International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 5, July-August 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Effect on High Grade Concrete Due to Partial Replacement of Rice Hush Ash and Steel Fiber

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ABSTRACT

India is the second largest producer of cement in the world. It accounts for more than 8% of the global installed capacity. The pollutants commonly emitted by cement plants are dust or particulate matter, NOx, SOx, carbon oxides and methane, among others. Cement being the major contributor to air pollution, an approximate number of 4,90,000 annual deaths may be attributed to emissions from the cement industry. Cement is the need of growing infrastructure and real estate and researchers are trying for some alternative materials of cement which will not only partially replace the cement content but also improves its strength. In this research work the Rice Husk Ash (RHA) and steel fiber (SF) are used as partial replacement. The analysis has been carried out for percentage with proportions of 0%, 5%, 10%, 15%, 20% and 25% RHA by weight of cement in addition to that combined effect of adding various percentage of SF of 0.5%, 1% and 1.5% to obtain optimum result. The analytical study concluded that mix 10% RHA and 1.5% SF is the optimum combination among all mixes.

***KEYWORDS:** Rice Husk Ash, Steel Fiber, Partial Replacement, Cement*

How to cite this paper: Yashwantrao Vishal Sharad Sharmila | Ankita Ramchandra Bhoir | M. D Daniyal "Effect on High Grade Concrete Due to Partial Replacement of Rice Hush Ash and Steel Fiber" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-5, August 2022, pp.776-782, URL: www.ijtsrd.com/papers/ijtsrd50564.pdf

IJTSRD50564

I. INTRODUCTION

The construction industry is increasing at an exponential proportion and this has an influence on the prerequisite for construction materials which plays vital role in any industry. Currently, sustainable progress is one of the most wellbeing in India and around the world. Natural material like aggregates used in construction is bit by bit being depleted. Therefore, the development of sustainable construction materials is necessary. There is a direct correlation between the construction industry, available resources, energy intake and emissions of carbon dioxide (CO_2). Negative environmental

Impacts associated with widespread use of cement has led researchers to take giant steps concerning the advancement of tools and materials with the aim of decreasing the over-reliance of cement in the production of concrete and masonry building materials

On the other hand, a large quantity of agricultural leftover was disposed in most of countries particularly in Asia region like India, Thailand, Philippine and Malaysia. If the agriculture waste is not disposed appropriately, it will lead to social and environmental concerns. Recycling or reusing of the disposed material is one of the appropriate ways of treating the agricultural leftover and waste. The use of RHA material in the development of a composite material that can be used for construction can be helpful in many prospects. RHA is hazardous to environment if not dispose appropriately.

It is well known fact that, during manufacturing of 1 tone of Portland cement, cements industry required equal amount of earth resources and equal amount of CO2 are released into the nature. Past researches have been focusing towards the utilization of waste materials in concretes. Even research has been intensified in the use of some locally available materials which can serve as partial replacement for cement in construction works due to the need to decrease to high cost involved in using Ordinary

Portland cement in concrete. In this paper, the research works carried out to analyses the effect of RHA on the compressive strength of concrete after 7, 14 and 28 days at different percentages and to evaluate the combine effect of RHA and steel fiber added to concrete as a partial replacement.

A. Problem Statement

Concrete is the second highest material used in world in usage next to water. For last few decades, there are many concerns raised for the continuous increase of cement use because the manufacturing of cement causes enormous amount of CO_2 emission and it also consume noteworthy amount of natural rock and minerals that may prime to deplete at one point of time. Manufacture of one tone of Portland cement (PC) generates about one ton of CO_2 to the atmosphere which constitutes 5% global CO_2 emission (Worrell, 2001 as cited by Gaurav and Amit, 2015). Approximately 8% - 10% of the CO_2 emissions in the world come from the manufacturing of cement; this makes it a crucial area when it comes to the mitigation approaches concerned with the reduction of CO_2 emissions (Ernst Worrell et al, 2001 as cited by Gupta and Wayal, 2015). Due to increase in the cost of conventional building materials and environmental threat, the designers and developers are looking for 'alternative materials' to reduce the use of cement in construction practices.

B. Objective of Study

Following are the prime objectives of this research article

1. To investigate optimum percentage of Rice Husk Ash as a partial replacement of cement and find mechanical properties in fresh state and hardened state.
2. To study the combined effect of different percentage of Steel Fiber with optimum percentage of Rice Husk Ash in concrete.

