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STUDY ON EFFECT OF PARTIAL REPLACEMENT OF CEMENT BY RICE HUSK ASH ON PROPERTIES OF CONCRETE

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Abstract –*This study aims to optimize the use of rise husk ash in increasing the strength of concrete. Rice husk ash is one of the major byproduct of rice mill industry. Rice husk ash has huge proportion of silica in it and behaves as a good cementious material due to the presence of silica in it. The fineness of rice husk ash particles allows it to get filled in between the voids in the concrete and thus increases the density of the concrete. The benefit of replacing cement with rice husk ash is that it is cheaply available, have high surface area, high silica content and high fineness modulus. In this study some proportion of cement is replaced with rice husk ash for M30 grade of concrete and the properties of new mix with 5 percent, 10 percent, 15 percent and 20 percent is compared with 0 percent replacement of RHA. The comparison of the results show that the compressive strength of concrete increased maximum upto 7.234 percent at 7 days and 8.978 percent at 28 days and split tensile strength increased maximum upto 8.367 percent at 7 days and 11.932 percent at 28 days at 15 percent replacement of cement with RHA. Also the flexure strength increased maximum upto 1.96 percent at 7 days and 1.06 percent at 28 days with 10 percent replacement of cement by RHA.*

Key Words: RHA(Rice Husk Ash), OPC(Ordinary Portland Cement), FA(Fine Aggregate), CA(Course Aggregate), IS(Indian Standard), SCM(Supplementary cementing materials)

1.INTRODUCTION

Concrete is the commonly used construction material due to its structural stability, durability and strength. The demand of concrete is increasing day by day due to growing population, urbanization, transportation and industrialization. Due to this there is a scarcity of resources like cement, fine and coarse aggregate required for making concrete. On other side speedy growth of industrialization contributed to different types of waste by-product which is environmentally risky. So, the industrial wastes are effectively used in the concrete to save the environment. In civil construction some industrial wastes are utilized in various works. Concrete is the most frequently used building material on the planet, second only to water in terms of usage. Concrete is a man-made substance used to construct a wide range of constructions. It is composed of aggregate kept together by cement, sand, and water. Every year, billions of tonnes of concrete are made, necessitating a colossal amount of raw materials. The concrete industry has also been dubbed the "most natural resource-intensive" industry. Aside from the depletion of natural resources, the production of ordinary portland cement (OPC), the major binder in concrete, is one of the most significant sources of human-caused carbon dioxide. Furthermore, increased carbon emissions from OPC manufacturing are projected in the next years due to the planned exponential increase in concrete/cement consumption. As a result, the concrete industry, particularly OPC, must find a solution to reduce or replace the amount of natural resources used in concrete. Over the years, a variety of methods have been examined, including partial to complete OPC replacement, the use of waste materials as aggregate in concrete, the use of wastewater, and so on. One of the most effective ways to reduce the embodied carbon of concrete is to partially replace OPC with extra cementitious ingredients. SCMs are mostly waste materials with pozzolanic and hydraulic properties. SCMs such fly ash, slag, silica fume, metakaolin, and rice husk ash (RHA) have been used as a partial replacement over the years. SCMs in concrete also provide a way to manage these wastes, lowering the risk of environmental damage as a result of their disposal. These SCMs have varying effects on the fresh and hardened characteristics of concrete, and the most effective technique to incorporate these waste materials into concrete has been reported to be proper type selection and OPC replacement level. RHA, a type of SCM and agricultural waste, has been discovered to improve the mechanical and durability of concrete. Due to its high reactivity and silica concentration, RHA is a preferred SCM above fly ash and silica fume.

2. MATERIALS USED IN THE STUDY

2.1 CEMENT

The cement used in this study was Ordinary Portland Cement of 43 grade with trade name “ULTRA TECH” bought from the local market near BIT SINDRI. The physical properties of cement are given in the table 1 below.

Table -1: Physical properties of cement

Sl. No.	Parameter	Test results
1.	Fineness	5.0% residue on 90micron I.S sieve.

