A STUDY ON SELF COMPACTING CONCRETE AND ORDINARY CONCRETE WITH RICE HUSK ASH AS A PARTIAL REPLACEMENT FOR CEMENT

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ABSTRACT

This paper presents a review on self compacting concrete and ordinary concrete with RHA (Rice husk ash) as a partial replacement of cement, due to the high increase in construction which has brought a heavy demand for ingredients of concrete such as cement and sand, and these materials are becoming costly and scarce. Rice Husk ash is a waste material its use in the production of concrete may prove to be advantageous in an agriculture driven economy like India. It has been used as a highly reactive pozzolanic material to improve the microstructure of the interfacial transition zone (ITZ) between the cement paste and the aggregate in self-compacting concrete. The basic objective of the study is to understand the strength characteristics of the self-compaction mixes with different compositions of RHA (5% 7.5% 10% 12.5% 15%) and are compared with conventional concrete. Various specimens were tested for compressive, split tensile and flexural strength of self-compacting concrete and ordinary concrete incorporating various percentage of rice husk ash.

KEYWORDS: Rice Husk Ash, Viscosity Modifying Agent, Super plasticizer, Compressive strength, Split tensile strength and Flexural Strength.

I.INTRODUCTION

One of the most outstanding advances in the concrete technology over the last decade is "self compacting concrete". SCC is highly workable concrete that can flow through densely reinforced and complex structural elements under its own weight and adequately fill all voids without segregation, excessive bleeding, excessive air migration (air-popping), or other separation of materials, and without the need for vibration or other mechanical consolidation. SCC must be highly workable so that it can move under the force of gravity without vibration, during mixing, transportation, handling, and placement. The scope of this research was to determine the usefulness of Rice husk ash in the development of economical self compacting concrete. The cost of materials will be decreased by reducing the cement content by using waste material like rice husk ash.RHA is a waste material its use in the production of concrete may prove to be advantageous in an agriculture driven economy like India. Advantageous of SCC are

- Reduced vibration effort and noise during placing.
- Ability to fill complex forms with limited accessibility.
- More uniform distribution in areas of closely bunched reinforcement.
- Rapid pumping of concrete.
- Uniform and compact surface.
- Reduced labour cost.
- Smooth surface finishing

Ahmadi et al[3] studied the development of Mechanical properties up to 180 days of self-compacting and ordinary concrete mixes with rice-husk ash (RHA), from a rice paddy milling industry. Two different replacement percentages of cement by RHA, 10%, and 20%, and two different water/cementitious material ratios (0.40 and 0.35) were used for both of self-compacting and normal concrete specimens. The results were compared with those of the self-compacting concrete without RHA. SCC mixes show higher compressive and flexural strength and lower modulus of elasticity rather than the normal concrete. Replacement up to 20% of cement with rice husk ash in matrix caused reduction in utilization of cement and expenditures, and also improved the quality of concrete at the age of more than 60 days. It was concluded that RHA provides a positive effect on the Mechanical properties after 60 days.

Prof. Shriram[6] states that Self-compacting concrete (SCC) is one of the High Performance Concrete with excellent strength and durability properties. However, its mix proportioning and testing methods for flow characteristics are different from those of the ordinary concrete. SCC has high powder content and a super plasticizer for enabling flow while keeping coarse aggregate in a viscous suspension. The powder is usually cement and a filler material. In this paper an attempt has been made to study fresh and hardened properties of self compacting concrete using Rice Husk Ash as partial replacement of cement in different percentages in addition to filler. Modified Nan-su method has been used for design mix as the study was carried out for medium strength of concrete.

Shazim Ali Memon et al[5] studied the use of Rice Husk Ash (RHA) to increase the amount of fines and hence achieving self-compacting concrete in an economical way. They compared the properties of fresh SCC containing varying amounts of RHA with that containing commercially available viscosity modifying admixture. The comparison was done at different dosages of super plasticizer keeping cement, water, coarse aggregate, and fine aggregate contents constant. Test results substantiate the feasibility to develop low cost SCC using RHA. Cost analysis showed that the cost of ingredients of specific SCC mix is 42.47 percent less than that of control concrete.

