Mechanical Properties of Fibre Reinforced Self Compacting Concrete using Rice Husk Ash

V Mallikarjuna Reddy, S Manikanta

Abstract: Self-compacting concrete (SCC) is relatively a recent development in the construction world. SCC can flow through dense reinforcement under its own weight without any segregation, bleeding, and vibration. The use of steel fibers is being encouraged to increase mechanical characteristics of SSC. However, adding fibers to fresh concrete results in loss of workability. Steel fibers operate as crack arrestors in concrete and extend the span of structures. In the present study, the mechanical properties of SCC with cement is partially replaced by rice husk ash (RHA) & P500 (ultra-fine fly ash). A total of 5 mixes with 0.3 W/C ratio were cast for 7, 28 and 56 days water curing. The replacement of fibres is considered as 0%, 0.5%, 1%, 1.5%, and 2% by weight of cement. Workability, Compressive, Split Tensile and Flexural strength is studied in this investigation. Superior strength was observed at optimum dosage of steel fibers at 1.5% by weight of cement.

***Keywords*: SCC, Husk Ash, P500 (ultra-fine fly ash) , steel fibres**

I. INTRODUCTION

This paper gives a review on Self Compacting Concrete (SCC) to be made using various Mineral Admixtures and steel Fibres. Due to the difficulty in placing the concrete in congested reinforcement where there is no possibility for the vibrator to compact manually so an invention of new type of concrete is done and named as self-compacting concrete (SCC)[1]. This concrete can pass through congested reinforcement easily and to all corners of shuttering SCC can compact by its own weight without requirement of any manual compaction [2].

Rice Husk Ash (RHA) is produced after burning of Rice husks (RH) which has high reactivity and pozzolanic property. RHA having less density so concrete density also decreases. Strength development can be increased& durability of the structure is improved. Due to its large surface area and has a high amount of silica content the pores in the concrete are neglected and seepage of liquids through concrete is minimized. Use of rice husk ash economize the construction materials. Proper consumption of these RHA contributes to solving environmental pollution and also

produces cost-effective concrete. Greenhouse gases can be decreased to a greater extent when we use RHA in concrete with partial replacement of cement [3].

Steel fiber is a metal reinforcement. A certain amount of steel fiber in concrete can cause qualitative changes in concrete's physical properties. Steel fibers are well known to improve the resistance to crack growth thereby improves the mechanical properties. But the problem with steel fibers reduces the workability [4]. To control plastic shrinkage cracking and drying shrinkage cracking fibres are used. They also lower the permeability of concrete and thus reduce bleeding of water[5].

II. MATERIALS

2.1 Cement- Ordinary Portland Cement of 53 grade confirming to be12269 is used and the physical properties are as shown in table.1**.**

Table.1 Physical properties of Cement

S.No	Property	Details
1	Specific gravity	3.12 gm/cc
2	Fineness	8%
3	Normal consistency	28%
4	Initial Setting time	37min
5	Final Setting time	450min

2.2Rice Husk Ash: - Rice Husk Ash is collected from brick Manufacturers after that it is Ground in ball mill and Sieved to required size. Ignition loss is found to be 5% and the Specific gravity of RHA is determined as 1.83. Chemical properties of RHA is as shown in Table.2

Table.2. Chemical Properties of RHA

S.No	Compound	% By total mass
		RHA
1	SiO_2	92.39
2	Al_2O_3	0.54
3	Fe_2O_3	0.91

Manuscript published on 30 September 2019
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4	MgO	0.87
5	CaO	1.32
6	Others	3.97

2.3 P500 (Ultrafine fly ash): -ultrafine fly ash is produced from pure class F fly ash by grinding and specific gravity is 2.18, mean particle size is 3.9-5.0, the surface area is 13000sqcm/kg.

Fig.1 Rice husk ash

Fig.2 Ultrafine fly ash

2.4Fine Aggregate (F.A)

Locally available river sand used in SCC with particle size less than 0.125mm. which is confirming to zone II.

2.5 Coarse Aggregate (C.A)

Coarse aggregate used for the preparation of SCC was 12mm in size and their Properties are as shown in Table.3

Table.3 Properties of F.A& C.A

Property	F.A	C.A
Bulk Density (kg/m^3)	1550	1502
Specific Gravity	2.63	2.6
Surface water (%)	0.5	0.5
Water Adsorption (%)	0.4	0.2

2.6 Super Plasticizer

The superplasticizer used in the mix was Master Ease 3709. This plasticizer is the product of BASF. This plasticizer also contains viscosity modifying agents (VMA). The workability of concrete is high due to the presence of VMA.

