"THE EFFECT OF RICE HUSK ASH ON STRENGTH PROPERTIES OF CONCRETE"

An Experimental Study

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Abstract - *Portland cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This threat to ecology has led to researchers to use industrial by products as supplementary cementations material in making concrete.* ***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 concrete with partial replacement of cement by rice husk ash by 0, 5, 10, 15, and 20%. This paper presents a detailed experimental study on Compressive strength, split tensile strength, flexural strength at age of 7 and 28 day. Test results indicate that use of rice husk ash in concrete has improved the performance of concrete in strength.* ***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: Rice husk ash (RHA), Cement replacement, Durability, Compressive strength, Split tensile strength, Flexural strength.

1. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. The usage, behavior as well as the durability of concrete structures, built during the last first half of the century with Ordinary Portland Cement (OPC) and plain round bars of mild steel, the ease of procuring the constituent materials (whatever may be their qualities) of concrete and the knowledge that almost any combination of the constituents leads to a mass of concrete have bred contempt. Strength was stressed without a thought on the durability of structures.

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for greenhouse effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. Addition of rice husk ash to concrete has many advantages like high strength, durability and reduction in cement production. The optimum rice husk ash replacement percentage for obtaining maximum 28-days strength of concrete ranged from 5 to 10%.

1.1 The Objective of the present investigation:

- To study different strength properties compressive Strength, flexural strength and split tensile strength of Rice husk ash concrete with age in comparison to Control concrete.
- To study the relative strength development with age of Rice husk ash concrete with Control concrete of same grade.
- To determine the optimum level of replacement of rice husk ash with ordinary Portland cement.
- To determine the initial setting time and final setting time of rice husk ash concrete.
- To determine the workability of Rice husk ash concrete with super plasticizer.
- To conduct durability studies on Rice husk ash concrete with mineral admixtures.

- To reduce the quantity of cement in manufacture of concrete.
- To reduce the cost of concrete.

2. LITERATURE SURVEY

Kulkarni MS, Mirgal PG, Bodhale PP, Tande SN, (2014) [1] studied that RHA contains silica in amorphous and highly cellular form that improves workability and stability, and it decreases the development and impermeability as well as durability in strengthening zone.

Paramveer Singh, Tarunbir Singh and Gurpreet Singh, (2016) [2] studied that the strength of the Mortar with the partial replacement of RHA will gain 10 percent more after 7 days and 20 percent after 28 days comparing with regular concrete.

K.Ganesan, K.Rajagopal and K.Thangavelu, (2005) [3] studied that the concrete with partial replacement of cement with rice husk ash and he concluded in his study that concrete with replacement of 15% of rice husk ash showed an almost compressive strength and the compressive strength is loss at increasing content of rise husk ash more than 15%.

Ephraim M, Akeke GA, Ukpata JO (2012) [4] 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 management.

Kartini, K, Mahmud HB, Hamidah MS (2006) [5] said that RHA is a economical cementing material since it is waste product having high silica content, high porosity, light weight with high surface area.

C. Marthong (2012) [6] examine that the stability of RHA cementitious paste decreased as compared to OPC cement paste. This shows reduction in water demand and should reduce shrinkage.

3. EXPERIMENTAL INVESTIGATION

3.1 Materials

A) Ordinary Portland cement (OPC) of 43 grades J.K. Cement was used throughout the course of investigation. Specific gravity of this cement is 3.13.

Table 1: Properties of OPC 43 grade cement

S. No.	Characteristics	Value obtained Experimentally
1	Specific Gravity	3.13
2	Standard Consistency	34%
3	Initial Setting Time	49 minutes
4	Final Setting Time	252 minutes
5	Compressive Strength	
	3 days	25.3 N/mm2
	7 days	32.6 N/mm2
	28 days	44.3 N/mm2

B) Fine Aggregate

Aggregates of which pass through 4.75 mm is sieve is known as fine aggregate. Natural sand used Specific gravity was 2.40, as per IS: 383-1987[10] locally available River sand was used.

C) Coarse Aggregate

Natural coarse aggregates Specific gravity of these aggregates was 2.80 Crushed aggregate confirming to IS: 383-1987[10] was used. Aggregates of size 20mm and 10 mm of specific gravity 2.74 and fineness modulus 7.17 were used.

D) Rice Husk Ash

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. Rest 22% of the weight of paddy is received as husk. 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.

Fig -1: Rice Husk

Fig -2: Rice Husk Ash

Rice husk can be burnt into ash that fulfils the physical characteristics and chemical composition of mineral admixtures. Pozzolanic activity of rice husk ash (RHA) depends on (i) silica content, (ii) silica crystallization phase, and (iii) size and surface area of ash particles. In addition, ash must contain only a small amount of carbon. 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.

The following properties of the concrete are altered with the addition of rice husk:

- The heat of hydration is reduced. This itself help in drying shrinkage and facilitate durability of the concrete mix.
- The reduction in the permeability of concrete structure. This will help in penetration of chloride ions, thus avoiding the disintegration of the concrete structure.
- There is a higher increase in the chloride and sulphate attack resistance.