II.EXPERIMENTAL PROGRAM

2.1 MATERIALS USED

2.1.1CEMENT

Grade 43 chettinad cement was used for casting cubes and cylinders for all concrete mixes. The cement was of uniform colour i.e grey with light greenish shade and free from any hard lumps. Summary of the various tests conducted on cement are as under given below in table 4.1

Table 1 Physical properties of cement

S.No	Characteristics	Values Obtained	Standard Values
1.	Normal Consistency	33%	-
2.	Initial Setting time	48 min	Not be less than 30 minutes

3.	Final setting time	240 min	Not to be greater than 600 mins
4.	Fineness	4.8%	<10
5.	Specific gravity	3.00	-

2.1.2RICE HUSK ASH

Rice husk is the outer covering of the rice grain that is removed as a result of milling process on rice kernel. Huge amounts of RHA obtained after burning of rice husk, probably has no use at all Rice husks ash has high reactivity and pozzolanic property. Indian Standard code of practice for plain and reinforced concrete, IS 456- 2000, recommends use of RHA in concrete. RHA for this project was collected from madha rice mill located in gundur, trichy. The specific gravity of Rice husk ash was found to be 2.13.

2.1.3COARSE AGGREGATE

The material which is retained on sieve no. 4.75 is termed as a coarse aggregate. The crushed stone is generally used as coarse aggregate. The nature of work decides the maximum size of 10mm was in our work for SCC and 60% of 10mm and 40% of 20mm aggregate was used for ordinary specimens. The aggregate were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383- 1970. The results of various tests conducted on coarse aggregate are given in Table 4.5

Table 2 Physical Properties of Coarse Aggregates (10 mm)

Sl.No	Characteristics	Value
1	Type	crushed
2	Specific Gravity	2.66
3	Total Water Absorption	0.56
4	Fineness Modulus	6.83

2.1.4 FINE AGGREGATE

The sand used for the experimental programme was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through 4.75mm sieve to remove any particles greater than 4.75 mm.

Table 3 Physical properties of fine aggregate

Sl.No	Characteristics	Value
1.	Specific gravity	2.46
2.	Bulk density	1.4 kg/m^3
3.	Fineness modulus	2.56 m^2/g
4.	Water absorption	0.85%
5.	Grading Zone	Zone II

2.1.5 ADMIXTURES

The super plasticizer named GLENIUM B233 was used which is a high range water reducing admixture. It is a Polycarboxylate ether-based super plasticizers which was used water reduction up to 40% and gives flow ability. GLENIUM STREAM 2 is used as the viscosity modifying agent. It Reduced risk of segregation and bleeding. The sequence of addition of VMA and super plasticizer into the concrete is important. If VMA is added before super plasticizer, it swells in water and it becomes difficult to produce flowing concrete. To avoid this problem VMA should be added after the super plasticizer has come in contact with the cement particles. Another method of addition is to disperse the super plasticizer in mixing water and then add VMA to this mixture.

2.2 MIXTURE PROPORTIONING

A rational mix-design method for self-compacting concrete using a variety of materials is necessary. Okamura and Ozawa have proposed a simple mix-proportioning system assuming

general supply from ready-mixed concrete plants. The coarse and fine aggregate contents are fixed so that self compatibility can be achieved easily by adjusting the water powder ratio and super plasticizer dosage only. Fresh properties amount are in acceptable limited from European Specifications and Guidelines for Self Compacting Concrete. Concrete mix design for ordinary concrete specimens in this experiment was designed as per the guidelines specified in I.S. 10262-1982.Six series of self compacting concrete with six series of ordinary concrete were mixed: Different replacement percentages of cement by RHA, 5% 7.5% 10% 12.5% 15% with mix have no RHA were used for both of self compacting and ordinary concrete specimens. The mixture proportions according to water/Binder ratio adopted and are reported in Tables 4 and 5.

