RESEARCH PAPER | Engineering | Volume : 5 | Issue : 5 | May 2015 | ISSN - 2249-555X

Mechanical Properties of High Performance Concrete Incorporating Rice Husk Ash

KEYWORDS: Ordinary Portland cement, High Performance Concrete, Rice Husk Ash, Mineral Admixture, and Superplasticizer.

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ABSTRACT *In the present investigation, a feasibility study is made to utilize the rice husk ash as an mineral admixture in HPC and to investigate the mechanical properties of concrete. The properties of cement, fine aggregate, coarse aggregate and water for M60 grade concrete is arrived as per ACI 211.1-91. HPC mixes incorporating different percentages of RHA by weight of cement along with some suitable super plasticizer. OPC was replaced with RHA by weight at 0%, 2.5%, 5%,7.5%, and 10%. w/c ratio between 0.35. Slump flow test was carried out on fresh concrete were prepared to have a slump between 175- 225mm while Mechanical strength properties was carried out on hardened 150 mm concrete cubes after 3, 7, 14 and 28 days curing in water. The results of the study indicate that the Mechanical properties of HPC mixes improved by incorporating RHA up to a desirable content of 7.5% by weight of cement.*

I. Introduction

Concrete is probably the most extensively used construction material in the world. However, when the high range water reducer or super plasticizer was invented and began to be used to decrease the water/cement (w/c) or water/binder (w/b) ratios rather than being exclusively used as fluid modifiers for normal-strength concretes, it was found that in addition to improvement in strength, concretes with very low w/c or w/b ratios also demonstrated other improved characteristics, such as higher fluidity, higher elastic modulus, higher flexural strength, lower permeability, improved abrasion resistance, and better durability. This fact led to the development of HPC. HPC is the latest development in concrete. It has become more popular these days and is being used in many prestigious projects such as Nuclear power projects, flyovers, multistoried buildings etc.

Since 1990s, HPC has become very popular in construction works. At present, the use of HPC has spread throughout the world. In 1993, the American Concrete Institute (ACI) published a broad definition for HPC and is defined as the concrete which meets special performance and uniformity requirements that cannot always be achieved by using only the conventional materials and mixing, placing and curing practices. The performance requirements may involve enhancements of placement and compaction without segregation, long-term mechanical properties, early age strength, toughness, volume stability, or service life in severe environments.

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.

II. Experimental Programme

A. Materials Used

Cement	Ordinary Portland cement of 53 grade
Aggregate	Fine aggregate conforming to zone II of IS: 383-19704
	Coarse aggregate of maximum size 20 mm, aggregage passing 10mm sieve and retaining on 4.75mm sieve
Rice Husk Ash (Particle Size)	25 microns
Superplasticiser	SP430
Mix proportion for M60	1:1.1:1.5 with w/c ratio 0.35

B. Batching, Casting and Curing of Specimens

Batching of materials was done by weight. The concrete mix design of HPC was done by using the guidelines of ACI 211-1 Standard Practice for Selecting Proportioning normal weight concrete of a maximum specified compressive strength of 60MPa. The percentage replacements of Ordinary Portland cement (OPC) by Rice Husk Ash (RHA) were 0%, 2.5%, 5%, 7.5% and 10. The 0% replacement was to serve as Conventional for other samples. Five mixes were prepared using different percentages of 0, 2.5, 5, 7.5 and 10 RHA. A tilting type rotary drum mixer was used to mix the ingredients. All the ingredients and water were placed in the mixer, RHA and water are added during rotation of drum. Super plasticizer SP430 is used for the M60 grade of concrete. concrete specimens Cubic of size 150 x 150 x 150 mm, Cylinder of size 100 x 200 mm and Prism of size 100 x 100x 500 mm are used compressive strength, split tensile strength and flexural strength of concrete respectively. cast iron moulds of standard sizes were used for casting cube, cylinders and prisms. The specimens were demoulded after 24 hours from the commencement of casting and submerged under water till the time of testing i.e. 3, 7,14 and 28 days.

Volume : 5 | Issue : 5 | May 2015 | ISSN - 2249-555X

C. Testing of Specimens

The concrete specimens of various mixes (A1, A2, A3, A4, and A5) After curing for specified periods, all the specimen samples were taken outside the curing tank and were tested under a compression testing machine of 2000KN capacity for compressive strength. The compression loads were noted and the average compressive strength of three specimens is determined.