2.	Normal Consistency	33%
3.	Specific Gravity	3.11
4.	Initial Setting Time	52 minutes
5.	Final Setting Time	257 minutes
6.	Unit Weight	1.34gm/cc
7.	Soundness of cement	2.0 mm
8.	Compressive Strength at	In MPa
	3 days	27.2
	7 days	35.8
	28 days	46.8

Table-2 Physical properties of fine aggregate

Sl.No	Property	Fine Aggregate
1.	Zone	II
2.	Specific gravity	2.62
3.	Unit weight	1.62gm/cc
4.	Fineness Modulus	2.71
5.	Water Absorption	1.5%

Table-3 Physical properties of coarse aggregate

Sl. No	Property	Coarse Aggregate
1.	Specific Gravity	2.68
2.	Unit Weight	1.60gm/cc
3.	Fineness Modulus	6.86 (20mm)
4.		5.95 (10mm)
5.	Impact value	17%
6.	Crushing value	23.34%

Table -4: Physical properties of RHA(Rice Husk Ash)

S.No	Property	Rice husk ash
1.	Colour	Grey
2.	Specific gravity	2.3
3.	Particle Size	< 45 micron
4.	Odor	Odorless
5.	Mineralogy	Non crystalline
6.	Shape Texture	Irregular

Fig :1. Rice Husk Ash

3. RESEARCH METHODOLOGY

In this study at first collection of materials used that is rice husk ash, cement, fine aggregate and coarse aggregate. After that materials collected are tested for its various physical and chemical properties. After that the calculation of mix design was done with partial replacement of cement by rice husk ash by 0%, 5%, 10%, 15% and 20%. Then specimens were prepared for conducting various tests of concrete. The slump test, compressive test, split tensile test and flexure strength test were conducted for different percentage of replacement of cement with rice husk ash.

4. RESULTS AND DISCUSSION

4.1 Workability for partial replacement of RHA in concrete.

Slump value of concrete is investigated with the partial replacement cement @ 0%, 5%, 10%, 15% and 20% by RHA. It was observed that the partial replacement of cement by RHA reduces the workability of concrete.

Table -5: Variation of slump value with replacement of cement by RHA

% of RHA	0%	5%	10%	15%	20%
Slump value in (mm)	74	72	65	61	56

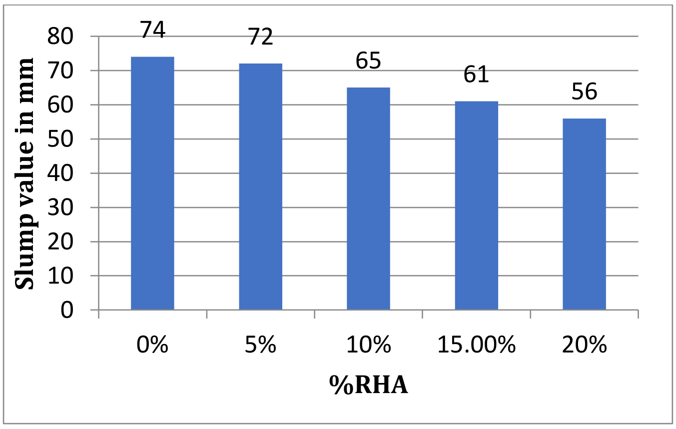

Fig: 2. Effect of RHA on slump value

4.2 Compressive strength for partial replacement of RHA in concrete.

The table 6. below compares the compressive strength of concrete of 0% replacement and different percentage of replacement of cement by rice husk ash. It shows that the compressive strength increases by 2.93% at 5% of rice husk ash, by 4.69% at 10% of rice husk ash, by 7.23% at 15% of rice husk ash and by 3.22% at 20% of rice husk ash after 7 days. It also shows that the compressive strength increases by 2.45% at 5% of rice husk ash, by 4.79% at 10% of rice husk ash, by 8.98% at 15% of rice husk ash and by 7.34% at 20% of rice husk ash after 28 days. It has been observed that the compressive strength increases maximum upto 7.23% at 15% replacement after 7 days and maximum upto 8.98% at 15% replacement after 28 days and after 15% replacement it starts decreasing and decreases upto 3.22% at 20%RHA at 7 days and upto 7.34% after 28 days at 20% replacement of rice husk ash.

