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REVIEW ARTICLE

A STUDY ON USE OF RICE HUSK ASH IN CONCRETE

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ABSTRACT

The rice husk is an agricultural waste which is obtained from milling process of paddy and approximately 22% of the weight of paddy is rice husk. The waste is used as fuel in producing stream in parboiling process. The 25 % the weight of husk is converted into ash which is known as rice husk ash (RHA) and is again a waste which is disposed. This ash consists of amorphous silica which can be used as pozzolana in making concrete and cement instead of disposing it without compromising on the properties of cement or concrete if replaced in specific proportion with other constituents of cement or concrete. In this study the ordinary Portland cement is replaced in different proportion with RHA to obtain concrete with comparable and satisfactory strength and properties to that of normal concrete. The proportions of replacement chosen are at 2.5% interval starting from 5 % to 15 % and the casted concrete were tested under compression at different ages and results obtained are compared with normal concrete of same grade and it is concluded that the results are comparable.

KEYWORDS

Rice Husk Ash, Cement, Concrete, Compressive strength, Split tensile strength, RHA

1. INTRODUCTION

The rice husk is produced in rice mill in the milling process of paddy and after the burning process of rice husk in boiler the RHA is obtained. The paddy grain is surrounded by the byproduct known as husk. In the milling process of paddy approximate 78% of weight is received as rice and 22% of weight is received as husk. The husk is use as fuel in the parboiling process for produce steam. In the firing process of rice husk, this husk has approximately 75% organic volatile substance and remaining 25% weight of husk is transformed into ash and this ash is known as rice husk ash (RHA). The RHA contains about 80-90% amorphous silica. In every 1000 kg of paddy, approximate 22% (220 kg) of husk is produced, and around 78% (780 kg) of rice is produce. In the milling process when this husk is burnt in the boiler approximate 25% (55 kg) of rice husk ash is produced [1-3].

India is a major rice producing country, and the husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion and / or by gasification. About 20 million tons of RHA is produced annually. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped. Lots of ways are being thought of for disposing it by making commercial use of this RHA. In the present investigation, Portland cement was replaced by rice husk ash at various percentages to study compressive and flexural strength [4,5].

2. MATERIAL USED

2.1 Cement

Cement used in the experimental work is ordinary Portland cement of 53 Grade conforming to IS: 12269-2013 of specific gravity 3.15 [6]. The physical properties of the cement obtained on conducting appropriate tests and the requirements as per IS: 12269-2013 is given in Table 1.

2.2 Rice Husk Ash

Rice Husk Ash used in the present experimental study was obtained from KRBL rice mill Ghaziabad, U.P. Specifications and Physical Properties and of this RHA are given in Table 2.

Table 1: Physical properties of procured OPC

Particulars	Test Results	Requirements of IS: 1489-1991
Specific Gravity	3.15	3.00-3.25
Fineness (m^2/kg)	369	300
Normal Consistency	32%	24-32%
Setting Time (Minutes):		
Initial	220	30
Final	320	600

Table 2: Physical properties of procured Rice Husk Ash

Physical State	**Solid – Non-Hazardous**
Appearance	Very fine powder
Particle Size	25 microns – mean
Color	Grey
Odour	Odourless
Specific Gravity	2.3

2.3 Aggregates

2.3.1 Fine Aggregate

Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms to zone III as per the specifications of IS 383: 1970.

(i) Specific gravity = 2.62
(ii) Fineness modulus = 2.58

2.3.2 Coarse Aggregate

Crushed granite of 20 mm maximum size has been used as coarse aggregate. The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates:

a) Specific gravity =2.64
b) Fineness Modulus = 6.816

2.3.2 Super Plasticizers

Super plasticizers are usually highly distinctive in their nature, and they make possible the production of concrete which, in its fresh or hardened state, is substantially different from concrete made using water-reducing admixtures [7].

Conplast SP430G8 is the name of the super plasticizing admixture manufactured by “FOSCROC Chemicals” used in this project. The main objectives of using this super plasticizer are to produce high workability concrete requiring little or no vibration during placing [8].

