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Experimental Study on the Strength of Concrete by Using Corrugated Steel Fibers with Rice Husk Ash

KEYWORDS
Cement, Concrete, Steel Fiber, Rice Husk Ash.

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ABSTRACT *This paper reports on a comprehensive study on the properties of concrete containing rice husk ash and steel fibers. Properties studied include workability of fresh concrete, compressive strength, flexural tensile strength, splitting tensile strength, modulus of elasticity for hardened concrete. Rice husk ash content was use from 10% to 25% in the interval of 5% in weight of cement. It was found that the strength of concrete reduces after further addition of 15% of rice husk ash. So to improve the strength of concrete steel fibers were added and fiber volume fraction was 0.5%, 1%, 1.5% and 2% in volume basis. The laboratory results Shown that steel fiber addition, either into Ordinary Portland cement concrete or rice husk ash concrete, improves the tensile strength properties. However, it reduced workability. Although rice husk ash replacements reduce strength properties, it reduced workability of steel fiber reinforced concrete. The performed experiments show that the behaviour of rice husk ash concrete is not similar to that of Portland cement concrete when rice husk ash is added.*

I. Introduction
Today inspired from the ancient application of techniques artificial fibers are commonly used now a day in order to improve the mechanical properties of concrete. Especially Synthetic (Polypropylene, polyester etc.,) glass, nylon, asbestos, carbon and steel fibers used in concrete caused good results to improve numerous concrete properties. In general, tensile, flexural, impact, deformation capability, loads bearing capacity after cracking and toughness properties of concrete are significantly improved by use of fibers in concrete mix. The addition of fibers to concrete considerably improves its structural characteristics such as flexural strength, impact strength, tensile strength, ductility and flexural toughness.

For long term, strength and toughness and high stress resistance, steel fiber reinforced Concrete (SFRC) is increasingly being used in structures such as flooring, housing, precast, tunnelling, heavy duty pavement and mining. Generally, aspect ratios of

steel fibers used in concrete mix are varied between 50 and 100.The most suitable volume fraction Values for concrete mixes are between 0.5% to 2% of concrete. In general, the character and performance of fiber reinforced concrete changes with varying concrete formulation as well as the fiber material type, fiber geometry, fiber distribution, fiber orientation and fiber concentration. Although, there were numerous studies carried out on the influence of fiber addition in concrete mixture on mechanical and durability properties of concrete limited research work has been carried out concerning the influence of fiber addition in concrete with pozzolonas. An area that has not been extensively examined previously is the effect of steel fiber additions on the mechanical and durability properties of rice husk ash concrete. Researchers have studied rice husk ash concrete and

fiber reinforced concrete separately; however, considering reinforcing fibers with rice husk ash in concrete is an area that needs more study.

The purpose of this research is to study the effects of steel fibers on the workability, compressive strength, flexural tensile strength, splitting tensile strengths, modulus of elasticity of rice husk ash on concrete.

II. Experimental Program
A. Materials
Purchase the required material which is

Needed to make the cement paste.
B. Cement
The cement used was Ordinary Portland cement (53Grade) with a specific gravity of 3.16.Initial and final setting times of the cement were 60 min and 250 min, respectively. Its chemical composition is given in Table 1.

C. Rice Husk Ash
Rice husk ash used was obtained from SHREE LAXMIVIJAY RICE & PULSE MILL, DHEDAL ROAD, BAVLA. The Specific gravity of rice husk ash is 2.3 and bulk density is 0.721 g/cc. Chemical oxide composition of cement and rice husk ash were given in Table 1. Rice husk ash was sieved from150 micron and used for further study.

D. Aggregate
Good quality river sand was used as a fine aggregate. The fineness modulus, specific gravity and dry density are 2.71, 2.7 and 1690 kg/m3. Coarse aggregate passing through 20mm and retained 10mm sieve was used. Its fineness modulus, specific gravity and dry density was 6.816, 2.68 and 1550 kg/m3.

E. Fibers
Steel fiber having low carbon and corrugated type used. The steel fibers have a length of 30 mm, diameter of 0.60 mm, aspect ratio of 50, and density of 7.85 g/cm3. Collect from FIBERZONE, AHMEDABAD.

F. Plasticizer
A commercial YASHKA Super Pra.20R plasticizer From Vardhaman Chemicals Private Limited from Ahmedabad was used to maintain the workability of fresh concrete. The dosage of hyper plasticizer was kept constant in mass basis; it was 0.8% of the binder content of concrete. The aim of keeping the amount of plasticizer constant is to neglect, if any, the influence of plasticizer on the properties of hardened concrete.

