

To Study Strength Characteristics of Concrete with Rice Husk Ash

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Abstract

Background/Objective: The research was carried out to study the mechanical properties of concrete by partial replacement of cement with rice husk ash. The M40 grade of concrete was used to examine compressive strength, split tensile strength and flexure strength after 7 days and 28 days of curing. The cement is to be replaced (by weight) with rice husk ash by 5%, 10%, 15% and 20% to get optimized results. **Methods/Statistical Analysis:** In this research work, emphasis was made on examining the optimized quantity of RHA used as replacement with cement (by weight) by the medium of experimental investigation. **Findings:** As per results, Compressive strength for 5% replacement i.e. M-RHA5 increased by 2.1% as compared with control mix and for 10% replacement i.e. M-RHA10 decreased by 1.4 % as compared with control mix and it decreases for M-RHA15 and M-RHA20 mixes by 14.6% and 28.8% respectively i.e. compressive strength increases up to 10% for rice husk ash replacement with cement for M40 grade of concrete. Similarly split tensile strength also increases after 5% replacement for M-RHA5 i.e. increased by 3.9 % and after 10% replacement it decrease by 17.5 % and further decreasing for 15% and 20 % replacement by 19.3% and 31.7 % respectively as compared with RHA. There is no significant effect on split tensile strength as only 5% replacement is coming optimum. Flexural strength is optimized for different percentage of RHA and compared with control mix, i.e. it is increased by 10.9% for M-RHA5 mix and then start decreasing for M-RHA10 by 3% as compared with control mix. So for compressive strength M-RHA10 is optimum and split tensile strength and for flexural strength optimum content for RHA in cement 5% i.e. M-RHA5. **Application/Improvement:** As RHA has significant role in increase of compressive strength as compared with split tensile strength and flexure strength. Cement replacement with RHA will help to reduce cost of construction.

Keywords: Cement replacement, Mechanical Properties, Rice Husk Ash (RHA)

1. Introduction

In present, concrete is used for construction widely, and main aim is to decrease the cost of construction. To overcome the cost of concrete various materials are replaced with concrete ingredients and waste materials are widely used to optimize the concrete cost. In present study, RHA is replaced with cement partially to visualize the mechanical

properties of concrete and to reduce the cost of construction. RHA is widely used as supplementary cementitious material to increase the strength of concrete. Rice husk ash is waste material i.e. residue of rice during their creation. In present time there is boost to use waste material to innovate new materials to strengthen the product. Similarly, Rice husk ash is used at various places for making new products by their low cost. Rice husk has burnt into ash to get their physical

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and chemical properties to be used as mineral admixture in concrete. Pozzolanic activity of (RHA) rest on silica content, silica crystallization phase, size and surface area of RHA particles¹. The most common use of RHA is to provide strength to the concrete and to decrease the cost of construction. Kartini et al. said that RHA is a economical cementing material since it is waste product having high silica content, high porosity, light weight with high surface area². Khassaf et al. determine that workability of fresh concrete fall with the increase of RHA content³. Marthong examine that the stability of RHA cementitious paste decreased as compared to OPC cement paste. This shows reduction in water demand and should reduce shrinkage⁴. Ephraim et al. conclude that use of Rice husk ash in construction works will decrease the environmental pollution, strengthen the concrete quality and optimize the cost of concrete as well as resolving the problem of agricultural waste management⁵.

1.1 Rice Husk Ash (RHA)

RHA is a consequence of the cultivated industry which contains great amount of silicon dioxide (SiO₂). About 70 million tons of rice husk ash is produced worldwide per year. During shattering of rice process about 78 percent of remaining weight is extracted as rice. Remaining 22 percent of the weight is received as husk. It contains about 75 percent of organic content and the remaining 25 percent of husk is transformed into ash during the burning process, is identified as rice husk ash. Every one thousand kilograms of material, about two hundred twenty kilograms (22 percent) of husk is formed and when husk is burnt it gives 55 kilograms (25 percent) of Rice Husk Ash. The super pozzolona are used to make high strength concrete mix. There is increasing demand of silica to make high performance and high strengthen concrete. Rice Husk Ash concrete gives a durable and good structural concrete for both short term and long term considerations⁶. Dabai et al. conclude that the chemical study prepared on rice husk ash directed high quantity of silica for RHA with good workability⁷.

2. Experimental Program

2.1 Materials

2.1.1 Cement

In the present study OPC 43 grade cement⁸ for design mix. The various properties of cement are examined

i.e. compressive strength after 3 days, 7 days and 28 days, specific gravity, consistency and initial and final setting of cement as shown in Table 1.