Complast SP430A2 is based on Sulphonated Naphthalene Polymers and is supplied as a brown liquid instantly dispersible in water. Conplast SP430A2 has been specially formulated to give high water reduction up to 25% without loss of workability or to produce high quality concrete of reduced permeability. The parameters considered for experiments were:

(i) Specific gravity: 1.265 – 1.280 at 270°C
(ii) Chloride content: Less than 0.05%
(iii) Air entrainment: Less than 1% over control

2.4 Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked in to very carefully. Mixing water should not contain undesirable organic substances or inorganic constituents in excessive proportion. Some specification also accept water for making concrete if the pH value of water lies between 6 and 8 and the water is free from organic matter. Carbonates and bi-carbonates of sodium and potassium effect the setting time of cement. While sodium carbonate may cause quick setting time, the bi- carbonates may either accelerate or retard the setting. The other higher concentration of these salts will materially reduce the concrete strength [9]. In this study clean potable water was obtained from Department of Civil Engineering, Vidya college of Engineering, Meerut for mixing and curing of concrete.

3. PRODUCTION OF RICE HUSK ASH

The RHA produce from the burning of husk in boiler at controlled temperature that fulfils the physical characteristics and chemical composition of mineral admixtures. The pozzolanic behavior of RHA depends upon the silica crystallization phase, silica content and size and surface area of ash. The amount of carbon content in RHA should be smallest. If the carbon contain is more in RHA the strength of concrete will be less.

4. BURNING PROCESS OF RICE HUSK

The rice husk is burn into ferrocement furnace or sometimes in boilers to produce RHA at controlled temperature. In furnace air ducts are provide which play two roles, one is supply air to husk in combustion process and other is act as passages for fire. Air ducts are controlling commotion temperature. Electric fans are attached to air ducts which control the combustion temperature. Air ducts also reduce the carbon content in RHA, if there are no air ducts the carbon content will be more in ash and the strength of concrete will be low. In the burning process of RHA the temperature of boiler or furnace is around 500-800°C for 24 hours. After the 24 hours the temperature is about 52°C. After the 48 hours the temperature of ash is about 25°C. At 500-800°C temperature the silica is remain in amorphous state.

4.1 Mixing Concrete

The concrete shall be mixed by hand or preferably in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moulding the desired number of test specimens.

4.2 Hand Mixing

The concrete batch shall be mixed on a water-tight, non-absorbent platform with a shovel, trowel or similar suitable implement, using the following procedure.

The cement and fine aggregate shall be mixed dry until the mixture is thoroughly blended and is uniform in color. The coarse aggregate shall then be added and mixed with the cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch, and the water shall then be added, and the entire batch mixed until the concrete appears to be homogenous and has the desired consistency. If repeated mixing is necessary, because of the addition of water in increments while adjusting the consistency, the batch shall be discarded, and a fresh batch made without interrupting the mixing to make trial consistency test.

5. MIX DESIGN

A trial mix has been designed for an assumed compaction factor of 0.80 as per IS 10262 - 1982 for M40 grade. The trial mix is obtained as 1:0.865:2.59 for water cement ratio of 0.40. The proportions for different ingredients of the mix without RHA are shown in Table 3 while ingredients of the mix with RHA (in different proportions) and superplastisizer (SP) are shown in Table 4.

Table 3: Mix proportions without RHA

Grade of concrete	Water (Kg)	Cement (Kg)	Fine aggregate (Kg)	Coarse aggregate (Kg)
In m^3	1.53	382.5	482.46	1394.06
M-40	0.40	1	1.261	3.64

Table 4: Mix proportions of Rice Husk Concrete

Amount of Rice husk (in %)	Cement (Kg/m^3)	RHA (Kg/m^3)	Water (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	SP (1% of cement weight)
0% RHA	382.5	0	153	482.46	1394.06	3.82
5% RHA	363.37	19.13	153	482.46	1394.06	3.63
7.5% RHA	353.81	28.68	153	482.46	1394.06	3.53
10% RHA	344.25	38.25	153	482.46	1394.06	3.44
12.5% RHA	334.68	47.81	153	482.46	1394.06	3.34
15% RHA	325.13	57.37	153	482.46	1394.06	3.25

