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Study on Strength Characteristics of High Strength Rice Husk Ash Concrete

RAVANDE KISHORE[1a], V.BHIKSHMA[2] AND P.JEEVANA PRAKASH[3]

[1]Department of Civil Engineering, University College of Engineering OsmaniaUniversity Hyderabad, India
[2]Department of Civil Engineering, University College of Engineering OsmaniaUniversity Hyderabad, India
[3]Department of Civil Engineering, University College of Engineering OsmaniaUniversity Hyderabad, India

Abstract

The objective of the study is to investigate the mechanical properties of high strength concrete with different replacement levels of ordinary Portland cement by Rice Husk Ash. The standard cubes (150mmX150mmX150mm), cylinders (150mmdiaX300mm height) and prisms (100mmX100mmX500mm) were caste. In all 144 specimens with M40 and M50 grade mix cases were caste and tested. The strength effect of High-strength concrete of various amounts of replacement of cement viz., 0%, 5%, 10%, 15% with Rice Husk Ash of both the grades were compared with that of the high-strength concrete with out Rice Husk Ash. The compressive strength at 7, 28 and 56 days have been obtained. The results of the mechanical properties of the rice husk ash at 28 days have shown quite encouraging and interesting results. The optimum replacement of rice husk ash found to be 10% in both the grades of the concrete.

Keywords: Strength Characteristics; Replacement levels; High Strength Concrete and Rice Husk Ash.

1. INTRODUCTION

Rice Husk is one of the waste materials in the rice growing regions. This not only makes the purposeful utilization of agricultural waste but it will also reduce the consumption of energy used in the production of cement. Therefore Rice Husk is an agro based product which can be used as a substitute of cement without sacrificing the strength and durability.

Generally the Rice Husk Ash is used while burning the raw clay bricks in the Brick Kilns. Till recently it is also used in Hotels for cooking but now it is replaced by LPG Gas. Since Rice Husk has negligible protein content, it is not useful for animal feeding. Rice Husk Ash is obtained from burning of Rice Husk, which is the by-product of rice milling. It is estimated that 1,000 kg of rice grain produce 200 kg of Rice Husk; after Rice Husk is burnt, about 20 percent of the Rice Husk or 40 kg would become RHA. Rice Husk Ash contains as much as 80-85% silica which is highly reactive, depending upon the temperature of

[a] Corresponding author & presenter: v.bhikshma@yahoo.co.in

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incineration. Due to relative high water demand, the lime Rice Husk Ash cement developed lower compressive strengths.

However, the strength characteristics are considered adequate for general masonry work.Portland Rice Husk Ash cements containing upto 50% Ash by weight showed compressive strengths which were considerably higher than the control Portland cements even at early ages of 3 and 7 days. The cements containing Rice Husk Ash possess excellent resistance to dilute organic and mineral acids.The water demand for normal consistency tends to increase with increasing Ash content of the blended cements. However, this can be corrected by application of certain water reducing admixtures.The investigations as outlined above point towards encouraging trend. Normally fly Ash may be used for partially replacing cement to the extent of about 25% of cement. Reactions that take place in the preparation of Rice Husk Ash concrete are; Silicon burnt in the presence of Oxygen gives Silica.

$$Si + O_2 \text{--------}\rightarrow SiO_2$$

$$C_3S\ (Cement) + H_2O \text{-----------}\rightarrow CSH + Ca\ (OH)_2$$

The highly reactive silica reacts with Calcium hydroxide released during the hydration of cement, resulting in the formation of Calcium Silicates responsible for strength.

$$SiO_2 + Ca\ (OH)_2 \text{-----}\rightarrow CSH + SiO_2$$

Rice Husk Ash when mixed with Ordinary Portland Cement even upto 70%, replacement gives high compressive strength as early as at 3 days.

Mehta, P.K., (1) has conducted investigations on Portland Rice Husk Ash cements up to 50% of Ash showed higher compressive strength than the control Portland cement even at as early as 3 days. **Mehta, P.K.,** and **D.Pirtz** (2) in a concrete mixture, when 30% Rice Husk Ash by weight of the total cementing material was present, the 7 days and the 28 days compressive strengths were higher and the adiabatic temperature rise was 1.80^0 F lower than the control concrete. S.**James,J. and Subba Rao, M.,** (3) studied the reaction product of lime and silicate from Rice Husk Ash and showed that it is Calcium Silicate Hydrate (C-S-H) which accounts for the strength of lime Rice Husk Ash cements. **Rahman, M.N.,** (4) found no reduction in strength up to 40% replacement by Rice Husk Ash in the manufacture of sandcrete blocks.**M.V.Seshagiri Rao** (5) He obtained the fineness of ash ranging from 10000 to 20000 Sq.cm/gm, where he found that at 16000 Sq. cm/gm fineness and even at 40% replacement of RHA not much difference in the strengths were observed.

2. OBJECTIVE THE WORK

The objective of this experimental work is to determine the strength characteristics of high strength Rice Husk Ash concrete of grades M40 and M50 with a partial replacement of cement by Rice Husk Ash 0%, 5%, 10% and 15% concrete.