D. Split Tensile Strength

Testing for split tensile strength of concrete is done as per IS 5816-1959. The test is conducted on compression testing machine of capacity 2000 kN as shown in Fig. The cylinder is placed horizontally between the loading surfaces of compression testing machine and the load is applied till failure of the cylinder. Packing material such as plywood is used to avoid any sudden loading. During the test the platens of the testing machine should not be allowed to rotate in a plane perpendicular to the axis of cylinder.

$$\text{Split tensile strength} = \frac{2P}{\pi LD}$$

E. Flexural Strength

Flexural strength test is done as per IS: 516-19595. Prisms are tested for flexure in Universal testing machine of capacity 100kN. 11. The bearing surfaces of the supporting and loading rollers are wiped clean before loading. The prisms are placed in the machine in such a manner that the load is applied to the uppermost surface along the two lines spaced 13.3 cm apart. The axis of the specimen is aligned with the axis of the loading device. The specimen is loaded till it fails and the maximum load (P) applied to the specimen during test is noted. After fracture the distance (a) between the crack and nearest support is measured. The flexural strength of the specimen is expressed as the modulus of rupture

$$f_b = \frac{P \text{ X } L}{b \text{ X } d^2}$$

when a is greater than 13.3 cm or

$$f_b = \frac{3P \text{ X } a}{b \text{ X } d^2}$$

when a is in between11.0 cm and 13.3 cm

III. RESULTS AND DISCUSSIONS

(i) Compressive Strength Tests

The test was carried out compressive strength of M60grade of concrete. The compressive strength of High strength concrete with OPC and RHA concrete specimens of various mixes (A1, A2, A3, A4, and A5) at 3 Days, 7 Days, 14 Days and 28 Days at the age of 28 days is presented in Table 1.

In figure 1 shows that compressive strength firstly increases and after a limit the compressive strength decreases.

(ii) Splitting tensile Test

The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder, along the vertical diameter.

The splitting tensile test can be calculated using the equation

Fsp = 2p/ (π L D)

The results of the compressive strength test specimens of various mixes (A1, A2, A3, A4, and A5) at 28 Days on concrete cylinder specimens are shown in Table 2.

In figure 2 the graph is plotted between flexural strength and % RHA. Graph shows that Flexural strength firstly increases and after a limit the flexural strength decreases.

(iii) Flexural Strength Test

The test was carried out on beam specimen, the test results of the mixes were presented in the Table 3 .

In figure 3 the graph is plotted between flexural strength and % RHA. Graph shows that Flexural strength firstly increases and after a limit the flexural strength decreases. This is because proper binding is not taking place between cement replaced by RHA & aggregate.

Table 1: Compressive Strength of Concrete Cubes with various percentages of RHA

Trial mix	RHA	Compressive Strength in N/mm^2			
	%	3 Days	7 Days	14 Days	28 Days
A1	0	39	53	55	65
A2	1	38	47	51	60
A3	2	40	48	52	62.5
A4	3	45	54	58	66
A5	4	40	52	54	62

Table 2: Split tensile strength of concrete cubes with various percentages of RHA

Trial mix	RHA Replacement	Split Tensile Strength in N/mm^2
	%	3 Days
A1	0	5.42
A2	1	5.60
A3	2	5.68
A4	3	5.90
A5	4	5.71

Table 3: Flexural strength of concrete cubes with various percentages of RHA

Trial mix	RHA Replacement	Flexural Strength in N/mm^2
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A1	0	5.42
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A4	3	5.90
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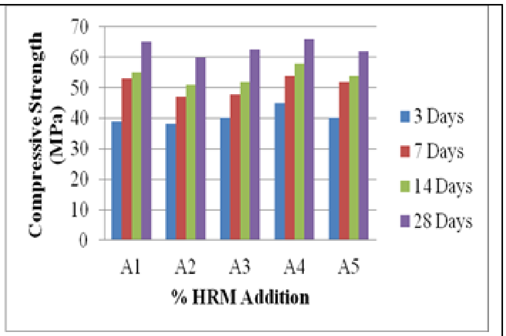