Table: 6. Compressive strength test of concrete by replacing cement by RHA at 7 and 28 days

% of RHA	Comp. Strength at 7 Days (N/mm^2)	Comp. Strength at 28 Days (N/mm^2)
0%	27.92	39.65
5%	28.74	40.62
10%	29.23	41.55
15%	29.94	43.21
20%	28.82	42.56

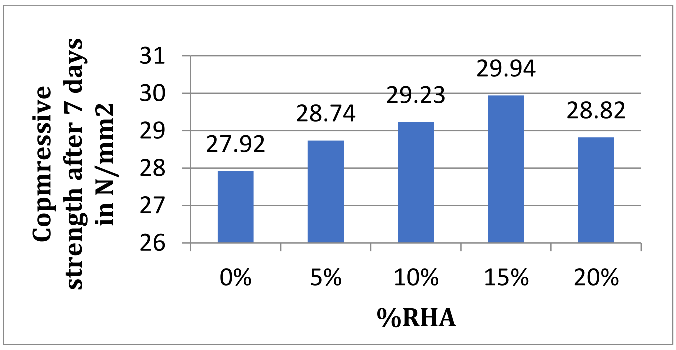

Fig: 3. Compressive strength of concrete by replacing cement by RHA after 7 days

The above figure 3. shows that the compressive strength of concrete mixed with the different percentage of RHA after 7 days increases from 0% to 15% and with further increase in the RHA in the mix the compressive strength decreases.

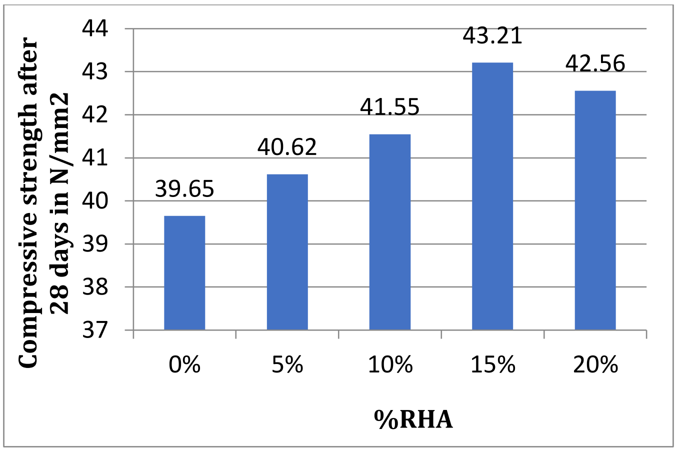

Fig: 4. Compressive strength of concrete by replacing cement by RHA after 28 days

The above figure 4. shows that the compressive strength of concrete mixed with the different percentage of RHA after 28 days increases from 0% to 15% and with further increase in the RHA in the mix the compressive strength decreases.

4.3 Split tensile strength for partial replacement of RHA in concrete.

The table 7 below compares the split tensile strength of concrete of 0% replacement and different percentage of replacement of cement by rice husk ash. It shows that the split tensile strength increases by 2.39% at 5% of rice husk ash, by 4.78% at 10% of rice husk ash, by 8.37% at 15% of rice husk ash and by 3.19% at 20% of rice husk ash after 7 days. It also shows that the split tensile strength increases by 2.84% at 5% of rice husk ash, by 4.55% at 10% of rice husk ash, by 11.93% at 15% of rice husk ash and by 5.11% at 20% of rice husk ash after 28 days. It has been observed that the split tensile strength increases maximum upto 8.37% at 15% replacement after 7 days and maximum upto 11.93% at 15% replacement after 28 days and after 15% replacement it starts decreasing and decreases upto 3.19% at 20%RHA after 7 days and upto 5.11% after 28 days at 20% replacement of rice husk ash.