III. Mixture Composition and Proportion
Mix design is made for M25 grade of concrete accordance with the Indian Standard Recommended Method IS 10262-1982. At the beginning of the mixture design, binder content 385.5kg/m3(M25) and water– cement ratio 0.50(M25) were kept constant and then, the volume of aggregate was determined for reference Ordinary Portland Cement concrete by assuming approximately 2% air is trapped in fresh concrete. The volume of aggregate was used to determine the aggregate weight. Fresh concretes containing 10% to 25%

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rice husk ash as cement replacement in weight basis were prepared by modifying the reference Ordinary Portland cement concrete. Fresh fiber reinforced concretes containing 0.5%, 1.0%, 1.5% and 2.0% steel fiber in volume basis were prepared. Aggregate weight for a cubic meter was adjusted when rice husk ash or fiber introduced into concrete. The procedures for mixing the fiber reinforced concrete involved the following.

1. First, the gravel and sand were placed in a concrete mixer and dry mixed for 1 min.
2. Second, the cement and fiber were spread and dry mixed for 1 min.
3. Third, the mixing water (90%) was added and mixed for approximately 2 min.
4. Fourth, the remaining mixing water (10%) and plasticizer were added and mixed 3 min.
5. Finally, the freshly mixed fiber-reinforced concrete was cast into specimens mould and vibrated simultaneously to remove any air remained entrapped. After casting, each of the specimens was allowed to stand for 24 h in laboratory before demolding. Various percentages of rice husk ash and steel fibers for M25 Grade of concrete are shownintable2.

Table 1 Chemical Composition of CEMENT and RICE HUSK ASH (%)

OXIDE	Sio_2	Al_2O_3	Fe_2O_3	CaO	MgO	So_3	K_2O	Na_2O_3	LiO
CEMENT	21.52	5.65	4.43	66.24	1.22	2.89	0.93	0.3	1.04
RICE HUSK ASH	93.8	0.74	0.30	0.89	0.32	0.10	0.12	0.28	3.37

IV. TESTING METHODS

Experimental investigation of fresh mix properties of fiber reinforced rice husk ash concrete was conducted based on IS: 516 – 1959 using a slump cone. Compressive and Flexural strength of each specimen was determined using IS: 516 - 1959 and splitting tensile strength of each specimen was determined using IS: 5816 - 1959.Length change was measured according to IS: 516 - 1959. Compressive strength were measured 7, 28 and 56 days and flexural tensile strengths were measured 7 and 28 days of testing. Splitting tensile strengths were measured at 7 and 28 days. Specimens were cube with a 150 mm side for compressive strength, prism with dimensions of 100 * 100 * 700 mm for flexural tensile strength, cylinder with 150 mm diameter and 300 mm height for splitting tensile strength.

V. RESULTS AND DISCUSSION

A. Unit weight and workability

Unit weight, V-B time and slump value workability measurement were carried out on fresh fiber reinforced rice husk ash concrete. The results of unit weight, V-B time and slump values for M25 grade of concrete are presented in Table2. The results indicate that the unit weight of concrete increased uniformly with the increase in fiber content and decreased with the increase of rice husk ash content. Generally, the unit weights of steel fiber reinforced concretes were higher than that of concrete without fibers for each group. Table 2 shows that inclusion of steel fiber reduced workability. Furthermore, increase in the steel fiber content causes additional reduction in workability. However, incorporation of rice husk ash as cement replacement in fresh steel fiber reinforced concrete also decreases workability when compared to reference concrete made without rice husk ash. Moreover, increase in the rice husk ash content causes further decrease in workability. It is found that V-B time is more sensitive not only towards steel fiber addition but also rice husk ash addition. Therefore, these comparisons made between V-B time and slump value workability's, show that V-B time measurement is more appropriate than the slump value measurement as an indicator of the workability of fresh fiber reinforced concrete (see Table 2).

B. Compressive strength

Compressive strength of concrete mixtures was measured at the ages of 7, 28 and 56 days and shown in Table 3. There was an increase up to 10% and reduction up to 6% compressive strength of cube concrete specimens produced with steel fiber.