Fig.3 Super Plasticizer

2.7 steel fibers

The fibers used are hooked end steel fibers of aspect ratio 40.which are randomly oriented and uniformly distributed. This study is carried out by changing the fiber proportions from 0% to 2% with 0.5% increment.

2.8 Water

Portable water is generally considered for mixing concrete which was free from oils, impurities, acids and salts and also That should fulfill the requirements of IS:456-2000.

III. MIX DESIGN

Grade of concrete = M40

Cementitious material = 470 Kg per m^3 (Cement+RHA+P500)

Fine Aggregate (M-sand) = 920 Kg per m^3

Coarse Aggregate (10mm) = 808 Kg per m^3

Superplasticizer =1% of Total Binder

w/c ratio =0.3

3.1 Specimens Used

A total of 135 specimens were cast where 45 no. of cubes are used to conduct the Compressive Strength, 45 no. of Cylinder used for Split Tensile Strength and 45 no. of Beams are used for the Flexural Strength.

IV. RESULTS AND DISCUSSIONS

Initially, a test was conducted for 28 days of compressive strength to know the optimum percentage replacement of rice husk ash with four different mix proportions 5%,10%,15%,20%.

To determine the compressive strength for 28 days 3 cubes for each mix is prepared.

Table.4 compressive strength for 28 days

RHA %	28 days compressive strength(N/mm^2)
5%	45.1
10%	46.73
15%	48.21
20%	47.25

From table 4 it is observed that 15% replacement of rice husk ash is giving more strength and further increasing the RHA% decreases the strength. So therefore 15% RHA is taken as the optimum replacement and further experiments with different proportions of fibers are determined.

Retrieval Number C5665098319/2019©BEIESP
DOI: 10.35940/ijrte.C5665.098319
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Five mixes with 0%, 0.5%, 1.0%, 1.5% and 2.0% replacement of fibres with weight of binder is considered and remaining materials are kept constant . They are designated as Mix-1, Mix-2, Mix-3, Mix-4 & Mix-5. Mix-1 is considered a conventional mix when comparing mechanical properties.

V. EXPERIMENTAL RESULTS

Each mix tested for Fresh concrete properties and Hardened properties. Fresh properties of SCC are tested as per EFNARC Guidelines. Fresh properties are as shown in Table.5.

Table.5 Fresh Properties of SCC

Property	M-1	M-2	M-3	M-4	M-5
Slump (mm)	640	628	615	602	588
L-box (ratio)	0.89	0.85	0.79	0.76	0.71
V-funnel (sec)	11	15	18	21	25

5.1 Hardened Properties

The strength test on concrete is conducted as per IS 516-1959. Compressive, Split Tensile and Flexural Strengths are shown graphically below. Each property tested for 7days, 28days and 56 days.

5.1.1 Compressive Strength

Compressive strength of concrete is considered with the strength of 150mm cube but I have used 100mm cube and then the obtained strength is multiplied with the conversion factor 0.9. The cubes are cast and cured for 7 days, 28days and 56 days. Compressive strength results & percentage gain according to a conventional mix are shown in table 6.

Table 6: Compressive Strength results

Mix	7days	% gain	28 days	% gain	56 days	% gain
Mix1	28.26	0	48.2	0	51.2	0
Mix2	29.3	3.68	48.83	1.31	52.43	2.4
Mix3	30.47	7.82	49.16	1.99	53.66	4.8
Mix4	32.01	13.27	50.03	3.8	54.63	6.7
Mix5	31.05	9.87	49.3	2.28	53.9	5.27

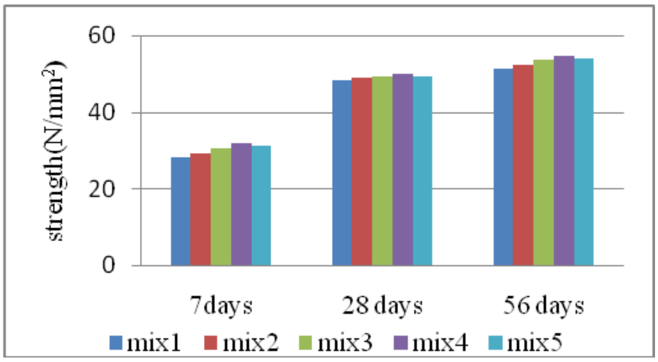

Fig 4: compressive strength results

The percentage variation in the strength is compared with the conventional mix and it was observed that %gain in strength is increased from 0 to 3.80 for 28days and 0 to 6.70 for 56 days. Further increase in fibers decreases strength.