Table : 7 Split tensile strength of concrete for different percentage of RHA.

Variation of RHA	Split tensile strength (N/mm²) after 7 days	Split tensile strength (N/mm²) after 28 days
0%	2.51	3.52
5%	2.57	3.62
10%	2.63	3.68
15%	2.72	3.94
20%	2.59	3.70

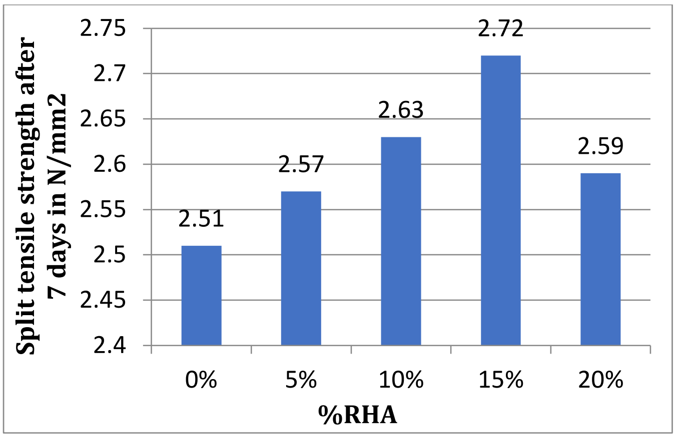

Fig: 5. Split tensile strength after 7 days

The above figure 5. shows that the split tensile strength of concrete mixed with the different percentage of RHA after 7 day increases from 0% to 15% and with further increase in the RHA in the mix the split strength decreases.

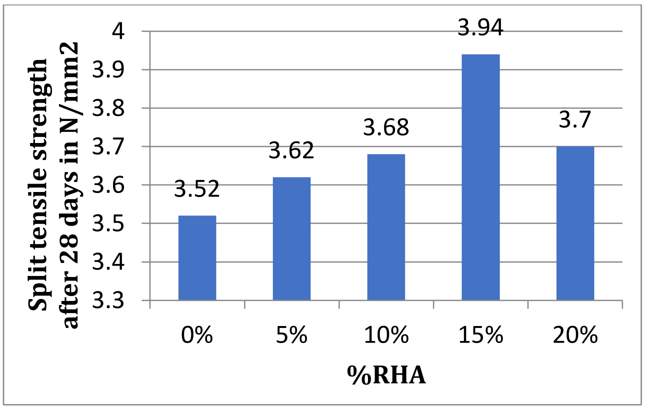

Fig: 6 Split tensile strength after 28 days

The above figure 6 shows that the split tensile strength of concrete mixed with the different percentage of RHA after 28 days increases from 0% to 15% and with further increase in the RHA in the mix the split strength decreases.

4.4 Flexure strength for partial replacement of RHA in concrete.

The table 8 below compares the flexure strength of concrete of 0% replacement and different percentage of replacement of cement by rice husk ash. It shows that the flexure strength increases by 0.39% at 5% of rice husk ash and by 1.96% at 10% of rice husk ash after 7 days. It also shows that the flexure strength increases by 0.45% at 5% of rice and by 1.06% at 10% of rice husk ash after 28 days. It has been observed that the flexure strength increases maximum upto 1.96% at 10% replacement after 7 days and maximum upto 1.06% at 10% replacement after 28 days and after 10% replacement it starts decreasing and decreases upto 1.18% at 15% RHA and 0.78% at 20% replacement of rice husk ash after 7 days and decreases upto 0.78% at 15% RHA and 0.30% at 20% RHA after 28 days.