Table 4 Mix Proportions of SCC specimens

Mix Id	Cement	RHA	Sand	Gravel	Water	W/B
SCC 1	464	0	970	770	185	0.4
SCC 2	441	23	970	770	185	0.4
SCC 3	429	35	970	770	185	0.4
SCC 4	418	46	970	770	185	0.4
SCC 5	406	58	970	770	185	0.4
SCC 6	394	70	970	770	185	0.4

Table 5 Mix Proportions of SCC specimens

Mix Id	Cement	RHA	Sand	Gravel	Water	W/B
OC 1	464	0	530	1154	185	0.4
OC 2	441	23	530	1154	185	0.4
OC 3	429	35	530	1154	185	0.4
OC 4	418	46	530	1154	185	0.4
OC 5	406	58	530	1154	185	0.4
OC 6	394	70	530	1154	185	0.4

III.EXPERIMENTAL METHODOLGY

The specimen of standard cube of 150mm x 150mm x 150mm and cylinders of 300mm x150mm and beam of 500x 100x100mm were casted and used to determine the compressive strength, split tensile strength and flexural strength of concrete. The constituents were weighed and the materials were mixed by machine mixing and vibrated by hand compaction for ordinary concrete specimens and for self compacting concrete compaction is not needed. The water cement ratio adopted was 0.40 through all the mix proportions. The specimens were demoulded after 24 hrs, cured in water for 7 and 28 days and Compression Testing Machine (CTM) with capacity of 2000KN were used to test its compressive strength ,split tensile strength and flexural strength.

IV.RESULTS AND DISCUSSIONS

4.1 FRESH CONCRETE PROPERTIES

The results of fresh properties of all Self compacting concrete with RHA are included in the table. The table shows the properties such as slump flow, V- funnel flow times, L-box. In terma of slump flow, all SCCs exhibited satisfactory slump flows in the range of 500-700 mm, which is an indication of a good deformability.

Table 6 Fresh Concrete properties

MIXTURE ID	SLUMP (mm)	V-funnel (sec)	L-Box (H2/H1)
SCC 1	530	11	0.8
SCC 2	590	13	0.9
SCC 3	610	9	0.8
SCC 4	630	12	0.9
SCC 5	670	12	0.9
SCC 6	690	10	0.9

4.2 COMPRESSIVE STRENGTH OF CUBES

In order to study the effect on compressive strength when rice husk ash is added into self-compacting concrete and ordinary concrete as cement replacement, the cube containing different

proportion of rice husk ash were prepared and kept for curing 7 and 28 days. The test was conducted on UTM of capacity 2000 KN. From the results (table 5.2 and table 5.3) it is concluded that increase in replacement of RHA in both SCC and ordinary concrete increases the compressive strength than the controlled specimens.

Table 7 Compressive strength of SCC mixes

MIXTURE ID	COMPRESSIVE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
SCC 1	29.76	43.15
SCC 2	37.02	52.53
SCC 3	38.26	54.37
SCC 4	40.37	60.84
SCC 5	41.26	62.18
SCC 6	33.11	48.31

Table 8 Compressive strength of Ordinary concrete mixes

MIXTURE ID	COMPRESSIVE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
OC1	30.22	42.53
OC2	33.82	43.20
OC3	33.96	45.37
OC4	39.51	47.81
OC5	40.22	48.22
OC6	32.13	39.91

