A Study on Use of Rice Husk Ash in Concrete

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ABSTRACT

Cement and fine aggregates are the major materials used in construction. Increase in the demand for these materials lead to the skyrocketing price of the construction. Due to this, the lower- and middle-income families are not able to build their own houses. There were studies about the research institutions are looking for alternatives can be used for construction to reduce the construction cost. In this regard an attempt has made to know the utilization of waste materials. In this project, Rice Husk Ash and Waste Foundry Sand were used in concrete for the replacement of cement and fine aggregate respectively. The most expensive concrete material is the binder (cement) and if such all-important expensive material is partially replaced with more natural, local and affordable material like RHA will not only take care of waste management but will also reduce the problem of high cost of concrete and housing. In this project, Rice Husk Ash which is taken from a brick kiln was used after grinding in a ball mill. Rice husk ash contains 90-95% SiO_2, 1-3% K_2O and < 5% un burnt carbon. Foundry sand is high quality silica sand with uniform physical characteristics. It is a By-product of ferrous and nonferrous steel industries, where sand has been used as a molding material. After the multiple usages the foundry sand it is used as land filling material. This experimental investigation was performed to evaluate the strength properties of concrete in which cement and fine aggregates were partially replaced with Rice Husk Ash and Waste Foundry Sand. Compression test, Split Tensile test, Flexural strength test and workability tests were conducted at the age of 28,56 and 90 days by replacement of river sand with different percentages (0%,10%,20%,30%,40%,50%and 60%) and also with 10% incorporating with rice husk ash. Compressive strength test was carried out on cement mortar cubes to know the optimum percentage of rice husk ash. The results indicate effective use of rice husk ash and waste foundry sand as partial replacement of cement and fine aggregate. However, the percentage of rice husk ash is limited to 10% and waste foundry sand is up to 40%. After these limitations the strength started decreasing. And also, the concrete incorporating with rice husk ash showed better workability than plain concrete with inclusion of waste foundry sand.

Keywords: Rice Husk Ash, Waste Foundry Sand, Compressive Strength, Split Tensile Strength, Flexure Strength

I. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. All the materials required producing such huge quantities of concrete come from the earth's crust. Thus, it depletes its resources every year creating ecological strains. On the other hand, human activities on the Earth produce solid waste in considerable quantities of over 2500/MT per year, including industrial wastes, agricultural wastes and wastes from rural and urban societies. Recent technological development has shown that these materials are valuable as inorganic and organic resources and can produce various useful products. Amongst the solid wastes, the most prominent ones are fly ash, blast furnace slag, rice husk, silica fume and demolished construction materials. From the middle of 20th century, there had been an increase in the consumption of mineral admixtures by the cement and concrete industries. The increasing demand for cement and concrete is met by partial cement replacement.

Substantial energy and cost savings can result when industrial by-products are used as a partial replacement for the energy intense Portland cement. The use of by-products is an environmentally friendly method of disposal of large quantities of materials that would otherwise pollute land, water and air. Most of the increase in cement demand will be met by the use of supplementary cementing materials. Rice milling generates a by-product known as husk. This surrounds the paddy grain. During the milling of paddy about 78 % of weight is received as rice, broken rice and bran. The 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 which burns up and the balance 25 % of the weight of this husk is converted into ash during the firing process, which is known as rice husk ash (RHA). Rice husk was burnt approximately 48 hours under uncontrolled combustion process. The burning temperature was within the range of 600 to 850 degrees. The ash obtained was ground in a ball mill for 30 minutes and its color was seen as grey. This RHA in turn contains around 85%-90% amorphous silica. So for every 1000 kg of paddy milled, about 220 kg (22%) of husk is produced, and when this husk is burnt in the boilers, about 55 kg (25%) of RHA is generated. 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 RHAis 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.

