Experimental investigate on the Influence of Sisal Fiber and Rice Husk Ash on Mechanical Properties of Self Compacting Concrete

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Abstract - *Concrete is an essential construction medium that is widely used throughout the world. Concrete is weak in tension. Several types of fibers are added to concrete in varying quantities to increase its tensile strength. The use of different synthetic fibers is common now a days. In this case we use a natural fiber. This study is to identify the effect of Sisal Fiber on concrete strength properties. Sisal Fiber is a natural fiber derived from the leaves of Sisal plant (Agava sisalana), which can be found in hot regions. Along with sisal fiber the cement is partially replaced with Rice Husk Ash (RHA) which is a waste material. The silica content available in them make it suitable supplementary cementitious material. This work aims to investigation of the use of sisal fibres and rice husk ash as partial replacement in SCC. The mix ratio is M30 and Sisal Fiber was added to concrete at 0,0.5%,1%,1.5%,2.0% by the volume of concrete and replacement of Rice Husk Ash by 5%. The specimens were subjected to tests and aimed to check the compression and tensile strength. After 7 days and 28 days of curing, the specimens' compressive and split tensile strengths were evaluated.*

***Key Words*: Self- compacting Concrete, sisal fibres, Superplasticizer, Mix Design, RHA, Compressive strength, Split tensile strength**

1.INTRODUCTION

Self-compacting concrete (SCC) is a very malleable concrete that fills the formwork by itself without the need for vibration. The necessity of self-compacting concrete can be recognized by seeing the growing issue of a trained labour shortage in the building sector. Self-compacting concrete can fill the mould without the need for mechanical vibration. It can be applied in situations where compacting freshly laid concrete would be laborious, such as underwater concreting, pile foundations, and walls with congested reinforcement. SCC's strength and durability can be increased by adding more cementitious materials, such as fly ash, pulverised granulated blast furnace slag, silica fume, and rice husk ash (RHA). RHA is a highly reactive pozzolanic substance produced by carefully burning rice husks at temps below 7000C.Another focus of this project is to incorporating sisal fiber in to the optimum percentage of RHA in different percentages and to check its strength properties. By including fibers in concrete, toughness, reduced creep strain, flexural strength, and shrinkage can all be increased. Cracks due to plastic shrinkage and dry shrinkage can also be controlled.

Sisal fibers in concrete is studied by various researchers like Biju C. Thomas and Y. Stalin Jose [3] studied the characteristics of using sisal fiber in concrete and it's performance. S. Suresh Kumar et.al [5] investigated the properties of sisal fiber in concrete when it is treated with NaOH. S. Solai Mathi et.al [2] used sisal fiber in self-compacting concrete to enhance the properties of the concrete using the fiber. The use of Rice Husk Ash by certain percentage proved to be an effective material for the replacement of cement. Elias Molaei Raisi et.al [7] examined the effect of RHA in self-compacting concrete and studied it's fresh concrete properties and mechanical properties. Deshmukh SD et.al [10] studied the properties of concrete using Rice Husk ash and steel fibers and it shows that incorporating steel fiber in concrete will increase the tensile strength but reduces it's workability. Anandaraj S et.al [1] studied strength properties of luffa fiber in Rice Husk Ash containing concrete by the weight of M25 grade concrete. Sai ER et.al [9] demonstrated that the addition of sugar cane baggase ash (0%, 2.5%, and 5%) and RHA (0%, 2.5%, and 5%) either separately or in blended mixes increased compressive strength for a period of time exceeding 28 days. Sabarinathan M et.al [6] highlighted that to solve the problems of waste disposal, minimise global warming, and raise the strength of concrete, they investigated the effects of silica fume and sisal fibre orientation on performance of concrete.

From the above studies we can see that many experiment were conducted using Rice Husk Ash and Sisal fiber but there is no study on incorporation Of Sisal fiber in concrete when the cement is replaced by RHA. The goal of this study is to thoroughly examine how RHA and Sisal fiber affects the mechanical performance and fresh qualities of SCC. For this experiment, cement was partially replaced by RHA in three dosages i.e 5%,10%,15% and the optimum is found by conducting mechanical properties. After finding the optimum percentage, keeping the optimum constant sisal fibers was added in different percentages 0.5%,1.0%.1.5%.2.0%. V-funnel flow time, L-box, and slump flow diameter and time tests were carried out to ascertain the fresh properties of SCC. Also, many hardened concrete specimens were formed to examine the mechanical performance of SCC.

2 MATERILAS AND MIX RATIO

2.1 Materials

Cement

Portland Pozzolana cement of Ultratech brand was used for this study. To study the properties of cement various experiment were done according to the IS code specifications.

Table -1: Properties of PPC Cement

Test on Cement	Obtained Value	IS 4031(1) Codal values
Fineness	6.33%	Less than 10%
Standard consistency	34%	24-32%
Specific gravity	3.06	3.0-125
Initial setting time	80 min	>30 min

Fine Aggregate

Due to the scarcity of natural sand, M-sand was used for this study as it is a best alternative for natural sand. M-sand is a product formed from crushed hard granite stone. IS: 383-1970 defines the fine aggregates as 7.25 particles, which will pass through 4.75mm IS sieve and retained on 150 micron.