3. EXPERIMENTAL PROGRAMME

The experimental program was designed to determine the mechanical properties i.e, compressive strength, flexural strength and splitting tensile strength and stress-strain curves of high strength concrete with M40 and M50 grade of concrete and with different replacement levels of ordinary Portland cement (ultra tech cement 53 grade) with replacement of Rice Husk Ash. The program consists of casting and testing of total of 144 specimens. Universal testing machine of 200 tones was used to test all the specimens. In first series the specimens were cast with M40 and M 50 grade concrete with different replacement levels of cement as 0%, 5%, 10% and 15%.

3.1 Properties

Specific gravity of the cement obtained was 3.15. Specific gravity and fineness modulus of fine aggregate were found to be 2.53 and 2.73 respectively.Crushed granite stone chips (angular) of maximum size 20mm were used. Specific gravity and fineness modulus for coarse aggregate were found to be 2.60 and 7.61 respectively. Conplast SP-430 (200ml per 50kg) was used for the experimental work. The mixing process of the fresh state concrete is presented in plate 1.physical properties of cement; rice husk ash, constituent materials, and slump and compaction facters are presented in Tables 1-4.

3.2 Testing Programme

3.2.1 Compressive Strength

The cube specimen was placed in the machine, of 2000kN capacity. The load was applied at a rate of approximately 140 kg/sq.cm/min until the resistance of the specimen to the increasing load can be sustained, was shown in Plate 1. Results are presented in Tables 5 and 6.

3.2.2 Splitting Tensile Strength

The cylinder specimen was placed horizontally in the centering with packing skip (wooden strip)/or loading pieces carefully positioned along the top and bottom of the plane of loading of the specimen. The load was applied without shock and increased continuously at a nominal rate with in the range 1.2 N/mm^2/min to 2.4 N/mm^2/min until failure the specimen. The maximum load applied was recorded at failure. Appearance of concrete and unused features in the type of failure was also observed are shown in Plate 2.The test results are presented in Table 7.

3.2.3 Flexural Strength

The specimen was placed in the machine in such a manner that the load was applied to the uppermost surface as cast in the mould, along two lines spaced 13.33cm apart. The axis of the specimen was carefully aligned with the axis of the loading device. The load was applied through two similar steel rollers, 38mm in diameter, mounted at the third points of the supporting span that is spaced at 13.33cm center to centre. The load was applied with out shock and increasing continuously at a rate of 180 kg/min until the specimen filed. Test results are presented in Table 8.The failure pattern has been presented in plate 3 and 4.

3.2.4 Stress-Strain Curves

Stress-strain curve of concrete in compression determined by means of testing conforming to IS:516-1959.Three test specimens were removed from the water tank at the end of 28th day, and allowed wiping off the surface water and grit. The test cylinder was fixed with the frame having dial gauges, which are fixed with the frame in opposite directions. These arrangements are presented in Plate 5and results in Table 9.

4. DISCUSSIONS ON TEST RESULTS

4.1 Compressive Strength of Concrete

For M40 grade concrete at 15% replacement, the percentage increase in strength for 7 days to 28 days observed as 42%. At 90 days, the maximum compressive strength of M40 grade mix cubes with 15%

replacement was 45.04MPa. At 90 days the maximum compressive strength of M50 grade mix cubes with 15% replacement was 52.50MPa which was 16% lesser than that of the strength compared to the maximum strength of M50 grade mix cubes with 0% replacement.

4.2 Splitting tensile Strength of Concrete

As the replacement level increases there is decrease in splitting tensile strength at 28 days age of curing for both M40 and M50 grades of concrete by 5 to 10%. The splitting tensile strength for both M40 and M50 grade of concrete was 3.98MPa and 4.19MPa respectively. It shows that the splitting tensile strength at 15% replacement decreased by 5.1% and 9.1% respectively for M40 and M50 grade of concrete, when compared with that of the conventional concrete.

4.3 Flexural Strength and Modulus of Elasticity of Concrete

It is observed that for both grade of concretes the flexural strengths were decreased at 15% replacement of rice husk ash with cement, but obtained target strength at 10% replacement. The modulus of elasticity obtained is satisfied with the target strength values for all replacements.

5. CONCLUSIONS

1. As the replacement of cement by RHA in concrete increases, the workability of concrete decreases by 27% slump and 9% compaction factor.
2. Replacement of cement with Rice Husk Ash leads to decrease in the compressive strength improved the workability and achieved the target strength at 10% replacement for both the grades of concrete.
3. The rate of increase with age of concrete was good for the replacement levels and was on par with the conventional cases at early ages.
4. The optimum replacement level of Rice Husk Ash is found to be to10% for both M40 and M50 grades of concrete.

