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Utilization Of Rice Husk Ash

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ABSTRACT
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 tones of Rice Husk Ash (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 them by making commercial use of this RHA. RHA can be used as a replacement for concrete (15 to 25%).This paper evaluates how different contents of Rice Husk Ash added to concrete may influence its physical and mechanical properties. Sample Cubes were tested with different percentage of RHA and different w/c ratio, replacing in mass the cement. Properties like Compressive strength, Water absorption and Slump retention were evaluated.

Keywords: Rice Husk Ash, Concrete, Compressive strength, Water Absorption, Slump Retention.

INTRODUCTION
Rice milling generates a by product know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran .Rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA). This RHA in turn contains around 85 % - 90 % amorphous silica. So for every 1000 kgs of paddy milled, about 220 kgs (22 %) of husk is produced, and when this husk is burnt in the boilers, about 55 kgs (25 %) of RHA is generated. Pozzolanas are materials containing reactive silica and/or alumina which on their own have little or no binding property but, when mixed with lime in the presence of water, will set and harden like cement. Pozzolanas are an important ingredient in the production of alternative cementing materials to Portland cement (OPC). Alternative cements provide an excellent technical option to OPC at a much lower cost and have the potential to make a significant contribution towards the provision of low-cost building materials and consequently affordable shelter. Pozzolanas can be used in combination with lime and/or OPC. When mixed with lime, pozzolanas will greatly improve the properties of lime-based mortars, concretes and renders for use in a wide range of building applications. Alternatively, they can be blended with OPC to improve the durability of concrete and its workability, and considerably reduce its cost. A wide variety of siliceous or aluminous materials may be pozzolanic, including the ash from a number of agricultural and industrial wastes. Of the agricultural wastes, rice husk has been identified as having the greatest potential as it is widely available and, on burning, produces a relatively large proportion of ash, which contains around 90% silica. About one tonne of husk is produced from five tonnes of rice paddy and it has been estimated that some 120 million tonnes of husk could be available annually on a global basis for pozzolana production. As the ash content by weight is about 20%, there are potentially 24 million tonnes of RHA available as a pozzolana. Rice is grown in large quantities in many Third World countries including China, the Indian sub-continent, South-east Asia and, in smaller quantities, in some regions of Africa and South America. Traditionally, rice husk has been considered a waste material and has generally been disposed of by dumping or burning, although some has been used as a low-grade fuel. Nevertheless, RHA has been successfully used as a pozzolana in commercial production in a number of countries including Columbia, Thailand and India.

Chemical Composition of RHA

Fe_2O_3	0.54
K_2O	0.1 – 2.54
SiO_2	62.5 – 97.6
CaO	0.1 – 1.31
MgO	0.01 – 1.96
Na_2O	0.01- 1.58
P_2O_5	0.01 – 2.69

SiO3	0.1 – 1.23
Carbon	2.71 – 6.42

The average particle size and Specific gravity of RHA are 63.8 µm and 2.11 respectively.

Applications of RHA

- Aggregates and fillers for concrete and board production.
- economical substitute for micro silica / silica fumes
- absorbents for oils and chemicals
- soil ameliorants (An ameliorant is something that helps improve soil drainage, slows drainage, breaks up soil or binds soil, feeds and improves structure etc.)
- as a source of silicon
- as insulation powder in steel mills
- as repellents in the form of "vinegar-tar"
- as a release agent in the ceramics industry
- as an insulation material for homes and refrigerants

OBJECTIVE

To assess the feasibility of utilizing the rice husk ash for producing an economical concrete by studying the properties like Compressive Strength, Water Absorption and Slump Retention.

METHODOLOGY

• Combustion

To produce the best pozzolanas, the burning of the husk must be carefully controlled to keep the temperature below 700°C and to ensure that the creation of carbon is kept to a minimum by supplying an adequate quantity of air. At burning temperatures below 700°C an ash rich in amorphous silica is formed which is highly reactive. Temperatures above 700°C produce crystalline silica which is far less reactive. The presence of large quantities of carbon in the ash will adversely affect the strength of any concrete or mortar produced using RHA cements. Where possible, the carbon content of the ash should be limited to a maximum of 10%. There are several designs of small simple incinerators, normally made of fired clay bricks, which are capable of burning ash at temperatures below 700°C and without excessive quantities of carbon. The temperature is monitored by a pyrometer (an industrial instrument for measuring high temperatures) and rapid cooling is necessary if the temperature rises above 650°C. This is normally achieved by removing the ash and spreading it on the ground. Incinerators of this type are normally used in banks of three or four to produce approximately one tonne of ash per day.