Table -2: Properties of Fine Aggregate

Property of Aggregate	Results	Range	IS Code
Specific gravity	2.57	2.5-2.9	IS 2386(I)- 1963
Fineness module	2.9	2.2-3.5	IS 383-1970
zone	Zone II		1S 2386(I)-1963

Coarse Aggregate

An aggregate that is mostly retained on a 4.75mm IS sieve is referred to as coarse aggregate. Coarse aggregate of size 12mm was used in this study and complied with IS 383:1970.

Table -3: Properties of Coarse Aggregate

Property of Aggregate	Results	Range	IS Code
Specific gravity	2.7	2.5-3	IS 2386(I)- 1963
Fineness modules	4.25	5.5-8	IS 383-1970

Rice Husk Ash (RHA)

As an agricultural waste product, rice husk is widely available and accounts for 20% of the world's yearly rice production of 649,7 million tonnes. This procedure, which also adds to pollution, uses the milling plant by product, which is husk that has been partially burned, as fuel. RHA was created by burning at a reasonably high temperature of around 700^{0}C while heating at a rate of 10^{0}C/min [7]. The RHA was preferred for the partial replacement of cement after passing through a sieve with an opening of 75 µm. This method yields 25% of RHA .This ash is very pozzolanic and contains 85% to 90% amorphous silica and 5% alumina, which makes it highly pozzolanic. Use of RHA minimise the need for cement and lowers the overall cost of producing concrete.

Table 4: Chemical and physical properties of rice husk ash (7)

Chemical Composition	Percentage content	Physical Properties	Magnitude
Silica	89.13	Mean particle size (µm)	0.15-0.25 µm
Alumina	.85	Specific gravity	2.24
Iron oxide	.72	Colour	Grey
Calcium oxide	1.12	Specific surface area (m2 /g)	36.47

Fig -1: Rice Husk Ash

Sisal fiber

Sisal plant can be seen in hot and dry areas which are unsuitable for most of other plants to grow. The most popular technique for obtaining sisal fiber is decortication. The fleshy pulp is separated from the fiber by crushing the leaves between blunt blades and wetness in this process. Debris found in the leaves is cleaned with water. The sisal fiber is harvested and cured in the scorching sun. The fiber is treated with NaOH and dried before incorporating in concrete.

Table 5: Chemical and physical properties of Sisal fiber (4)

Chemical Composition	% by Weight of Fiber	Physical Properties	% by Weight of Fiber
Cellulose	55-65	Fiber length (mm)	1000-1250
Hemi-cellulose	10-15	Density(g/cm3)	1.46
Pectin	2-4	Moisture content (%)	11.4
Lignin	10-20	Tensile strength (Mpa)	297
Water soluble materials	1-4	Young's modulus (Mpa)	10.64

Fig -2: Sisal fiber

Admixture

The admixture used here is Master Rheobuild 1126nd.It is specifically created to allow for a significant reduction in mixing water while keeping control over the extent of set retardation. It is used in the proportion of 6 ml per kg of cement. ,Some of the benefits of Master Rheobuild are reduced permeability, high workability for longer periods, improved durability, reduced shrinkage and creep etc.

2.2 Mix ratio

M30 mix was used for the study and the design was done as per IS 10262. The mix proportion obtained was 1:2.1:3.4. The water per cement ratio was 0.45. The total materials required for per m3 of concrete were 400 kg of cement,127 L of water, 843 kg of fine aggregate and 1234 kg of coarse aggregate. After conducting all the fresh properties of concrete we concluded that this proportion of concrete is suitable for casting.

3. EXPERIMENTAL STUDY

3.1 Specimen details

For finding the mechanical properties of control specimen a total of 6 cubes and 3 cylinders were casted. A total of 18 cubes and 9 cylinders were casted for the initial stages of experiment for finding the optimum percentage of Rice Husk Ash in concrete. After finding the optimum percentage, a total of 24 cubes and 12 cylinder was casted keeping the optimum percentage of RHA constant and changing the percentages of sisal fiber.

3.2 Preparation of specimen

For the control specimens, the necessary amounts of cement, fine aggregate, coarse aggregate, super plasticizers, mineral admixture, and water were collected. Rice husk ash and Sisal was also combined with the components. Machine mixing was done for concrete mixing. Coarse aggregate along with superplasticiser is mixed during initial stages and mixed with fine aggregate and cement. Water is added to concrete during various intervals. Both the cube and cylinder mould have to be oiled and screwed tightly before pouring the concrete in to it. By this process control specimen as well as SCC incorporating RHA is made. After finding the optimum percentage of RHA, keeping it constant casting of concrete is done by adding sisal fiber in different ratios by the volume of concrete.