REFERENCE

[1] P.K.Mehta, “Properties of Blended Cements Made from Rice Husk Ash”, ACI Journal/September 1977 pp. 440-442.
[2] P.K.Mehta and D.Pritz, “Use of Rice Husk Ash to Reduce Temp in HSC”, Journal/February 1978 pp. 60-63.
[3] James, J., Subba rao .M., “Reactive of Rice Husk Ash”, Cement and Concrete Research, Vol.16, 1986.
[4] Rahman M.N., “Curing of RHA Mix sand concrete blocks”, International Journal of Structures, Vol. 8, No.1, 1988.
[5] Seshagiri Rao M.V., Chankravarthi R.K., Narasimha Murthy, “Rice Husk Ash Blend Cement” National Seminar on “Recent Advances in Civil Engg. With Special. Reference to Building Industry”, JNTU College of Engg. & Tech., Hyderabad1992

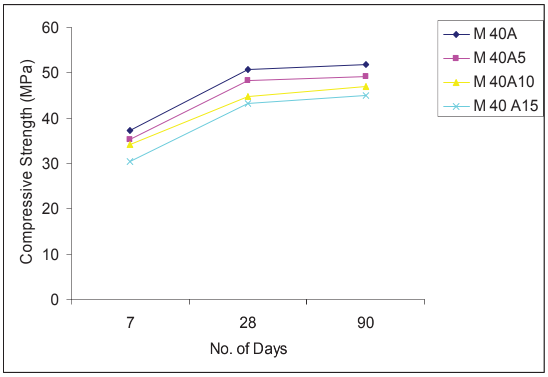

Figure 1: Variation of Compressive Strength of M40 Grade Concrete

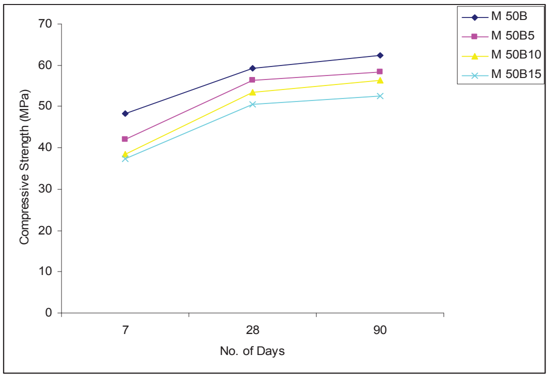

Figure 2: Variation of Compressive Strength of M50 Grade Concrete

Figure 3: Plate 1 Test for Compressive Strength

Figure 4: Plate 2 Test for Splitting Tensile Strength

Plate 3 Test for Flexural Strength of Concrete

Plate 4 Cracking Pattern of Prism Specimen

Plate 5 Test for Stress-Strain Curve of Concrete

Table 1 Physical Properties of Cement and Rice Husk Ash

Designation	Specific gravity	Fineness (Brains) m^2/kg
Cement	3.15	290
Rice Husk Ash	2.27	-

Table 2 Chemical Properties of Cement

Characteristics	Result (% by mass)
Loss on ignition	1.95
Silica as (SiO_2)	23.50
Alumina as ($A1_2O_3$)	4.42
Iron as (Fe_2O_3)	11.38
Calcium as (C_aO)	58.51

Table 3 Constituent Materials of M40 and M50 Grade Concrete

Grade of mix	w/c ratio	Proportions of constituent materials		
		C	F.A	C.A
M 40	0.36	1	0.83	2.53
M 50	0.35	1	0.78	2.36

Table 4 Slump and Compaction factor values of M40 and M50 grades concrete

Rice Husk Ash %	M40		M50	
	Slump (mm)	Compaction Factor	Slump (mm)	Compaction Factor
0	40	0.87	35	0.87
5	37	0.86	32	0.83
10	35	0.82	29	0.81
15	32	0.80	27	0.80

Table 5 Compressive Strength of M40 Grade Rice Husk Ash Concrete

Rice Husk Ash %	Compressive strength (MPa)		
	7 days	28 days	90 days
0	37.20	50.80	51.74
5	35.34	48.26	49.15
10	34.12	44.72	47.08
15	30.36	43.18	45.04

Note: RHA%-Replacement of cement by Rice Husk Ash.

Table 6 Compressive Strength of 50 Grade Rice Husk Ash Concrete

Rice Husk Ash %	Compressive strength (MPa) of M50		
	7 days	28 days	90 days
0	48.31	59.37	62.50
5	42.00	56.40	58.36
10	38.40	53.43	56.40
15	37.37	50.46	52.50

Table 7 Twenty Eight days Splitting Tensile Strength of Concrete

Rice Husk Ash %	Splitting Tensile Strength (MPa)	
	M40	M50
0	4.19	4.19
5	4.05	4.60
10	4.05	4.26
15	3.98	4.19

Table 8 Twenty Eight days Flexural Strength of Concrete

Rice Husk Ash %	Flexural Strength (MPa)	
	M40	M50
0	4.87	5.36
5	4.40	4.87
10	4.34	4.76
15	4.17	4.72

Table 9 Twenty Eight days Modulus of Elasticity of Concrete

Rice Husk Ash %	M40 grade of concrete (GPa)	M50 grade of concrete (GPa)
0	47.23	50.68
5	44.57	47.23
10	39.50	43.52
15	35.57	38.94