II. EXPERIMENTAL MATERIALS

The materials used in this experimental study were cement, fine aggregate, coarse aggregate, water, waste foundry sand, Rice Husk Ash and super plasticizer.

a) Cement

Ordinary Portland cement (Ultra tech cement) of 53 grades confirming to IS: 12269-1987was used. It was tested for its physical properties as per IS 4031 (part II)-1988.

b) Aggregate

The size, shape and gradation of the aggregate play an important role in achieving a proper concrete. The flaky and elongated particles will lead to blocking problems in confined zones. The sizes of aggregates will depend upon the size of rebar spacing. The coarse aggregate chosen for Concrete was typically angular in shape, well graded, and smaller than maximum size suited for conventional concrete; typical conventional concrete should have a maximum aggregate size of 20mm. Gradation is an important factor in choosing a coarse aggregate. Gap-graded coarse aggregate promotes segregation to a greater degree than the well graded coarse aggregate.

b.1) Fine Aggregate

The locally available river sand was used as fine aggregate in the present investigation. The sand was free from clayey matter, salt and organic impurities. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963. The fine aggregate was conforming to standard specifications.

b.2) Coarse Aggregate

Machine crushed angular granite metal of 20mm nominal size from the local source was used as coarse aggregate. It was free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with IS 2386 -1963. 3

b.3) Waste Foundry Sand

Waste foundry sand was obtained locally from Agarwal Rolling Mills, Shamshabad, and Hyderabad. WFS were used as a partial replacement of fine aggregate (natural river sand). Metal poured in the foundry is gray iron. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963. The details of test results are given in below table

c) Water

Locally available water used for mixing and curing which is potable and is free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

d) Rice Husk Ash

Rice Husk Ash is brought from bricks making area at Nandyal near SVR Engineering College used in the present program.

e) Super Plasticizer

Super plasticizer by trade name Complots SP 430 manufactured by Fosroc Chemicals (India) limited obtained from S.V Enterprises, Habsiguda, Hyderabad was used as a water reducing agent to achieve the required workability. The dosage of super plasticizer was kept constant throughout the experimental program at 0.5% of the weight of the binder.

III. EXPERIMENTAL RESULTS

a) Compressive Strength Test

Table 1 Compressive Strength of Various Concrete Mixes with Replacement of Fine Aggregate over Waste Foundry Sand

S.No.	Mix ID	Compressive Strength (MPa		
		28 days	56 days	90 days
1	WFS0	32.6	42.4	52.07
2	WFS10	33.09	43.4	52.27
3	WFS20	33.32	43.8	53.15
4	WFS30	33.65	44	53.71
5	WFS40	34.22	44.5	54.74
6	WFS50	34.12	44.2	51.18
7	WFS60	32.03	42.1	46.43

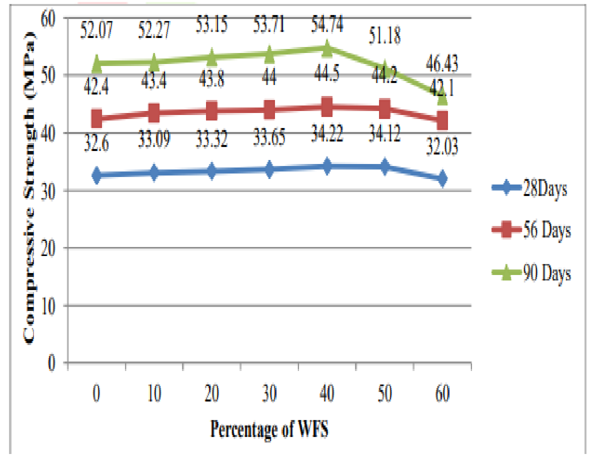

Figure 1: Compressive Strength of Various Concrete Mixes with Replacement of Fine Aggregate over Waste Foundry Sand at Different Ages

Table 2. Compressive Strength of Various Concrete Mixes with Different Percentage of rice husk ash at Different Ages

S.No.	Mix ID	Compressive Strength (MPa		
		28 days	56 days	90 days
1	RHA0	28.25	35.10	44.66
2	RHA5	30.56	37.10	45.10
3	RHA10	33.55	38.43	48.22
4	RHA15	31.5	37.32	47.47

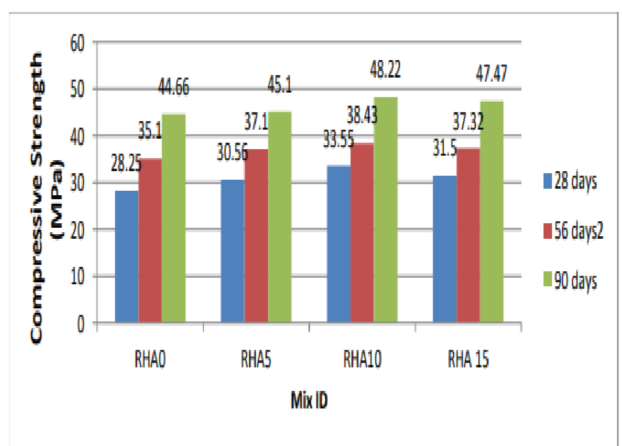

Figure 2: Compressive Strength of Various Concrete Mixes with Different Percentage of rice husk ashat Different Ages