Table 1. Properties of OPC 43 grade cement

S.no.	Characteristics	Value obtained Experimentally
1.	Specific Gravity	3.13
2.	Standard Consistency	33%
3.	Initial Setting Time	47 minutes
4.	Final Setting Time	252 minutes
5.	Compressive Strength	
	3 days	27.3 N/mm ²
	7 days	35.6 N/mm ²
	28 days	47.4 N/mm ²

2.1.2 Coarse Aggregate

Coarse aggregate used in experimental are combination of two nearby available stone of 20 mm and 10 mm size in 70:30 divisions respectively. The specific gravity examined for 20 mm and 10 mm aggregate is 2.73 and 2.71 respectively.

2.1.3 Fine Aggregate

Fine aggregate used for experimental work is of Zone II examined by IS: 383-1970⁹. The specific gravity examined is 2.49.

2.1.4 Rice Husk Ash (RHA)

RHA used for experimentation is collected from Rice Sheller and processed to size less than 45 microns to be replaced with cement. The specific gravity found to be 2.3.

2.2 Mix Design for Concrete

The main objective of experimental work is to investigate compressive strength, split tensile strength and flexural strength of concrete. M40 grade of concrete is used to examine the mechanical properties of concrete with 0.40 water -cement ratio. The mix design was prepared to examine the properties of concrete as per IS 10262-1982¹⁰. The mix proportion of concrete as given in Table 2.

Table 2. Mix Proportion for per cubic meter concrete

S. no	Mix	Mix proportion (C:FA:CAI:CAII) (1:1.828:1.936:0.83)							
		RHA %	RHA (Kg/m3)	Cement (Kg/m3)	w/b ratio	F.A (Kg/m3)	C.AI(20) (Kg/m3)	C.AII(10) (Kg/m3)	S.P. %
1	CM	0	-	390	0.4	713	755.30	323.70	0.5
2	M-RHA5	5	19.5	370.5	0.4	713	755.30	323.70	0.5
3	M-RHA10	10	39	351	0.4	713	755.30	323.70	1
4	M-RHA15	15	58.5	331.5	0.4	713	755.30	323.70	1
5	M-RHA20	20	78	312	0.4	713	755.30	323.70	1

C: Cement, F.A.: Fine Aggregate, C.AI (20): Coarse Aggregate of 20 mm, C.AII (10): Coarse aggregate of 10 mm, S.P: Super plasticizer
RHA: Rice Husk Ash CM: Control Mix

3. Test Results and Discussion

3.1 Compressive Strength

The 150 mm cube mould are used for testing the compressive strength after 7 days and 28 days as per IS: 516-1959¹¹. Specimens has been made for control mix and compared with different percentages replacement of cement with RHA i.e. for 5%, 10%, 15 % and 20 % by weight. Specimens were tested after seven days and twenty days age of curing and average results of are shown in Figure 1.

The compressive strength examined for different percentages of RHA with replacement of cement (by weight) i.e. for 5%, 10%, 15% and 20%. Compressive strength for 5% replacement i.e. M-RHA5 increased by 2.1% as compared with control mix after 28 days testing and for

10% replacement i.e. M-RHA10 decreased by 1.4 % as compared with control mix after 28 days testing and it decreases for M-RHA15 and M-RHA20 mixes by 14.6% and 28.8% respectively. RHA is pozzolonic material contain high silica have same property like cement. RHA when mixed with concrete mix, due to their fineness it will make good bond with other material particles in concrete mix at some content of RHA and it will increase the compressive strength of concrete due to their pozzolonic effect but after further addition of RHA strength start decreasing because it will effect heat of hydration of cement which will effect the compressive strength of concrete mix. As discuss in Figure 1, after addition of 15 % and 20 % replacement of RHA strength decreases suddenly. So range of 5-10% of RHA is optimum content for concrete mix for compressive strength of concrete because at 5 % replacement there is slight rise in compressive strength after 28 days and at 10 % replacement slight decrease in strength as compared with control mix. So use of M-RHA10 will reduce the cost of construction as compared to M-RHA5.

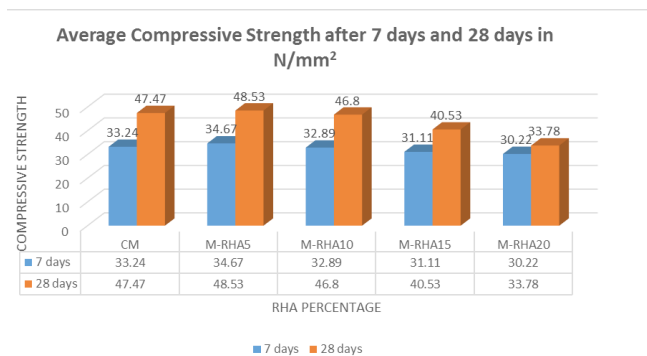


Figure 1. Average compressive strength after 7 days and 28 days in N/mm².