II. LITERATURE REVIEW

An extensive literature review has been carried out to explore the background information on current knowledge related to the research topic.

TABLE I RESEARCH PAPER ON RHA

Year of Publish	Tittle of Research Paper	RHA (%)	Properties	Effect
2017	Rice husk ash as a partial replacement of cement in high strength concrete containing micro silica	20	Compressive Strength	+ 6.9 %
			Tensile Strength	+6.8 %
			water Permeability	-26%
			chloride Permeation	-78%
2017	Effect of RHA as Partial Replacement of Cement on Concrete Properties	20	Workability	Dec.
			Compressive Strength	Inc.
			Shrinkage	No effect
			Setting Times	Inc.
2018	Performance Evaluation of Steel Fibers in Rice Husk Ash Substituted Concretes	10	Compressive Strength	Inc.
			Tensile Strength	Inc.
2018	Effect of Rice Husk Ash on Properties of Concrete	20	Compressive Strength	Inc.
			Tensile,	Inc.
			Flexure	Inc.
2019	Use Of Rice Husk Ash As Partial Replacement For Cement In Concrete	0 -20	Compacting Factor	Dec.
			Compressive Strength	Inc.
2020	Effect of Partial Replacement of Cement by Rice Husk Ash in Concrete	10	Cost	-(7-10)%
			Compressive Strength	Inc.
2020	Experimental Study on Rice Husk Ash in Concrete by Partial Replacement	12.5	Tensile Strength	Inc.
			Flexural Strength	Inc.
			Compressive Strength	Inc.
2021	An Experimental Study on Rice Husk Ash as Partial Replacement for Cement in Concrete	20	Flexural Strength	Inc.
			Compressive Strength	Inc.
			Cost	Dec.
2021	Characteristics of Fiber-Reinforced Rice Husk Ash Concrete on Strength	15	Flexural Strength	Inc.
			Compressive Strength	Inc.
			Cost	Dec.

TABLE II RESEARCH PAPER ON SF

Year of Publish	Tittle of Research Paper	SF (%)	Properties	Effect
2016	Effect of Partial Replacement of Cement by Fly Ash, Rice Husk Ash with Using Steel Fiber in Concrete	0.75	Compressive Strength	Inc.
			Flexural Strength	Inc.
2018	Characteristics of Fiber-Reinforced Rice Husk Ash Concrete on Strength	1.5	Compressive Strength	+29.79%
			Splitting Tensile Strength	+15.44%
			Flexural Strength	+47.61%
2019	Optimization of Mechanical Properties of Glass Fiber Reinforced Concrete with the Combination of Rice Husk Ash	1	Compressive Strength	Inc.
			Flexural Strength	Inc.
2019	Experimental Study on Strength of Concrete by Using Artificial Fibers with Rice Husk Ash	0.75	Splitting Tensile Strength	Inc.
			Flexural Strength	Inc.
2020	Experimental study on steel fiber reinforced concrete with a partial replacement of cement by rice husk ash	1.5	Compressive Strength	Inc.
			Splitting Tensile Strength	Inc.
			Flexural Strength	Inc.

III. MATERIALS

The concrete mix is designed as per relevant code of practice. Different materials used in present study were cement, coarse aggregates, fine aggregates, Rice husk Ash and steel fibers.

A. Cement

Shree Cement Ltd. Cement Company, Ordinary Portland Cement (OPC) of 43 Grade of an Ultra tech brand from a single lot was used throughout the course of the investigation. It was fresh and without any lumps. The physical properties of the cement as determined from third party certification to the lot were conforming to Indian Standards IS: 8112:1989.

B. Fine Aggregate

The sand used for the work was locally procured and conformed to Indian Standard Specifications IS: 383-1970.In this experimental program, fine aggregate (stone dust) were collected from Vsi Crusher and conforming to Grade Zone I. It was coarse sand light brown in colour.

C. Course Aggregate

Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The aggregates were tested as per IS: 383-1970. The aggregates were washed to remove dirt, dust and then dried to surface dry condition.

D. Rice Husk Ash

Rice husk ash used in investigation has been obtained from Madhav Enterprise. The Specific gravity of rice husk ash sample is 2.28.