Figure 1: Compressive strength test at 3, 7, 21 and 28 days

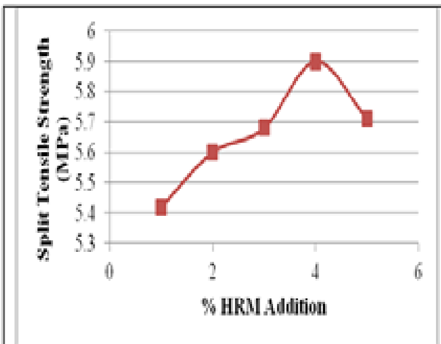

Figure 2: Split tensile strength test at 28 days

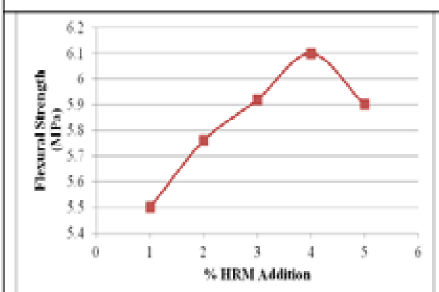

Figure 3: Flexural strength test at 28 days

IV. Observations

1. Cement replacement up to 7.5% with RHA leads to increase in compressive strength, splitting tensile strength and flexural strength, for M60grade.
2. Beyond 7.5% there is a decrease in compressive strength, tensile strength and flexural strength for 28 days curing period.
3. There is a decrease in workability as the replacement level increases, and hence water Consumption will be more for higher replacements.
4. The maximum replacement level of RHA is 10% for M60grade of concrete.
5. Use of RHA gives significant result on properties of concrete as compared to conventional concrete.
6. Use of RHA solves the problem of disposal of these materials.
7. Addition of RHA in concrete improves the properties of concrete. The Optimum content of RHA is found.

V. CONCLUSION

With the experimental studies conducted on HPC the following conclusions can be drawn:

The optimum replacement of Ordinary Portland Cement by the supplementary cementitious material such as rise husk ash is found as7.5% (A4 mix).

From the trial mixes, it is found that the water-binder ratio 0.35 gave better results. It also satisfies the workability conditions such as slump and compaction factor values. It has a slump of 180mm and the compaction factor of 0.90.

The mix proportion for the High Performance Concrete using Rise Husk Ash of M_{60} is obtained.

The compressive strength of High Performance Concrete using Rise Husk Ash is greater than the normal concrete.

The workability, strength and permeation properties are fundamentally important properties of structural concrete.

. From fig. 1,2 & 3. The Compressive, Split tensile and Flexural strengths of M60 at 28 days are good. It is observed that there is a gradual increased in strength as up to 7.5 % replacement of RHA.

From fig. . 1,2 & 3. it is observed that at later ages for high performance concrete the flexural strengths are increasing with RHA, whereas for conventional concrete the values are decreasing. with RHA.

REFERENCE 1. G. C. Cordeiro, R. D. T. Filho, L. M. Tavares, E. M. R. Fairbairn, S. Hempel, "Influence of particle size and specific surface area on the pozzolanic activity of residual rice husk ash," Cement and Concrete Composites, 2011. | 2. H. Chao-Lung, B.Le Anh-Tuan, C. Chun-Tsun, "Effect of rice husk ash on the strength and durability characteristics of concrete," Construction and building materials, 2011. | 3. E. Abalaka, O. G. Okoli, M. M. Garba, I. K. Zubairu, "Effects of Nigerian rice husk ash produced using a charcoal fired incinerator on properties of cement mortar and concrete: preliminary results," July 2011. | 4. Salas, S. Delvasto, R. Mejía de Gutierrez, D. Lange, "Comparison of two processes for treating rice husk ash for use in high performance concrete," Cement and concrete research, 2009. | 5. F. Giannotti da Silva, J. B. L. Liborio, P. Helene. (2008.). Improvement of physical and chemical properties of concrete with Brazilian silica rice husk (SRH), Revista Ingeniería deConstrucción. | 6. G. Giaccio, G. Rodriguez de Sensale, R. Zerbino, "Failure mechanism of normal and high-strength concrete with rice-husk ash," Cement and concrete composites, 2007. | 7. G. Rodriguez de Sensale, "Strength development of concrete with rice-husk ash," Cement and concrete composites, 2006. | 8. D. D. Bui, J. Hu, P. Stroeven, "Particle size effect on the strength of rice husk ash blended gap-graded Portland cement concrete," Cement and concrete composites, 2005. | 9. ACI 211-1, "standard practice for selecting proportions for normal, heavy weight and mass concrete", "ACI Manual of concrete practice",1993 | a