Small incinerators have a number of advantages: they are simple and inexpensive to construct, easy to operate and will produce ash of an acceptable quality. On the other hand, their output is rather small. They also require constant supervision and, perhaps most importantly, they make no use of the energy value of the husk. Rice husk has an energy value about half that of coal and is therefore an important potential energy source. Although rice husk is still burnt as waste, this practice is likely to become less common, as other more traditional fuel sources become less readily available and/or more expensive. Recently attempts have been made to
design kilns or furnaces for husks which will utilize the potential energy value of the husk by making it available for useful work, and which control the temperature of combustion to below 700°C. The transportation of rice husk is not an economically viable option, even over quite short distances, due to its low bulk density and the fact that only 20% of its

weight can be utilized as a pozzolana. The location of incinerators or kilns has to be close to a rice mill with sufficient capacity to supply the quantity of husk required for cement production.

• Grinding

The second step in processing is grinding the RHA to a fine powder, and ball or hammer mills are usually used for this purpose. Crystalline ash is harder and will require more grinding in order to achieve the desired fineness. Fineness similar to or slightly greater than that of OPC is usually recommended for pozzolanas although some have been ground considerably finer. The minimum fineness recommended by the Indian Standards for pozzolana (1344) is 320 and 250m^2/kg for grade 1 and 2 pozzolanas respectively, measured by the Blaine air permeability test. Although this standard is for calcined clay, the fineness requirements are also suitable for RHA.

Mix Design for RHA Concrete Blocks

Mix	Gravel (kg)	Sand (kg)	Water (kg/m^3)	Cement (kg)	RHA (kg)	W/C
OC (0%RHA)	4.261 4.283 4.268	1.900 1.997 2.176	0.629 0.628 0.628	1.397 1.256 1.046	0 0 0	0.45 0.50 0.60
RC (15%RHA)	4.261 4.283 4.268	1.900 1.997 2.176	0.629 0.628 0.628	1.187 1.067 0.889	0.209 0.184 0.157	0.45 0.50 0.60

OC=Ordinary Concrete & RC=Rice Husk Ash Concrete

The fine aggregate used is natural sand conforming to Zone II & standard sand of Grade 2. The coarse aggregate used are of sizes 20 mm and 12.5mm. Cement used is of 43 grade. The mix proportion used is M20.

RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH

Sr. No.	w/c ratio	Description of Block	Days	Coding	Compressive Strength (N/mm^2)
1	0.45	O.C (0%RHA)	28	C1	27.5
2	0.45	O.C (0%RHA)	21	C2	26
3	0.45	O.C (0%RHA)	14	C3	24
4	0.45	O.C (0%RHA)	7	C4	20
5	0.5	O.C (0%RHA)	28	C13	26.5
6	0.5	O.C (0%RHA)	21	C14	21.78
7	0.5	O.C (0%RHA)	14	C15	16.79
8	0.5	O.C (0%RHA)	7	C16	11.76
9	0.6	O.C (0%RHA)	28	C25	25
10	0.6	O.C (0%RHA)	21	C26	20.1
11	0.6	O.C (0%RHA)	14	C27	14.86
12	0.6	O.C (0%RHA)	7	C28	5.55
13	0.45	RC (15%RHA)	28	C37	24.5
14	0.45	RC (15%RHA)	21	C38	23
15	0.45	RC (15%RHA)	14	C39	20.11
16	0.45	RC (15%RHA)	7	C40	7.42
17	0.5	RC (15%RHA)	28	C49	23.8
18	0.5	RC (15%RHA)	21	C50	22.5
19	0.5	RC (15%RHA)	14	C51	19.778
20	0.5	RC (15%RHA)	7	C52	7.26
21	0.6	RC (15%RHA)	28	C61	18.65
22	0.6	RC (15%RHA)	21	C62	14.05
23	0.6	RC (15%RHA)	14	C63	10
24	0.6	RC (15%RHA)	7	C64	7.18