E. Steel Fiber

Mild steel fibers used in this investigation are purchased from Riddhi Enterprise having 25 to 30 mm length and 0.6 mm thickness i.e. aspect ratio (l/d) 50 which are corrugated and obtained through respective cutting of steel wires to have a good workability in used.

F. Water

The potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly potable water was used from laboratory tap for making concrete. The water was clean, free from any visible impurities and any detrimental contaminants and was good to be used quality.

IV. RESULT AND DISCUSSION

The test has been performed in standard size 150 X 150 X 150 mm to check the compressive strength with mix for various percentage of steel fiber and replacement of Rice husk Ash has been illustrated in tabular form as follows.

TABLE III COMPRESSIVE STRENGTH OF CUBE SPECIMEN AT VARIOUS INTERVALS

Srl No.	Composition of concrete	7 days	14 days	28 days
1	RHA 0% / SF 0%	26.40	36.99	47.7
2	RHA 5% / SF 0%	25.99	36.0	46.1
3	RHA 10% / SF 0%	25.76	35.7	45.7
4	RHA 15% / SF 0%	24.48	32.6	40.7
5	RHA 20% / SF 0%	22.81	29.4	36.1
6	RHA 25% / SF 0%	20.97	28.1	35.3
7	RHA 5% / SF 0.5%	26.08	36.8	47.5
8	RHA 10% / SF 0.5%	26.13	36.9	47.7
9	RHA 15% / SF 0.5%	23.06	33.0	43.0
10	RHA 20% / SF 0.5%	22.11	29.2	37.1
11	RHA 25% / SF 0.5%	20.85	27.2	34.6
12	RHA 5% / SF 1%	26.88	37.4	48.5
13	RHA 10% / SF 1%	26.93	37.9	48.9
14	RHA 15% / SF 1%	25.27	33.9	43.2
15	RHA 20% / SF 1%	21.98	30.0	38.2
16	RHA 25% / SF 1%	20.28	28.6	37.0
17	RHA 5% / SF 1.5%	27.43	37.8	48.6
18	RHA 10% / SF 1.5%	27.69	39.0	50.3
19	RHA 15% / SF 1.5%	24.43	34.4	44.4
20	RHA 20% / SF 1.5%	21.55	30.3	39.2
21	RHA 25% / SF 1.5%	21.18	28.9	36.6

Above table clearly showing the variation of compressive strength, it is also observed that with the increase in percentage of steel fiber the strength increases. This happens because when steel fibers are added to concrete, the propagation of cracks was restrained due to the bonding of fibers into the concrete (ductile failure). Also it is observed that one of the most desirable benefits of adding fibers to concrete is to increase its energy absorbing capability or saying more precisely ductility. Referring to the graphs of above section, it is observed that for addition of 1.5% steel fiber and replacement of cement with 10% Rice husk Ash, the compressive strength increases the most when compared to nominal mix.

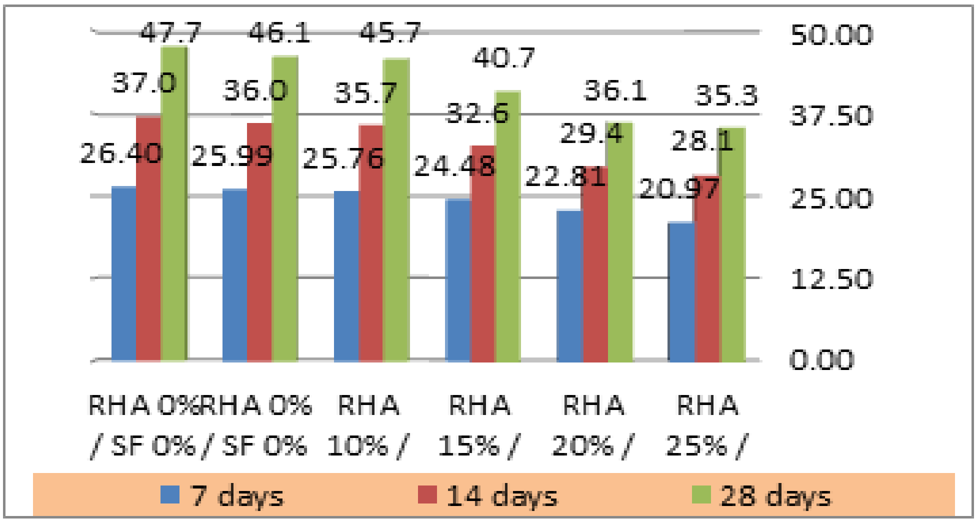

Fig. No. 1: Compressive Strength of Concrete For 0% S.F and Different Percentage of RHA