6. RESULTS AND DISCUSSION

The cube compressive strength of M-40 mix results at the various ages such as 7 and 28 days and at the replacement levels such as 0%, 5%, 7.5%, 10%, 12.5% and 15% of rice husk ash are presented in Table 5. The variations of compressive strength at 7 and 28 days with different percentage of RHA were plotted in the form of graphs as shown in Table 6

The Split tensile strength results at the various ages such as 7and 28 days and at the replacement levels such as 0%, 5%, 7.5%, 10%, 12.5% and 15% of rice husk ash are presented in Table 7. The variations of split tensile strength at 7 and 28 days with different percentage of RHA were plotted in the form of graphs as shown in Table 8.

Table 5: Compressive strength of M-40 mix

Rice Husk Ash (in %)	7 days (Mpa)	28 days (Mpa)
0	27.8	41.70
5	26.6	39.90
7.5	28.3	42.45
10	27.3	40.95
12.5	26.2	39.30
15	25.9	38.85

Table 6: Bar graphs showing compressive strength of M-40 mix at different % levels of RHA

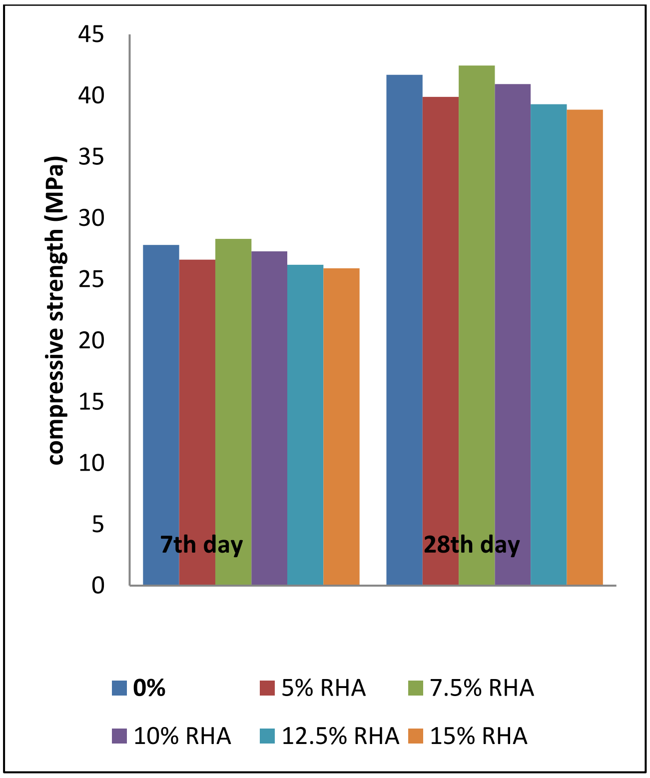
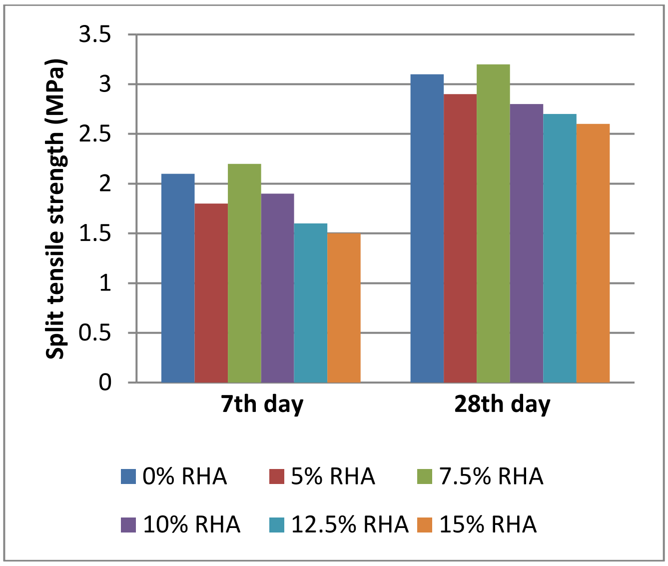