WATER ABSORPTION

Sr. No.	w/c ratio	Description of Block	Days	Coding	Water Absorption (%)
1	0.45	O.C (0%RHA)	28	C5	0.90
2	0.45	O.C (0%RHA)	14	C6	1.02
3	0.45	O.C (0%RHA)	7	C7	1.30
4	0.5	O.C (0%RHA)	28	C17	0.86
5	0.5	O.C (0%RHA)	14	C18	0.90
6	0.5	O.C (0%RHA)	7	C19	1.05
7	0.6	O.C (0%RHA)	28	C29	0.57
8	0.6	O.C (0%RHA)	14	C30	0.90
9	0.6	O.C (0%RHA)	7	C31	1.01
10	0.45	RC (15%RHA)	28	C41	0.50
11	0.45	RC (15%RHA)	14	C42	0.86
12	0.45	RC (15%RHA)	7	C43	0.93
13	0.5	RC (15%RHA)	28	C53	0.49
14	0.5	RC (15%RHA)	14	C54	0.70
15	0.5	RC (15%RHA)	7	C55	0.89
16	0.6	RC (15%RHA)	28	C65	0.46
17	0.6	RC (15%RHA)	14	C66	0.66
18	0.6	RC (15%RHA)	7	C67	0.88

SLUMP TEST

Sr. No.	w/c ratio	Description of Block	Slump in mm
1	0.45	O.C (0%RHA)	40
2	0.5	O.C (0%RHA)	70
3	0.6	O.C (0%RHA)	130
4	0.45	RC (15%RHA)	0
5	0.5	RC (15%RHA)	0
6	0.6	RC (15%RHA)	0

It can be seen that Compressive Strength increases with increasing w/c ratio for different percentage of RHA in Concrete. Water Absorption tests reveal that higher substitution amounts results in lower water absorption values which is due to RHA being finer than cement. The Concrete Slump values decreases with the addition of RHA. This means that a less workable (stiff) mix is obtained when RHA is used as a cement blender. More water is therefore required to make a workable mix. The increased fines in the concrete due to excess RHA is partly responsible for this increased demand of water. This is clearly visible from the slump values for different w/c ratio.

COST ANALYSIS

The quantity of coarse & fine aggregates are same for all the replacement percentages while the proportions of cement & RHA vary, therefore, only cement & RHA have been considered for the cost analysis.

Sr. No.	RHA Replacement	W/C ratio	Ingredient	Quantity (kg)	Rates (Rs./bag)	Cost (Rs.)
1	0 %	0.45	Cement	1.397	230 /50 kg	6.43
			Total	1.397	-	6.43
2		0.50	Cement	1.256	230 /50 kg	5.78
			Total	1.256	-	5.78
3		0.60	Cement	1.046	230 /50 kg	4.81
			Total	1.046	-	4.81

Sr. No.	RHA Replacement	W/C ratio	Ingredient	Quantity (kg)	Rates (Rs./bag)	Cost (Rs.)
1	15 %	0.45	Cement	1.187	230 /50 kg	5.46
			RHA	0.209	2 /kg	0.42
			Total	1.397	-	5.88
2		0.50	Cement	1.067	230 /50 kg	4.91
			RHA	0.184	2 /kg	0.37
			Total	1.256	-	5.28
3		0.60	Cement	0.889	230 /50 kg	4.09
			RHA	0.157	2 /kg	0.31
			Total	1.046	-	4.4

Sr. No.	RHA Replacement	W/C ratio	Cost without RHA (Rs.)	Cost with RHA (Rs.)	Saving (Rs.)	% Saving
1	15 %	0.45	6.43	5.88	0.55	8.55 %
		0.5	5.78	5.28	0.50	8.65 %
		0.6	4.81	4.4	0.41	8.52 %

CONCLUSION

With the addition of RHA weight density of concrete reduces by 72-75%.Thus, RHA concrete can be effectively used as light weight concrete for the construction of structures where the weight of structure is of supreme importance. The cost of 1 m^3 of OPC concrete works out to Rs. 1157 while that of RHA concrete works out to Rs. 959. Thus, the use of RHA in concrete leads to around 8-12% saving in material cost. So, the addition of RHA in concrete helps in making an economical concrete. The Compressive Strength will increase with the addition of RHA.The use of RHA considerably reduces the water absorption of concrete. Thus, concrete containing RHA can be effectively used in places where the concrete can come in contact with water or moisture. RHA has the potential to act as an admixture, which increases the strength, workability & pozzolanic properties of concrete.

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