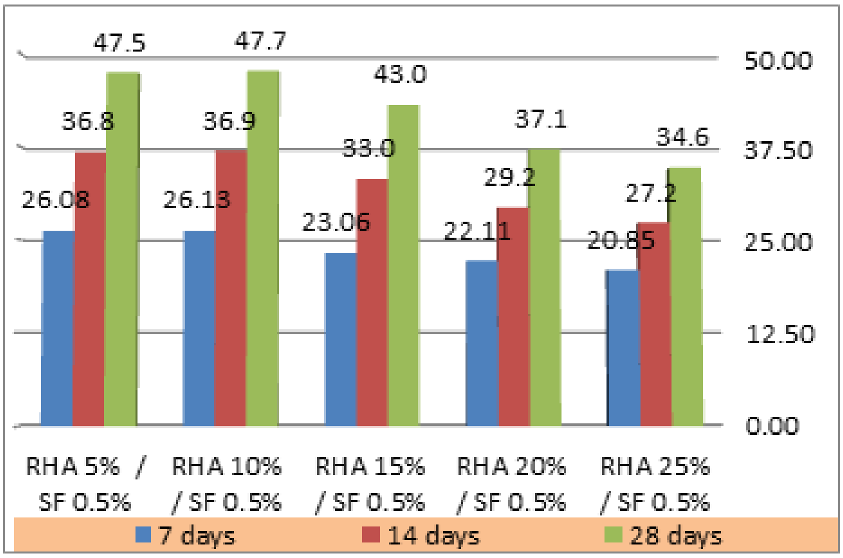

Fig. No. 2: Compressive Strength of Concrete For 0.5% S.F and Different Percentage of RHA

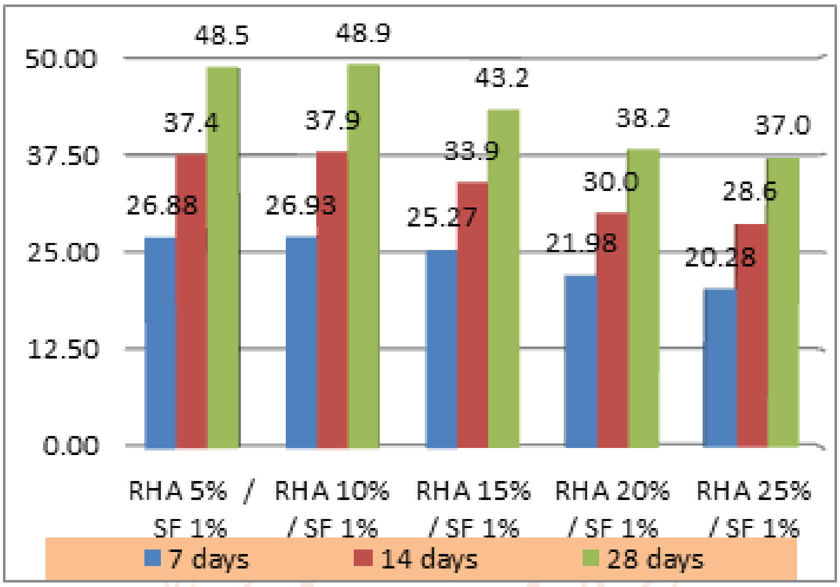

Fig. No. 3: Compressive Strength of Concrete For 1% S.F and Different Percentage of RHA

