteristics. Global production of rice is approximately 580 million tonnes a year and this is rising as the world population and the consumption of rice increases. Most of the rice husk is burned or dumped as waste. Hence, it is the time to look into the use of this local, sustainable and inexpensive waste material in replacing cement. This paper highlights outcomes from a study based on various laboratory tests.

Table 1. Chemical Composition of OPC and RHA

Chemical Composition(%)	OPC	RHA
SiO_2	15.05-20.09	92.00-96.70
Al_2O_3	2.56-4.76	0.21-1.01
Fe_2O_3	3.42-4.00	0.05-0.21
MgO	1.25-1.27	0.37-1.59
CaO	65.41-72.17	0.41-1.28
Na_2O	0.08-0.74	0.05-0.26
K_2O	0.35-0.41	0.91-2.31
SO_3	2.71-2.96	0.94-2.90
LOI	0.96-1.33	2.36-4.81

Reference: Sumrerng et al., Kartini et al., Habeeb et al., Tuan et al., Rukzon et al., and Abu Bakar et al.

II. MATERIALS AND METHODS

Sampling

The RHA used for this work was obtained from Guru Corporation, Prahladnagar, Ahmedabad-380015, Gujrat, India. There were 5 types of various RHA particle sizes were used viz., 25µm,40 µm,53 µm,63 µm,75 µm .The cement used for this work was Ordinary Portland Cement of 53 grade. The crushed sand having Sp. Gravity 2.66 and fineness modulus 2.5 were used as fine aggregate. Graded crushed stone aggregate with maximum nominal size of 20mm and down was used.

Chemical composition of OPC and RHA extracted from previous studies by Sumrerng et al., Kartini et al., Habeeb et al., Tuan et al., Rukzon et al., and Abu Bakar et al. is shown in Table 1 for reference.

Batching and mixing of materials

Batching of materials was done by weight.The percentage replacement of OPC by RHA were 20% constant for all the mixes with varying fineness of RHA. The 0% replacement was to serve as control for other samples.

Concrete Mix Design

The concrete used in this research work was M20 grade concrete made using Binder, Sand, Gravel. The concrete mix proportion was 1:1.74:3 by weight, Keeping target strength as 26.60 N/mm2.

Casting of Samples

Cubic specimens of concrete with size 150 X 150 X 150 mm were cast for determination of compressive strength of concrete. Five mixes were prepared for five different particle sizes of RHA with constant 20% replacement of OPC by RHA along with a mix with 0% OPC replacement. The concrete was mixed, placed and compacted in three layers. The samples were demoulded after 24 hrs and kept in a curing tank for 7 and 28 days.

Testing of Samples

The workability of concrete were determined by Slump Cone Test as per IS: 7320-1974. The compressive strength tests on the concrete cubes were carried out with the Compressive Testing Machine at Dept. of Civil Engg. DYPSOE, Pune. This is done in accordance with IS: 516-1959. The samples were weighted before being put in the compressive test machine. This machine automatically stops when failure occurs and then shows the applied load.

III. RESULTS AND DISCUSSIONS

Workability

Appropriate fineness of RHA is important for achieving the desired strength of concrete. Finer the RHA particle size, it results in increase of pozzolanic reactivity due to higher surface areaof RHA (G.A.Habeeb et al). The slump obtained was 118 – 105 mm for the RHA-OPC concrete as compared to conventional OPC concrete with 120 mm slump. For the same percentage of OPC replacement by RHA, decrease in RHA particle size decreases the concrete workability. There are two reasons for this; its absorptive characteristic and fineness of its size as referred by Habeeb and Fayyadh in (Zhang et al., 1996; Ganesan et al., 2008). Both of these features results in high water demand to wet the surface area ofRHA.