This may be due to the physical difficulties in providing a homogeneous distribution of the steel fibers within the concrete causing rise or drop in the compressive strength as compared to the plain concrete. The addition of steel fibers to the concrete mixture did not improve compressive strength of 7 days and 14 days of curing specimen, but after 28days and 90 days only small increase (up to 10%) in compressive strength with increase in fiber content was observed. The presence of rice husk ash, when compared with plain concrete, decreased the average compressive strength by 10% and 14% for 15% and 30% rice husk ash replacement ratio, respectively. It is observed that steel fibers did not recover the compressive strength loss of rice husk ash. If the amount of mixing water was reduced on the basis of equal V-B workability, it appears that the reduction in compressive strength due to addition of rice husk ash can be recovered significantly.

C. Flexural tensile strength

The results of flexural tensile strength tests are to be conducted on steel fiber reinforced concrete with and without rice husk ash are presented in Table 4.

When compared to plain concrete, the presence of rice husk ash in concrete decreased the average flexural tensile strength by 10% and 20% for 2.5% to 20% rice husk ash replacement ratio, respectively. This comparison is valid for the concrete made with steel fiber. This reduction decreases in time due to pozzolanic reaction of rice husk ash. On the other hand, steel fibers have significant effects on flexural tensile strength at 0.25% to 1.0% volume fractions used in this study. The increase in the fiber content in concrete results with the further increase in flexural tensile strength for both Portland cement concrete and rice husk ash concrete. However, it was the flexural tensile stress or strength that play an important role for the failure of beam. Randomly distributed steel fiber controls these cracks and stitch them. Therefore, when steel fiber controls these crack, the load to fail the beam specimen has to be increased to cause more crack for the failure. Thus, steel fiber addition increases the ultimate flexural tensile strength of material .The more the steel fiber amount in concrete the higher the increase in flexural tensile strength can easily be concluded.

D. Splitting tensile strength

The splitting tensile strength test results of fiber reinforced concrete with and without rice husk ash are presented in Table 4. The results show that in general, there is an increase in splitting tensile strength varying from 1% to 65% with the addition of fibers to the concrete. Steel fibers in the concrete increases the splitting tensile strength. The highest volume fraction of fibers gives the maximum increase of strength.

Table 2 Various Percentage and Properties of M 25 Grade of concrete

NO.	RHA(%) BY WEIGHT	FIBER(%) V_f	M 25		
			Density (kg/m^3)	V-B (s)	Slump (cm)
1	0	0	2530	7.3	19.5
2	10	0	2523	10.0	13.0
3	15	0	2518	13.8	11.0
4	20	0	2500	15.9	9.5
5	25	0	2489	17.4	8.0
6	15	0.5	2522	4.0	10.5
7	15	1.0	2528	7.9	8.0
8	15	1.5	2532	10.9	6.5
9	15	2.0	2538	12.3	5.0

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Table 3 Compressive Strength test on M25 Grade of concrete

NO.	RHA(%) BY WEIGHT	FIBER(%) V_f	Compressive Strength(M 25)		
			7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	0	0	30.95	36.12	39.93
2	10	0	31.70	37.87	41.27
3	15	0	32.83	43.65	47.87
4	20	0	30.29	36.12	40.34
5	25	0	28.56	31.90	37.83
6	15	0.5	32.49	42.54	46.12
7	15	1.0	34.07	44.15	48.07
8	15	1.5	35.26	45.98	49.12
9	15	2.0	37.11	47.12	52.76

Table 4 Flexural strength for M 25 grade of concrete

NO.	RHA(%) BY WEIGHT	FIBER(%) V_f	Flexural Strength(M 25)		
			3 Days (N/mm^2)	7 Days (N/mm^2)	28 Days (N/mm^2)
1	0	0	2.75	3.91	4.16
2	10	0	3.11	4.5	5.06
3	15	0	4.055	5.3	5.53
4	20	0	3.02	4.57	5.01
5	25	0	2.74	3.86	5.3
6	15	0.5	4.2	5.11	5.99
7	15	1.0	4.65	5.72	6.9
8	15	1.5	5.06	6.12	7.87
9	15	2.0	5.39	6.76	8.42

Table 5 Splitting tensile strength test for M 25 grade of concrete

NO.	RHA(%) BY WEIGHT	FIBER(%) V_f	Splitting Tensile Strength(M 25)		
			7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	0	0	1.78	3.14	4.13
2	10	0	2.16	3.89	5.17
3	15	0	2.97	4.57	5.7
4	20	0	2.87	3.96	4.9
5	25	0	2.46	3.56	4.55
6	15	0.5	3.46	4.80	6.87
7	15	1.0	4.06	5.97	7.12
8	15	1.5	4.385	6.56	8.54
9	15	2.0	4.905	8.87	10.89

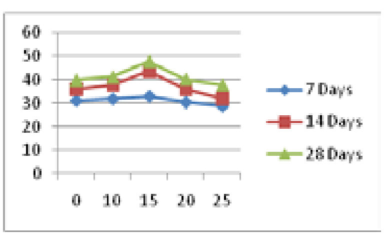

Fig. 1. Effect of Rice husk ash on compressive Strength of concrete for M 25.