b) Flexural Strength

It is seen that strength of concrete in compression and tension (both tension and flexural tension) are closely related, but the relationship is not of the type of direct proportionality. The ratio of the two strengths depends on general level of strength of concrete. In other words, for higher compressive strength, concrete shows higher tensile strength, but the rate of increase of tensile strength is of decreasing order. The use of pozzolanic material increases the tensile strength of concrete.

Table 3: Flexural strength of Control concrete in N/mm2

Curing Period	3 Days	7 Days	28 Days	56 Days
M20	1.01	1.17	4.21	4.95

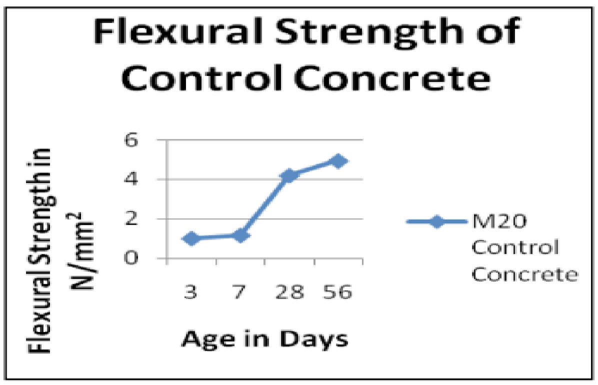

Figure 3 Flexural strength of Control concrete

Table 4: Flexural strength of Control and Rice Husk ash concrete in N/mm^2

Curing Period	3 days	7 days	28 days	56 days
0%	1.01	1.17	4.21	4.95
5%	1.22	1.36	3.62	4.21
7.5%	1.44	1.62	3.84	4.62
10%	1.34	1.41	2.75	3.29
12.5%	1.22	1.44	2.24	2.76
15%	1.04	1.25	2.08	2.35

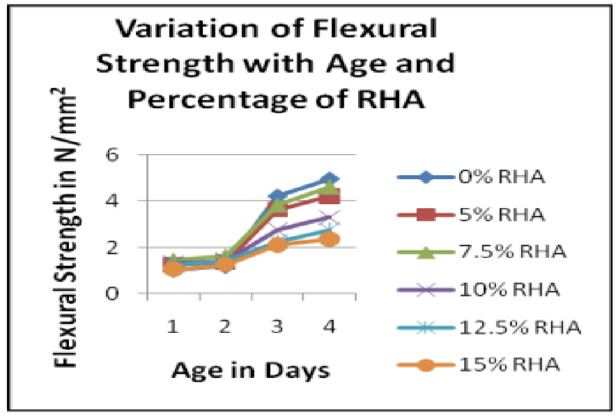

Figure 4 Flexural strength of RHA

Rice Husk Ash (RHA) Concrete: Variation of flexural strength with respect to age and percentage of RHA and effect of RHA percentage on Flexural strength of M20 grade concrete is depicted in the figures. The rate of development of flexural strength is higher at 7 days to 28 days. At the later age between 28 days to 56 days only a marginal increase is observed. At 28 days, there is very less variation in flexural strength of RHA concrete at the replacement levels, where as there is a comparative increase in flexural strengths of RHA concrete at higher curing period.

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IV. CONCLUSION

Based on the limited study carried out on the strength behavior of Rice Husk ash, the following conclusions are drawn: At all the cement replacement levels of Rice husk ash; there is gradual increase in compressive strength from 3 days to 7 days. However, there is significant increase in compressive strength from 7 days to 28 days followed by gradual increase from 28 days to 56 days. At the initial ages, with the increase in the percentage replacement of both Rice husk ash, the flexural strength of Rice husk ash concrete is found to be decrease gradually till 7.5% replacement. However, as the age advances, there is a significant decrease in the flexural strength of Rice Husk ash concrete. By using this Rice husk ash in concrete as replacement the emission of greenhouse gases can be decreased to a greater extent. As a result, there is greater possibility to gain more number of carbon credits. The technical and economic advantages of incorporating Rice Husk Ash in concrete should be exploited by the construction and rice industries, more so for the rice growing nations of Asia.

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