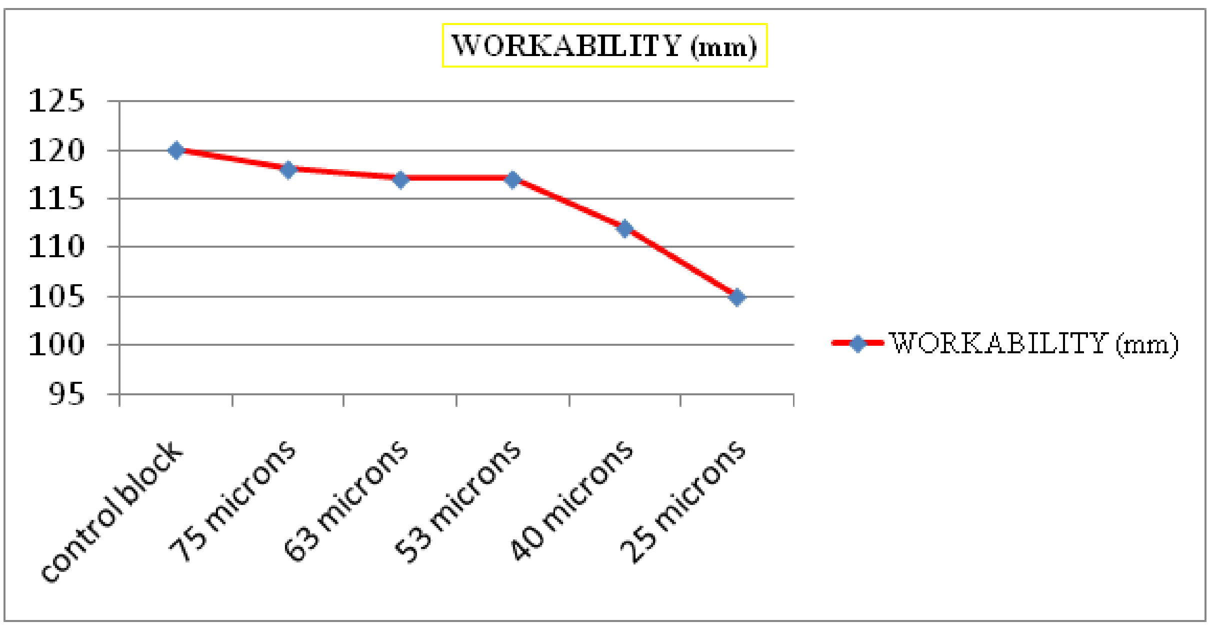

Figure 1: Effect of fineness of RHA on the workability of concrete

Compressive Strength

Compressive Strength of all the mixes is presented in table 2 and strength development graph profile is shown in figure 2. Two RHA-OPC concrete mixes(with 25 µm, 40 µm particle sizes) achieved the target strength of 26.60 N/mm2.

The RHA-OPC concrete with 53 µm particle size achieved almost the target compressive strength. The concrete mixes with 63 µm and 75 µm RHA particle sizes failed to achieve the target strength. From the results it is concluded that RHA-OPC concrete gains its initial strength slowly as compared to conventional OPC concrete. Furthermore RHA-OPC concrete gains its strength more rapidly than OPC concrete within 7 to 28 days.

In general compressive strength increases as fineness of RHA reduces. Since, RHA is a pozzolanic material, it contributes additional formation of Calcium Silicate gel that contributes to the strength development of concrete because the C-S-H gel has produced in larger amount (A.M. Neville). This gel fills the voids between cement matrix and causes the densification effect (A.M. Neville). As shown by Habeeb et al., the increase in fineness of RHA increases specific surface area. As a result, bigger quantity of C-S-H gel produced which increases the strength of concrete.The results shows that RHA-OPC concrete with particle sizes finer than 53 µm particle size can be used satisfactorily as an alternative for conventional OPC concrete.

Table 2: compressive strength

RHA fineness	7 days comp. strength (N/mm2)	28 days comp. strength (N/mm2)
control block	16.88	29.77
25 µm	15.25	31.7
40 µm	14.37	29.18
53 µm	11.85	26.07
63 µm	8.59	22.5
75 µm	7.11	20.29

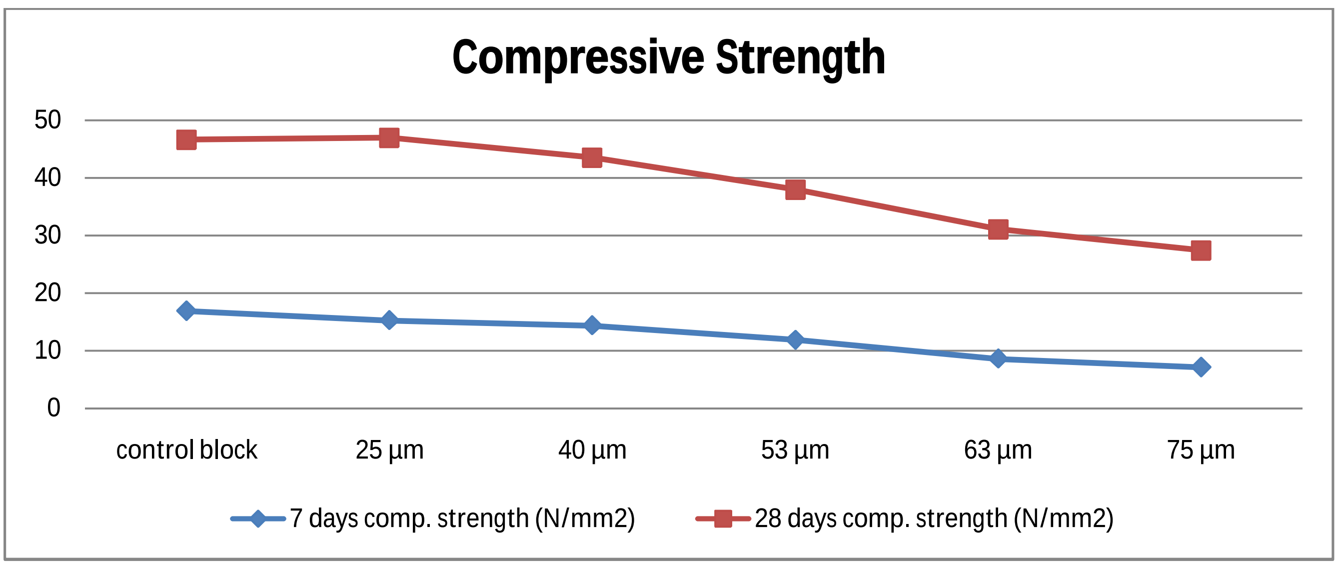

Figure 2: strength development graph profile

IV. CONCLUSION

For 20% replacement of OPC by finer RHA gives equivalent or even better compressive strength as compared to conventional concrete.