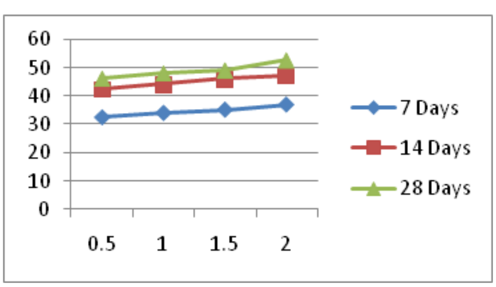

Fig. 2. Effect of fibers and RHA on compressive Strength of concrete for Max. % of RHA.

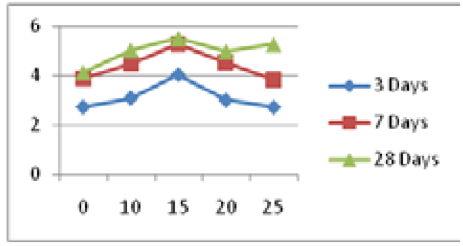

Fig. 3. Effect of Rice husk ash on Flexural strength of concrete for M 25.

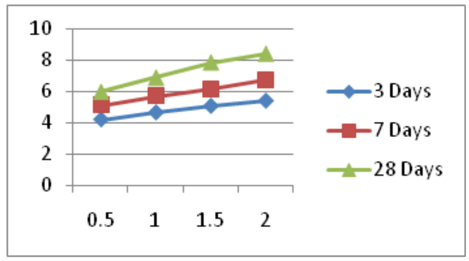

Fig. 4. Effect of fibers and RHA on Flexural Strength of concrete for Max. % of RHA.

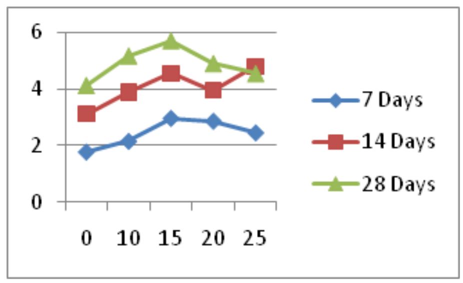

Fig. 5. Effect of Rice husk ash on Splitting Tensile strength of concrete for M 25.

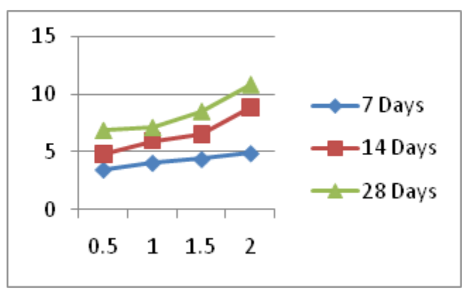

Fig. 6. Effect of fibers and RHA on Splitting Tensile Strength of concrete for Max. % of RHA.

VI. CONCLUSIONS

From this laboratory work the following conclusions were made:

1. The unit weight of concrete increased uniformly with the increase in fiber content and decreased with the increase of rice husk ash content.
2. The inclusion of steel fiber reduced workability with increasing fiber content.
3. However, incorporation of rice husk ash as cement replacement in fresh steel fiber reinforced concrete also decreases workability when compared to control concrete made without rice husk ash.
4. The comparisons made between V-B time and slump value workability's, show that V-B time measurement is more appropriate than the slump value measurement for an indicator of the workability of fresh fiber reinforced concrete.

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5. The addition of steel fibers into concrete mixture did not improve its ultimate compressive strength of 7 days and 14 days of curing specimen, but after 28day only small increase in compressive strength with increase in fiber content was observed.
6. It is observed that steel fibers did not recover the compressive strength loss of rice husk ash.
7. Steel fibers have showed more significant effects on flexural tensile strength at 0.5% to 2.0% volume fractions used in this study.
8. There is an increase in splitting tensile strength varying from 1% to 65% for concrete mixes having 0.5%, 1.0%, 1.5% and2.0% volume fractions of fibers with and without rice husk ash, respectively.
9. Moreover, there is no clear indication of significant effect of rice husk ash on the modulus of elasticity of concrete.
10. As the Steel fiber are expensive we could not able to maintain the economy of construction.

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