The rice husk ashes in the concrete react with the calcium hydroxide to bring more hydration products. The consumption of calcium hydroxide will enable lesser reactivity of chemicals from the external environment.

Table-2: Physical Properties of Rice Husk Ash

S.No	Particular Properties	
1	Color	Gray
2	Shape Texture	Irregular
3	Mineralogy	Non Crystalline
4	Particle Size	< 45 microns
5	Specific Gravity	2.37
6	Odor	Odorless

The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete. Using it provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions.

E) Super Plasticizer

Because of higher grade of concrete water reducing super plasticizer has been used in this thesis work. The super plasticizer which is used for the experimental performance is Shaliplast SP-431. It has high workability to flow for concrete mixes so that the voids can be filled by the concrete slurry even with very less amount of compaction.

F) Water

The water which is fit for drinking should be used for making concrete. Potable, fresh, colorless and clean municipal tap water, which is free from organic Matter, is used in this project work. PH of the water should be between 6 to 8 as much possible.

3.2 Mix Proportioning

All the samples were prepared using design mix M-40 grade of concrete was used for the present investigation. Mix design was done based on IS 10262-1982[11] The Table 3 shows mix proportion of concrete (Kg/m3).

Table-3: Mix Proportioning

S.N.	Mix Proportion (C:FA:CAI:CAII) (1:1.83:1.95:0.83)							
	RHA%	RHA	Cement	W c	F.A	C.AI (20)	C.AII(10)	SP %
1	0	- -	400	0.4	732	780	332	0.5
2	5	20	380	0.4	732	780	332	0.5
3	10	40	360	0.4	732	780	332	1
4	15	60	340	0.4	732	780	332	1
5	20	80	320	0.4	732	780	332	1

4. TEST RESULTS AND DISCUSSIONS

Consolidated results have been tabulated and have also been presented graphically. Variations with cement had been made, cement was to replace with different percentages replacement of cement with RHA i.e. for 5%, 10%, 15 % and 20 % by weight. The specimen**s** of standard cube of (150mm x 150mm x 150mm) and standard cylinder of (300mm x 150mm) and Beam of (150mm x150mm x 700mm) were used to determine the compressive strength, split Tensile strength and flexural strength of concrete. Three specimens were tested for 7 & 28 days with each proportion of Rice Husk Ash replacement as per Indian Standards.

Results of fresh and hardened concrete with partial replacement of Rice husk ash are discussed in comparison with those of normal concrete.

Table-4: Results of Compressive, Split Tensile and Flexural Strength

SN	RHA%	Compressive Strength (N/mm2)		Split tensile Strength (N/mm2)		Flexural Strength (N/mm2)	
		7 days	**28** days	**7** days	**28** days	**7** days	**28** days
1.	0	33.42	47.59	2.36	3.43	3.95	4.95
2.	05	34.87	48.63	2.44	3.38	4.25	5.57
3.	10	32.69	46.73	1.79	2.65	3.56	4.72
4.	15	31.47	40.91	1.62	2.49	3.15	3.83
5.	20	30.22	36.19	1.39	2.19	2.53	3.25

A) Compressive Strength

The results of compressive strength were presented in Table 4. The test was carried out conforming to IS 516-1959[9] to obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using Universal Testing Machine (UTM).

The compressive strength of the concrete with partial replacement of rice husk ash increases with increase the percentage of rice husk ash at some extent. 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.

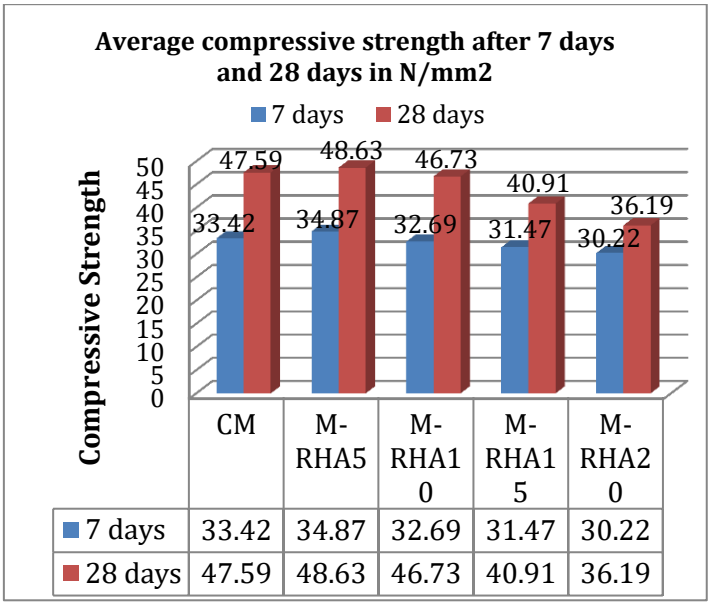

Chart-1: Effect of Rice Husk Ash on Compressive strength of concrete

B) Split Tensile Strength:

The results of Split Tensile strength were presented in Table 4. The test was carried out conforming to IS 516-1959[9] to obtain Split tensile strength of concrete at the age of 7 and 28 days. The cylinders were tested using Universal Testing Machine (UTM).