5.1.2 Split Tensile Strength

Split tensile strength is done by using 100mm diameter and 200mm height cylinders. It is one of the important properties of concrete. Split Tensile strength of concrete is much lower than its compressive strength. Totally 45 cylinders are cast to 5 mixes for 7, 28 and 56 days. Split tensile strength results & percentage gain according to the conventional mix are shown in table 7.

Table 7: Split tensile Strength results

Mix	7days	% gain	28 days	% gain	56 days	% gain
Mix1	2.86	0	3.18	0	3.82	0
Mix2	2.55	-10.8	3.32	4.4	3.9	2.09
Mix3	2.91	1.75	3.5	10.06	4.14	8.38
Mix4	3.5	22.38	3.82	20.13	4.45	16.49
Mix5	3.18	11.19	3.55	11.64	4.2	9.95

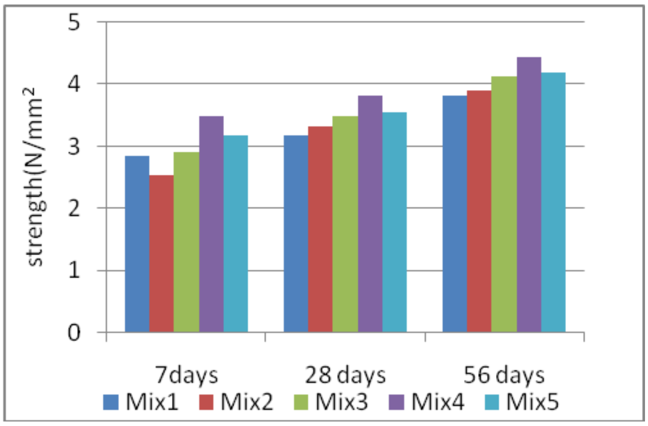

Fig 5: Split tensile Strength results

The percentage variation in the strength is compared with the conventional mix and it was observed that %gain in strength is increased from 0 to 20.13 for 28days and 0 to 16.49 for 56 days. Further increase in fibers decreases strength.

5.1.3 Flexural Strength

It is a measure of an un-reinforced concrete beam to resist failure in bending. The flexural strength of beam is tested on two-point loading and the cross-section of beam used was 100mm Square cross-section and 500mm length. The obtained Flexural strength values & percentage gain according to conventional mix are shown in table 8.

Table 8: Flexural strength results

Mix	7days	% gain	28 days	% gain	56 days	% gain
Mix1	4.4	0	4.8	0	5	0
Mix2	4.6	4.55	5	4.17	5.2	4
Mix3	4.72	7.27	5.2	8.33	5.4	8
Mix4	5	13.64	5.4	12.5	5.6	12
Mix5	4.8	9.09	5.28	10	5.52	10.4

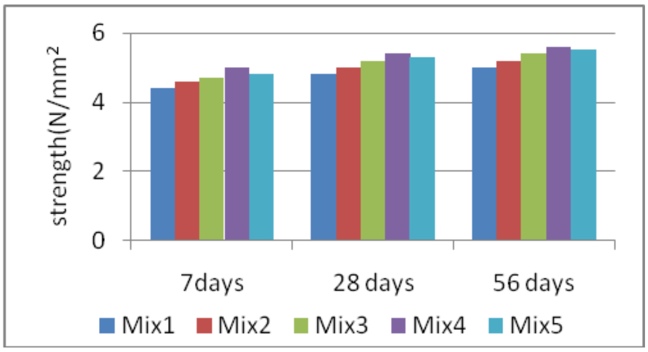

Fig 6: compressive strength results

The percentage variation in the strength is compared with the conventional mix and it was observed that %gain in strength is increased from 0 to 12.50 for 28days and 0 to 12.00 for 56 days. Further increase in fibers decreases strength.

VI. CONCLUSION

Based on the above experimental results the following conclusions were drawn;

- Compressive strength for 28 days is optimum when 15% of cement is replaced by rice husk ash and that is considered as the optimum RHA replacement.
- The increase in the percentage of fibers decreases the workability.
- From the results, it is observed that the compressive strength, split tensile strength and flexural strength increases with the increase in Steel fibers up to 1.5%.
- The cost of the construction can be minimized because rice husk ash cost is low compared to cement

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