Table 7: Split tensile strength of cylinder

Rice Husk Ash (in %)	**7 days (Mpa)**	**28 days (Mpa)**
0	2.1	3.1
5	1.8	2.9
7.5	2.2	3.2
10	1.9	2.8
12.5	1.6	2.7
15	1.5	2.6

Table 8: Split tensile strength of cylinder



7. COST ANALYSIS FOR 1 m³ OF CONCRETE

The price for 1m³ concrete without RHA is INR 5555.07 and for 1 m³ concrete with RHA is INR 5309.67 hence total saving in 1 m³ concrete is INR 245.4 (4.417%). The price distribution for different ingredients of M-40 mix without RHA is shown below in Table 9 and that for with RHA is given in Table 10.

Table 9: (price details of M-40 mix for 1m³ concrete without RHA)

Ingredients	Cement	Fine aggregate	Coarse aggregate	SP (1% of cement weight)	Total Price
Quantity (in Kg)	382.5	482.46	1394.06	3.82	INR 5555.07
Price (in INR)	3213	562.87	1626.40	152.8	

Table 10: (price details of M-40 mix for 1m³ concrete with RHA

Ingredients	RHA (7.5%)	Cement (92.5%)	Fine aggregate	Coarse aggregate	SP (1.05% of cement weight)	Total Price
Quantity (in Kg)	28.69	353.81	482.46	1394.06	3.71	INR 5309.67
Price (in INR)	0	2972	562.87	1626.40	148.4	

8. CONCLUSIONS

The addition of RHA had a significant effect on the compressive strength of concrete. Compressive strength of concrete increases with the addition of RHA upto a certain level, after which it decreases. Optimum cement replacement level (by RHA) is 7.5%, for which the compressive strength and split tensile strength is maximum. In this study the replacement of cement by rice husk (RHA) about 7.5 %, the overall cost of the work is decreased by 4.417% for 1m^3 of M-40 concrete mix. It would be the great opportunity to make the concrete at low price and hence the reduction of cost of construction.

REFERENCES

[1] Jaturapitakkul, C., Roongreung, B. 2003. Cementing Material from Calcium Carbide Residue-Rice Husk Ash, Journal of Materials in Civil Engineering, 15(5).

[2] de Sensale, G.R. 2005. Strength development of concrete with rice-husk ash, Cement and Concrete Composites, 28(2),158-160.

[3] Nair, D.G., Jagadish, K.S., Fraaij, A. 2006. Reactive pozzolanas from rice husk ash: An alternative to cement for rural housing, Cement and Concrete Research, 36,1062-1071.

[4] de Sensale, G.R. 2010. Effect of rice-husk ash on durability of cementitious materials, Cement and Concrete Composites, 32(9),718-725.

[5] Ramasamy, V. 2012. Compressive Strength and Durability Properties of Rice Husk Ash Concrete, KSCE Journal of Civil Engineering, 16(1),93-102.

[6] Mousavi, S.Y. 2011. Mechanical properties and durability assessment of rice husk ash concrete, Biosystems Engineering, 110(2), 144-152.

[7] Zain, M.F.M., Islam, M.N., Mahmud, F., Jamil, M. 2011. Production of rice husk ash for use in concrete as a supplementary cementitious material, Construction and Building Materials, 25(2),98-805.

[8] Krishna, R.N. 2012. Rice husk ash - an ideal admixture for concrete in aggressive environments, 37thConference on Our World in Concrete & Structures: 29 - 31 August 2012, Singapore Article Online Id: 100037026.

[9] Bahri, S., Mahmud, H.B. Rice Husk Ash - An Alternative Material to Silica Fume for Production of 100 MPa Mortar, Electronic Journal of Structural Engineering, 13(1),31-35