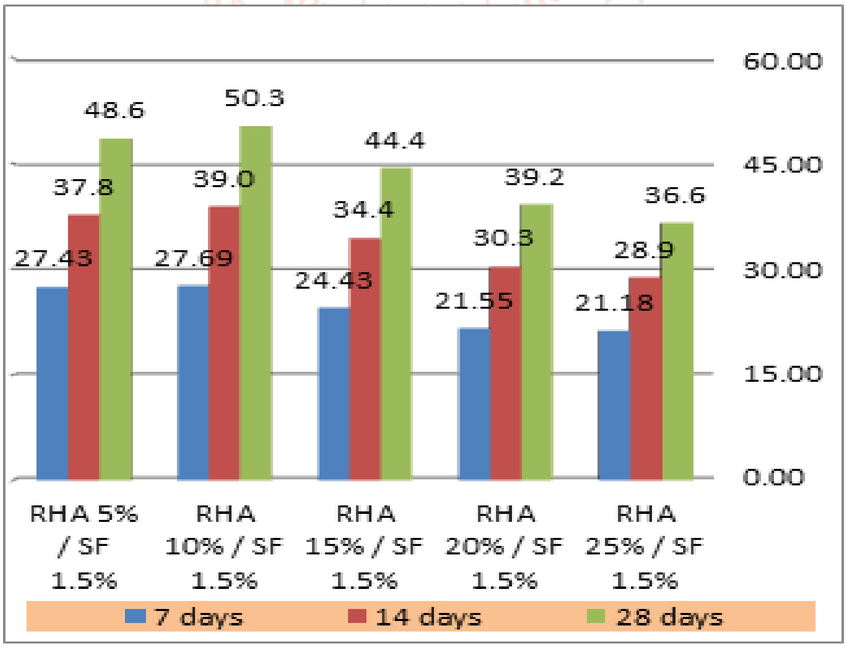

Fig. No. 4: Compressive Strength of Concrete For 1.5% S.F and Different Percentage of RHA

The test has been performed in standard size 150 X 150 X 700 mm to check the flexure strength with mix for various percentage of steel fiber and replacement of Rice husk Ash in flexure test machine has been illustrated in tabular as follows.

TABLE IV FLEXURE STRENGTH OF CUBE SPECIMEN AT VARIOUS INTERVALS

Srl No.	Composition of concrete	7 days	14 days	28 days
1	RHA 0% / SF 0%	4.13	4.72	5.28
2	RHA 5% / SF 0%	3.97	4.57	5.14
3	RHA 10% / SF 0%	3.70	4.26	4.79
4	RHA 15% / SF 0%	2.67	3.48	4.25
5	RHA 20% / SF 0%	2.39	3.08	3.73
6	RHA 25% / SF 0%	2.07	2.79	3.47
7	RHA 5% / SF 0.5%	3.90	4.49	5.05
8	RHA 10% / SF 0.5%	3.67	4.36	5.01
9	RHA 15% / SF 0.5%	2.81	3.59	4.34
10	RHA 20% / SF 0.5%	2.52	3.24	3.92
11	RHA 25% / SF 0.5%	2.21	2.86	3.48
12	RHA 5% / SF 1%	4.07	4.67	5.23
13	RHA 10% / SF 1%	3.97	4.61	5.22
14	RHA 15% / SF 1%	2.96	3.72	4.45
15	RHA 20% / SF 1%	2.65	3.40	4.12
16	RHA 25% / SF 1%	2.40	3.17	3.91
17	RHA 5% / SF 1.5%	4.22	4.78	5.30
18	RHA 10% / SF 1.5%	4.30	4.95	5.57
19	RHA 15% / SF 1.5%	3.80	4.60	5.36
20	RHA 20% / SF 1.5%	2.84	3.75	4.63
21	RHA 25% / SF 1.5%	2.52	3.39	4.22

Above section clearly showing the variation of flexure strength, it is also observed that with the increase in percentage of steel fiber the strength increases. This happens because when steel fibers are added to concrete, the propagation of cracks was restrained due to the bonding of fibers into the concrete (ductile failure). Also it is observed that one of the most desirable benefits of adding fibers to concrete is to increase its energy absorbing capability or saying more precisely ductility. Referring to the graphs of above section, it is observed that for addition of 1.5% steel fiber and replacement of cement with 10% Rice husk Ash, the flexure strength increases the most when compared to nominal mix.

V. CONCLUSION

- Concrete mix with 10 percent Rice husk Ash as replacement of cement and 1.5% addition of steel fiber is the optimum level and it has been observed to show a significant increase in compressive strength at 7days, 21 days and 28 days when compared with nominal mix.
- The flexure strength also tends to increase with the increase percentage of steel fiber, a trend similar to increase in compressive strength.
- On increasing the percentage replacement of cement with Rice husk Ash beyond 10%, there is significantly decrease in compressive and flexure strength value.

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