Fig 1Compressive strength of SCC mixes

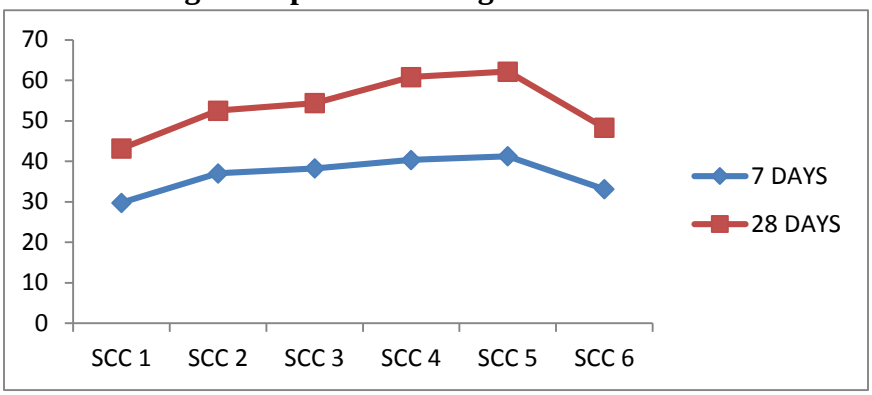
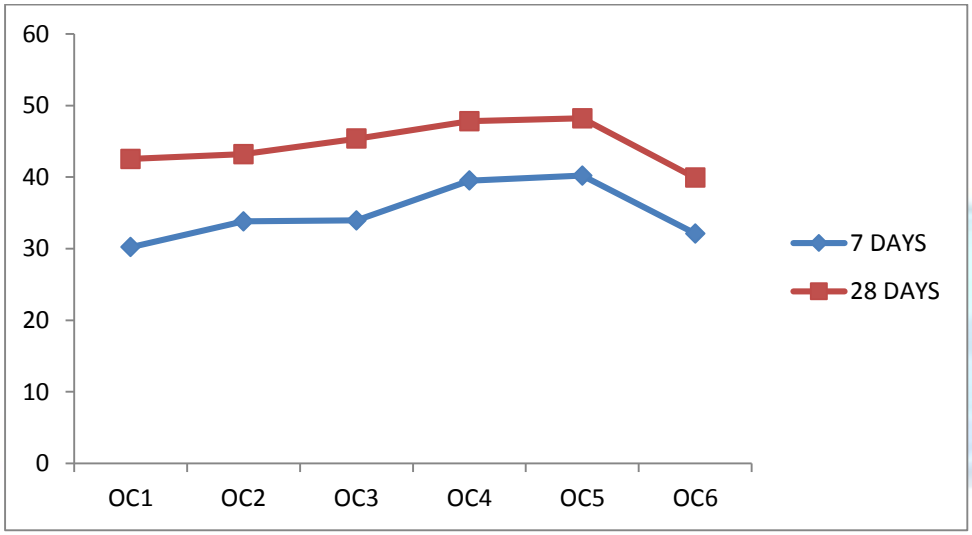


Fig 2 Compressive strength of OC mixes



The influence of RHA in compressive strength is given in the above representation. The percentage of 12.5% replacement in cement gives higher compressive strength in both Self Compacting Concrete and Ordinary Concrete. And the test results also indicates that SCC with replacement of RHA achieves higher compressive strength than ordinary concrete replaced with RHA for cement. RHA concrete at 28 days also shows higher compressive strength than the controlled specimens for both Ordinary and controlled concrete. When replacement of 15% of cement by RHA shows a considerable decrease in strength than the other mix specimens.

5.4 SPLIT CYLINDER TEST

In order to study the effect on tensile strength when rice husk ash is added into self-compacting concrete and ordinary concrete as cement replacement, the cylindrical containing different

proportion of rice husk ash were prepared and kept for curing 7 and 28 days. The test was conducted on UTM of capacity 2000 KN. The results are shown in table 9 and table 10

Table 9 Tensile strength of Self compacting concrete mixes

MIXTURE ID	TENSILE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
SCC 1	2.05	3.21
SCC 2	2.11	3.62
SCC 3	2.89	3.88
SCC 4	3.04	3.94
SCC 5	3.51	4.13
SCC 6	2.18	3.41

Table 10 Tensile strength of ordinary mixes

MIXTURE ID	TENSILE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
OC 1	2.31	3.34
OC 2	2.57	3.82
OC 3	2.93	3.92
OC 4	3.03	4.13
OC 5	3.18	4.51
OC 6	2.49	3.56