Table: 8 Flexural strength test of concrete for different percentage of RHA

Variation of RHA	Flexural strength (N/mm²) after 7 days	Flexural strength (N/mm²) after 28 days
0%	5.10	6.60
5%	5.12	6.63
10%	5.20	6.67
15%	5.16	6.65
20%	5.14	6.62

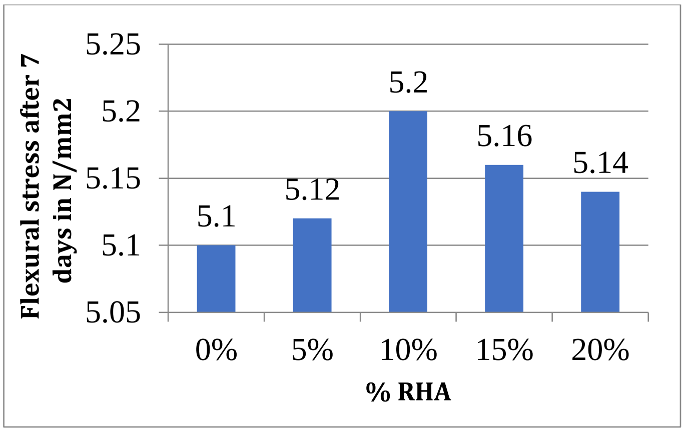

Fig: 7 Flexural strength after 7 days

The above figure 7 shows that the flexural strength of concrete mixed with the different percentage of RHA after 7 days increases from 0% to 10% and with further increase in the RHA in the mix the flexural strength decreases.

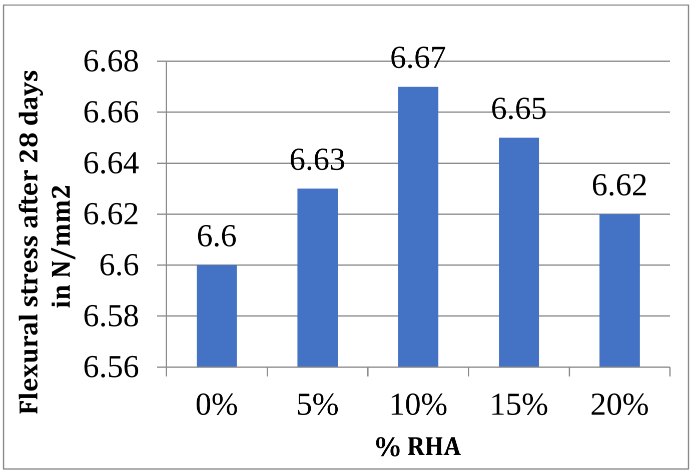

Fig: 8. Flexural strength after 28 days

The above figure 8 shows that the flexural strength of concrete mixed with the different percentage of RHA after 28 days increases from 0% to 10% and with further increase in the RHA in the mix the flexural strength decreases.

5. CONCLUSIONS

Based on the experimental investigation the following conclusion may be drawn.

(I) Slump value of concrete with partial replacement of cement by RHA decreases as increases the percentage of RHA from 0% to 20%.

(II) Compressive strength of concrete with partial replacement of cement by RHA increases up to 15% replacement at both 7 days and 28days and from 20% replacement it starts decreases.

(III) The compressive strength ofconcrete attained maximum at 15% RHA. The increase in the compressive strength is 7.234% and 8.978% at 7 days and 28 days respectively.

(IV) Split tensile strength of concrete with partial replacement of cement by RHA increases up to 15% replacement at both 7 days and 28days and from 20% replacement it decreases.

(V) Split tensile strength of concrete attained maximum at 15% RHA. The increase in the split tensile strength is 8.367% and 11.932% at 7 days and 28 days respectively.

(VI) Flexure strength of concrete with partial replacement of cement by RHA increases up to 10%replacment at both 7 days and 28days and from 15% replacement it decreases.

(VII) Flexure strength of concrete attained maximum at 10% RHA. The increase in the flexure strength is 1.96% and 1.06% at 7 days and 28 days respectively.

(VIII) A huge quantity of rice husk waste can be managed in preparation of good quality and sustainable green concrete that has ecological benefits.

(IX) Hence it is concluded that RHA in suitable as an alternative material for cement.

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