The rate of strength gain of RHA-OPC concrete is higher than conventional OPC concrete after 7 days age.

The OPC-RHA concrete with RHA particle sizes from 25 µm to 53 µm could be suitable for RCC work with 20% OPC replacement by RHA.

The OPC-RHA concrete with particle sizes from 53 µm upto 75 µm could be used for light load bearing work.

The workability of RHA-OPC concrete decreases as increase in fineness of RHA but it still remains within workable conditions for 20% replacement.

V. RECOMMENDATIONS

Durability studies of RHA-OPC concrete strength should be carried out.

Flexural behavior of RHA-OPC concrete should be studied out.

The effect of super plasticizers on the RHA-OPC concrete workability should be studied in order to increase the workability of concrete.

VI. REFERENCES

[1] "Influence of grinding of RHA to the workability and strength of concrete" Rahizuwan Hamid1, Norisham Ibrahim2 , Adiza Jamadin3 International Refereed Journal of Engineering and Science (IRJES) ISSN (Online) 2319-183X, (Print) 2319-1821 Volume 2, Issue 2(February 2013), PP.50-54.

[2] "Studies on the effect of RHA as cement admixtures " 1M.U Dabai, 1C. Muhammad, 1B.U. Bagudo and 2A.ISSN 0794-5698 Nigerian Journal of Basic and Applied Science (2009), 17(2)252-256.

[3] "Strength variation of OPC-RHA compsites with percentage RHA" Ettu L.O1, Ajoku C.A1, Nwachukwu K.C1, Awodiji C.T.G1, Eziefula U.G2. ISSN 2277 – 9442 Int. Journal of Applied Sciences and Engineering Research, Vol. 2, Issue 4, 2013

[4] "Effect of Rice Husk on compressive strength of concrete"Naveen*,SumitBansal** and Yogender Antil. ISSN No. (Print) : 0975-8364 International Journal on Emerging Technologies 6(1): 144-150(2015)

[5] "Review research paper on influence of RHA on properties of concrete "Nishant Kad & M.Vinod. e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015

[6] "Effect of RHA on the properties of concrete" Makarand Suresh Kulkarni1, Paresh GovindMirgal2, Prajyot Prakash Bodhale3, S.N. Tande4.Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 1; August, 2014 pp. 26-29

[7] "Use of RHA as Partial Replacement for cement in concrete"OBILADE, I.O. Sept. 2014. Vol. 5.No. 04 ISSN2305-8269 International Journal of Engineering and Applied Sciences © 2012 - 2014 EAAS & ARF.

[8] Satish D. Kene, Pravin V. Domke, Sandesh D. Deshmukh, R.S.Deotale/ International Journal ofEngineering Research and Applications (IJERA) ISSN: 2248-9622www.ijera.com Vol.1, Issue 3, pp.524-534

[9] S. D. Nagrale, Dr. HemantHajare, Pankaj R. Modak / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 4, July-August 2012, pp.001-005.

[10] I.S-456:2000

[11] Neville, A. M. 2008. Properties of Concrete, 4th ed. London, Pearson Education Ltd.

[12] Padney, S. P., Singh, A. K., Sharma, R. L., and Tiwari, A. K. 2003. Studies on high-performance blended/multiblended cements and their durability characteristics.Cement and Concrete Research, 33, pp.1433-1436.

[13] Rukzon, S., and Chindaprasirt, P. 2006. Strength of ternary blended cement mortar containing Portland cement, rice husk ash and fly ash. J. Eng. Inst. Thailand, 17, pp.547-551.

[14] Sakr, K. 2006. Effects of Silica Fume and Rice Husk Ash on the Properties of Heavy Weight Concrete.Journal of Materials in Civil Engineering, 18(3), pp.367-376.

[15] Wada, I., Kawano, T., and Mokotomaeda, N. 2000. Strength properties of concrete incorporating highly reactive rice-husk ash. Transaction of Japan Concrete Institute, 21 (1), pp.57–62.

[16] G.A. Habeeb, M.M. Fayyadh, Rice Husk Ash Concrete ,The effect of RHA average particle size on the mechanical properties and drying shrinkage, Australian Journal Of Basic And Applied Science, 3(3),2009,1616-1622.

[17] Sumrerng Rukzon And Prinya Chindaprasirt, Strength and carbonation model of rice husk ash cement mortar with different fineness, Journal Of Materials In Civil Engineering, March 2010, 253-259.