3.2 Split Tensile Strength

The 300mm x 150 mm cylinders¹² were used for testing the split tensile strength after 7 days and 28 days. Specimens have been made for control mix and compared with different percentages replacement of cement with RHA i.e. for 5%, 10%, 15 % and 20 %. The split tensile strength of all the mixes was determined at the age of 7 days and 28 days for various replacement levels of RHA in concrete mix and discussed in Figure 2.

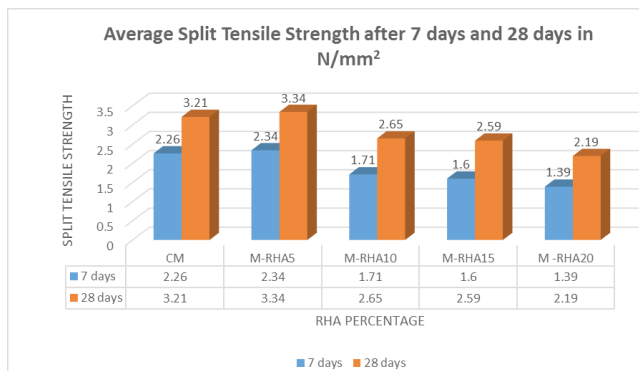


Figure 2. Average Split tensile Strength after 7 days and 28 days in N/mm².

The split tensile strength results of individual concrete mix are also shown graphically. Split tensile strength also increases after 5% replacement for M-RHA5 i.e. increased by 3.9 % and after 10% replacement it decrease by 17.5 % and further decreasing for 15% and 20 % replacement by 19.3% and 31.7 % respectively as compared with RHA. The maximum values of split tensile strength of concrete with addition of rice husk ash at 5% addition which is slightly higher than control mix. At 10 % addition of rice husk ash decrease in strength. For strength purpose 5% is acceptable for split tensile strength but for cost reduction 10% is also acceptable due to less decrease in strength after 28 days.

3.3 Flexural Strength

The beam specimens 100mm x 100mm x 500mm were used for testing the flexural strength after seven days and twenty-eight days. Specimens has been made for control mix and compared with different percentages replacement of cement with RHA i.e. for 5%, 10%, 15 % and 20 %. The flexural strength after seven days and twenty days discussed in given Figure 3.

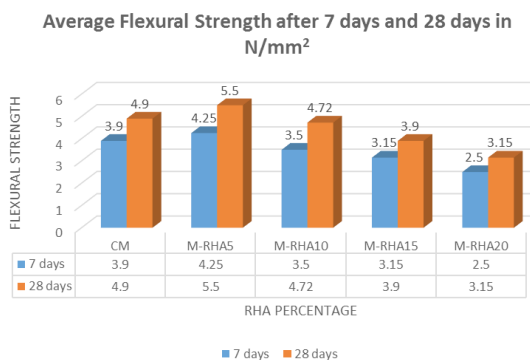


Figure 3. Flexural Strength after 7days and 28 days in N/mm².

As discussed in Figure 3, when RHA reinforced concrete and composite beams are loaded in pure bending, then the tensile strains develop. The load at first crack would increase with respect to rice husk ash reinforced concrete due to crack arresting mechanism of the closely spaced fibers. After the concrete matrix cracks, the fibers continue to take higher load which is provided. For M-RHA5, flexure strength increases by 12 % and beyond that it starts decreasing. For M-RHA10 decreases by 3.6 % due to effect on heat of hydration and further decreasing for M-RHA15 and M-RHA20 is 20.4% and 35.7% respectively. So M-RHA10 is adopted as optimum content as there is slight decrease in strength as if compared with M-RHA5 and control mix.

4. Conclusions

From these experiments work, the conclusion can be drawn:

- RHA is environment friendly and easily available and so it will give benefit if used for construction purpose.
- Concrete mix with 10 percent RHA as replacement of cement is the optimum level as it has been observed to show a significant increase in compressive strength at 28 days when compared with control mix.
- The split tensile strength also tends to increase with increase percentages of RHA up to 5% mix but slightly decrease after 10 % replacement but is more than control mix.
- On increasing the percentage replacement of cement with RHA beyond 5%, there is a reduction in the tensile strength value. So 5% RHA replacement is optimum for split tensile strength.
- Maximum flexure strength of incorporating RHA is achieved for 5% RHA replacement but at 10 % RHA replacement strength decrease slightly from control mix strength.
- Optimum content for compressive strength and flexure strength is 10% replacement with cement with rice husk ash after that strength start decreasing suddenly, for split tensile strength optimum content is 5% and after that is start decreasing with increase of RHA content.

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