The split tensile strength also tends to increase with increase percentages of RHA up to 5% mix and decrease after 10 % replacement. So 5% RHA replacement is optimum for split tensile strength.

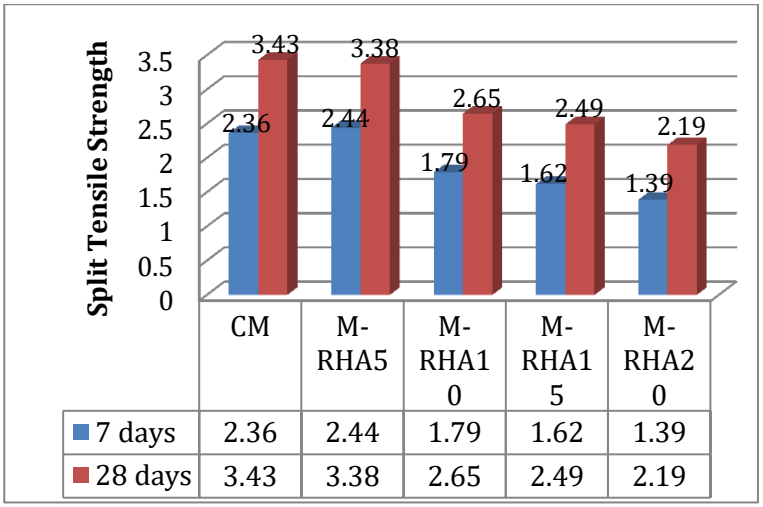

Chart-2: Effect of Rice Husk Ash on split tensile strength of concrete

C) Flexural Strength:

The results of flexural strength of normal concrete and Rice Husk Ash replaced concrete were presented in Table 4. The test was carried out conforming to IS 516-1959[9] to obtain Flexural strength of concrete at the age of 7 and 28 days.

The central point loading/single point loading method was used for this test. Maximum flexure strength of incorporating RHA is achieved for 5% RHA replacement but at 10 % RHA replacement strength decrease slightly from control mix strength. So 10% RHA replacement is optimum for Flexural strength.

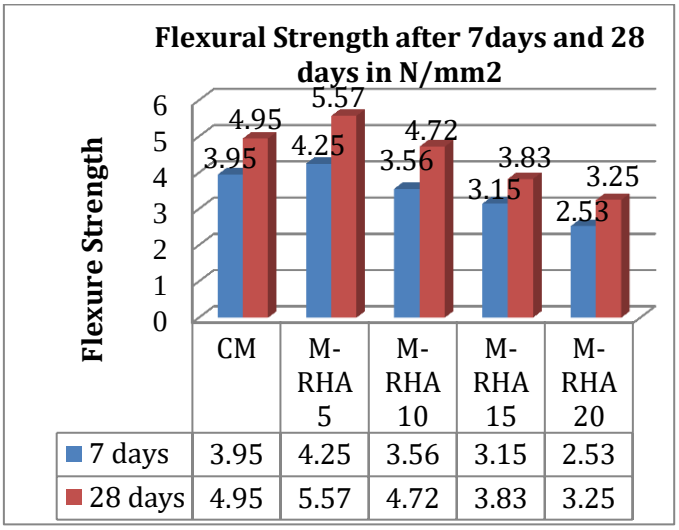

Chart-3: Effect of Rice Husk Ash on flexural strength of concrete

5. CONCLUSIONS

By using Rice Husk Ash with partial replacement of cement it's possible to achieve desire strength and durability properties through the use of waste material. Rice husk ask is having greater fineness than cement and greater surface area so the consistency increases greatly, when Rice husk ask percentage increases.

The optimum 7 and 28-day compressive strength and flexural strength have been obtained in the range of 10% Rice husk ash replacement level.

- The workability of rice husk ash decreased with increase in percentage of rice husk ash. The compaction factor has been decreased with increase in percentage of rice husk ash.
- Concrete mix with 10% 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 decrease after 10% replacement.
- 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. So 10% RHA replacement is optimum for flexure strength.
- Rice husk ash can be added to cement concrete as partial replacement of cement up to 10% without any significant reduction in any of the property of concrete. This will result in reduction in the cost of concrete to some extent.
- The rice husk concrete mix is economical than conventional concrete mix. It decreases the cost at a rate of 3.35% by replacement.
- Rice husk ash is environment polluting material and is best supplementary material for cement replacement as it is easily available in rice producing areas.

- Moreover with the use of rice husk ash, the weight of concrete reduces, thus making the concrete lighter which can be used as light weight construction material.

Optimum content for compressive strength and flexure strength is 10% replacement of 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.

6. REFERENCES

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