Fig 3 Tensile strength of SCC mixes

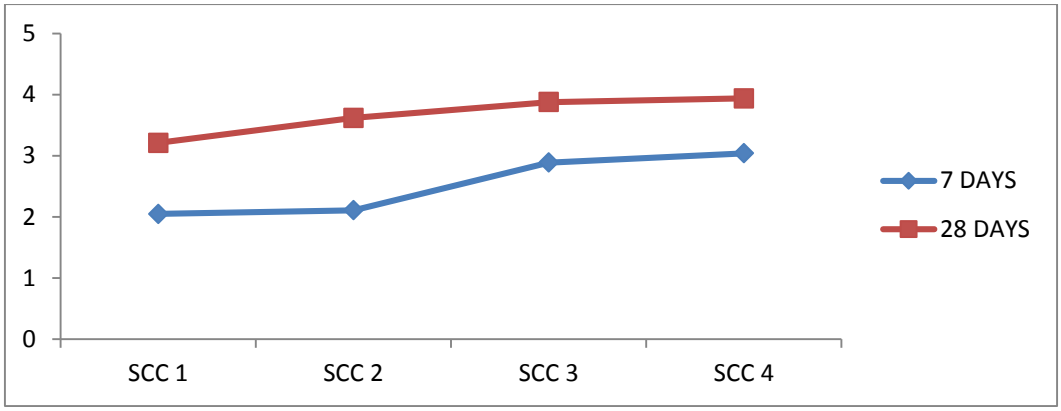
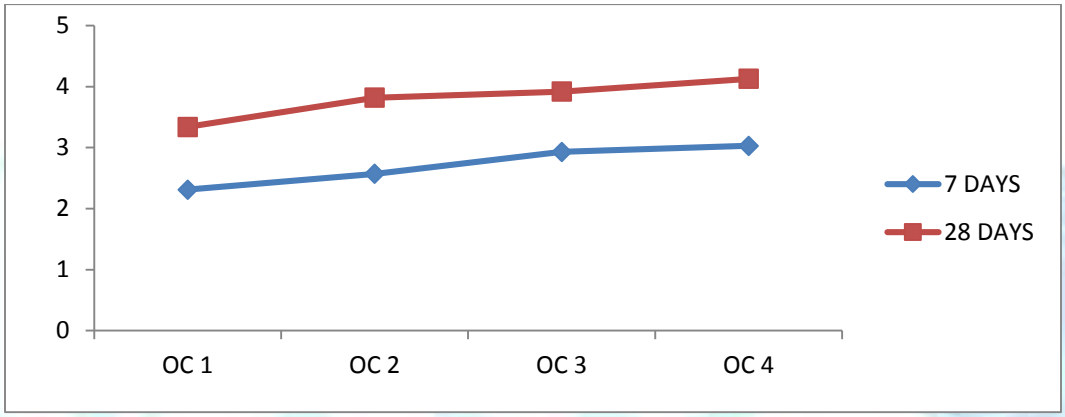


Fig 4 Tensile strength of OC mixes



The influence of RHA in tensile strength is given in the above representation. The percentage of 12.5% replacement in cement gives higher tensile strength in both Self Compacting Concrete and Ordinary Concrete. And the test results also indicates that SCC with replacement of RHA achieves higher tensile strength than ordinary concrete replaced with RHA for cement. RHA concrete at 28 days also shows higher tensile strength than the controlled specimens for both Ordinary and controlled concrete. When replacement of 15% of cement by RHA shows a considerable decrease in strength than the other mix specimens.

5.5 FLEXURAL TEST ON PLAIN CONCRETE BEAMS

In order to study the effect on flexural strength when rice husk ash is added into self-compacting concrete and ordinary concrete as cement replacement, a plain cement concrete beam is subjected to flexure using symmetrical two point loading until failure occurs. Because the load point is placed at $1/3^{rd}$ of the span, the test is also called third point loading test. The theoretical

maximum tensile stress reached in the bottom fiber of the test beam is called modulus of rupture. Flexural strength for prism specimens containing different proportion of rice husk ash were prepared and kept for curing 28 days are shown in table 11 and table 12