3.3 Testing of Specimen.

Fresh properties of concrete like Slump test, L box test, V funnel test were done during initial stages for the control specimen. Mechanical properties like compression test and tensile strength test were conducted for both SCC with RHA and SCC mix with RHA and Sisal Fiber

4. RESULT AND DISCUSSION

4.1 Effect of RHA on Tensile and Compressive strength

In this first part of the experiment 6 number of cubes and 3 number of cylinders were casted as control specimen and 18 cubes and 9 cylinders for the three percentages of Rice Husk Ash 5%.10%,15% which has been partially replaced by the cement. All the specimens were casted according to the M30 mix ratio. The specimen is then tested for mechanical properties after 28 days of curing. The test results of specimens are as follows

Table 6: Test results

Mix	Split tensile strength (N/mm^2)	Average compressive strength (N/mm^2)	
		7 days	28 days
Control specimen	3.89	21.03	36.2
5% RHA	3.92	23.5	36.8
10 % RHA	4.05	20.7	39.6
15 % RHA	3.74	22.4	32.6

4.2 Effect of Sisal fiber and RHA on Compressive Strength of Concrete

From the box above we see that cement can be replaced by Rice Hush Ash by 5 % in concrete. By keeping the RHA constant then we cast 24 cubes incorporating sisal fiber in different percentage 0.5%,1.0%,1.5%,2.0%. The specimens are casted for compressive test.

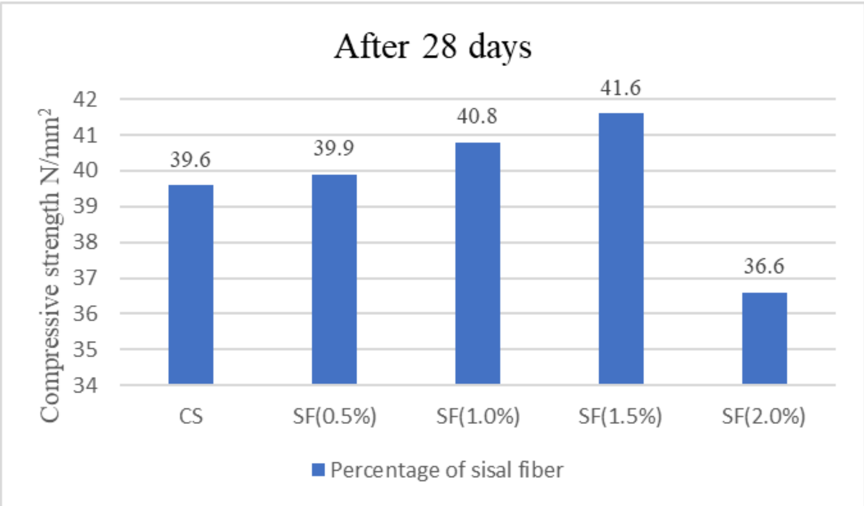

Chart -1: Compressive Strength of Concrete

4.3 Effect of Sisal fiber and RHA on Split Tensile Strength of Concrete

For finding the Split tensile strength of concrete a total of 12 cylinder were casted and tested after 28 days of curing

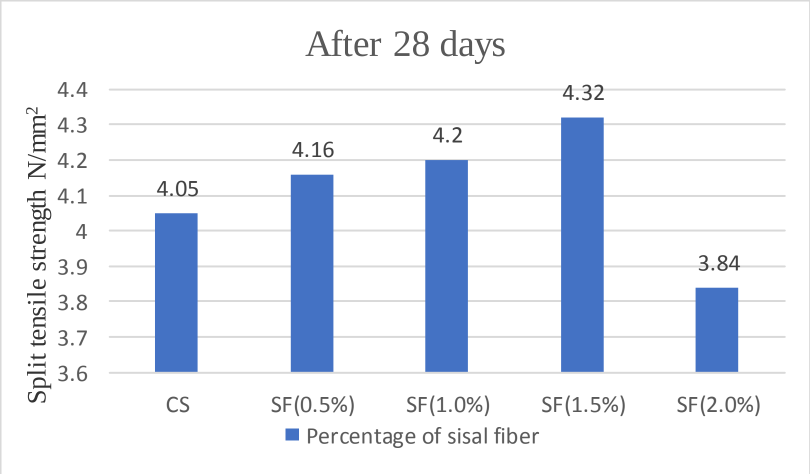

Chart -2: Split Tensile Strength of Concrete

5. CONCLUSIONS

The main findings of this investigation are

• For M30 mix of concrete the replacement of cement with Rice husk ash by 5%,10%,15% was done. It was found that compared to conventional concrete replacement of cement by RHA at 10 % found to be more effective.

•Compressive and split tensile strength of this concrete at 28 days is found out to be 36.4 N/mm^2 and 3.05 N/mm^2.

•For M30 mix of concrete keeping the RHA mix constant Sisal fiber is added to concrete by volume at proportions of 0.5%,1.0%,1.5%,2.0% and compared with control specimen after 28 days.

•Compressive and split tensile strength of concrete is maximum at 10% RHA and 1.5% addition of sisal fiber in to concrete and its value is 37.8 N/mm^2 and 3.32 N/mm^2

From this experiment we can conclude that by adding 1.5% of sisal fiber with 10 % of RHA gives optimum mechanical strength compared to other proportions.

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