Table 11 Flexural strength of SCC mixes

MIXTURE ID	FLEXURAL STRENGTH (N/mm^2)
SCC 1	5.16
SCC 2	5.82
SCC3	5.87
SCC 4	5.91
SCC 5	6.08
SCC 6	5.54

Table 12 Flexural strength of OC mixes

MIXTURE ID	FLEXURAL STRENGTH (N/mm^2)
OC 1	5.54
OC 2	5.79
OC 3	5.82
OC 4	5.87
OC 5	5.94
OC 6	5.76

Fig 5 Flexural strength of OC mixes

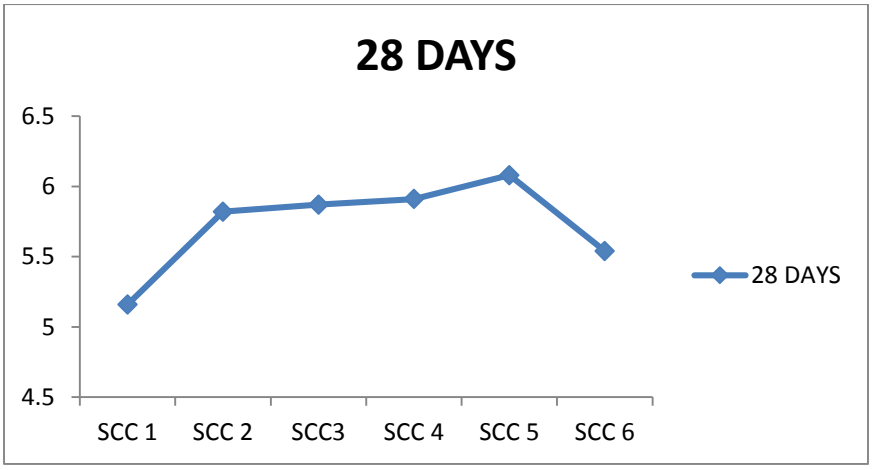
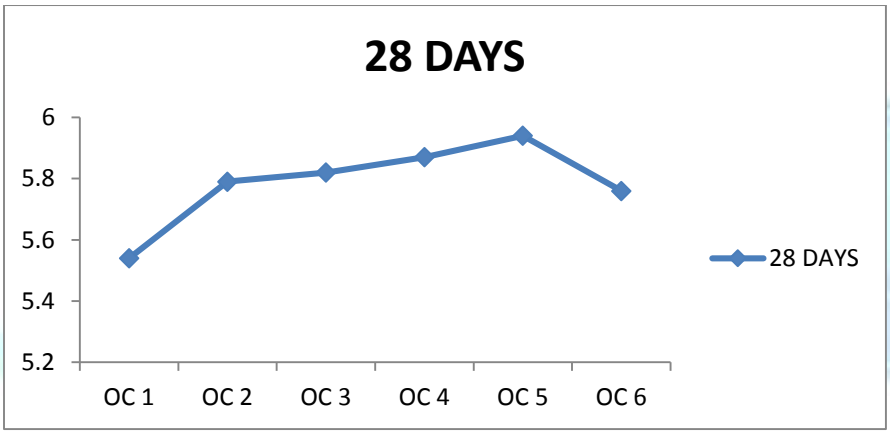


Fig 6 Flexural strength of OC mixes



The percentage of 12.5% replacement in cement gives higher flexural strength in both Self Compacting Concrete and Ordinary Concrete. RHA concrete at 28 days shows higher flexural strength than the controlled specimens for both Ordinary and controlled concrete.

v . CONCLUSIONS

In this study rice husk ash is used as a replacement of cement and their influence in strength properties such as compressive strength, tensile strength and flexural strength on both self compacting concrete and ordinary concrete have been studied and concluded that:

1. RHA can be used as replacement of cement for both SCC and ordinary concrete.

2. RHA can partially replace cement by 12.5% in both SCC and OC for achieving higher strength than the controlled specimen.
3. Its economical than the normal concrete and low cost SCC can be produced with RHA
4. The productivity of SCC requires less labor than the conventional concrete

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