INVESTIGATION ON THE FRESH AND HARDENED PROPERTIES OF SELF-COMPACTING CONCRETE USING COIR FIBER

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Abstract. The fresh and hardened properties of self-compacting concrete (SCC) containing fiber was investigated in this paper. The fiber has a continuous impact on the environment that promotes expect to accept the natural fibers like the coconut fibers for strengthening the concrete. The fiber has different proportion of aspect ratio of 0.1to 0.4 in SCC was adopted. Based on the flow of SCC the naphthalene-based superplasticizer ranging from 0.8 to 1% was used. To achieve the targeted strength of M30, twelve mixes were prepared and the fresh properties like flowing, filling and passing abilities were assessed through slump flow, V-Funnel and L-Box. The results of the mechanical properties of SCC showed that the addition of coir fiber 0.1 to 0.4% in SCC containing superplasticizer has no significant development in strength still upon 0.4% replacement the strength was improved to 2% on compared with the reference concrete. Addition of the coir fibers in concrete has led to higher improvement of tensile strength.

Keywords: Self-Compacting Concrete, Superplasticizer, Coir Fiber, Compressive strength, Split tensile strength

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Introduction

The environment is being polluted from dumped wastes and to efforts has to take to utilise those wastes effectively in the area were the shortage of raw materials prevails. One such area is an industrial area where depletion of raw materials is in peak level. The coir fibers are the fibers obtained from the coconut shells. Using coir fiber as when making concrete not only solves the problem of where to dispose of this solid waste but also promote resource conversation. Self-compacting concrete (SCC) is novel type of concrete that does not require vibration for placement and compaction, even in the place of closed reinforced area. The concrete totally flows and settles under its own weight.

B. S. Al-Azzawi and B. L. Karihaloo [1] studied the behaviour of an ultrahigh performance fiber-reinforced concrete (UPHFRC) has been investigated. Distribution of fiber plays a crucial role in the fatigue resistance of this material. Yiyan Lu and et al.,[2] in their investigation, the CFRP jacket could effectively delay or even prevent the local buckling of the steel, leading to better structural seismic performance. Nikita Gupta and et all [3] has carried out an experimental programme and investigated the use of sulphate resistance and drying shrinkage of self-compacting concrete (SCC) made with copper slage were studies. Ahmed T. Omar; [4] In these paper aims to evaluate and optimize the semi-light weight self-consolidation concrete (SLWSCC) mixtures. Jose D. Rios; Hector Cifuentes and et all, [5] discussed the high-performance structural concrete reinforced with polypropylene fibers can be used for application requiring long exposure time to high temperature, such as thermal energy storage system. H. Mazaheripour and et all, [6] the experimental findings of the durability qualities of self-compacting concretes. Adil Gultekin and et all., [7] in this paper the fresh properties, fracture energy, compressive strength, and flexural strength of self-compacting concrete were examined. The workability of concrete was decreased with fiber addition. M.M. Kamal,et al, [8]. This study glass fiber has greater effects on increasing flexural strength and decreasing the drying shrinkage rate in fly ash slage geopolymer mortars when compared to self-compacting mortars. Zhenpeng Yu et. al., [9] investigated the effect of binder types, w/b ratio, and exposure solution on the corrosion performance of steel reinforcement in self-compacting concrete (SCC). Dominic Stefan Law Yim Wan et.al., [10] have carried out mortar-level experiments to investigate the internally cured self-compacting cured concrete made with prewetted lightweight aggregates (LWAs) has a risk of segregation.

Characteristics of Coir Fiber

Coir fibers are the strongest natural fibers, having strength. Compared to other fibers, it can withstand strain that is 4-6 times higher. Many people have looked at coir fiber researchers for a variety of reasons. There are large differences some qualities include, for instance, the nearly equal diameter of the coir fiber and the levels of tensile strength are significantly varied, for instance, the fibroblasts of various dependent on the type of plant, its environment, and ageing. Length had an impact on the fiber's elasticity and rupture. Diameter ratio of the fiber determines the finial output. They are produced size and shape of the core hollow hole.

Materials and Experimental Work

The Ordinary Portland Cement (OPC) that compilers with the recommendations of ATMS code 150 – 07 were used. Coir collected from the local area of Tamil Nadu was used. It was then treated 6% sodium hydroxide concentration, soaked for 3 to 5 hours, washed thoroughly with clean distilled water to remove all traces of alkali from the fiber surface and rolled using a comb. The average diameter of coir fiber used in the experiment was 0.25mm. The physical properties coir fiber is display in table 1. A saturated surface dry fine aggregate m sand passed through 4.75 mm sieve with water absorption of 1.3 %, specific gravity of 2.3 and fineness modulus of 4.6 was used. Both mixing and curing were done with supplied tap water. To improve workability and obtain a fiber concrete mix with good strength, polymer-based superplasticizer was used as required.

Figure 1. Coir fiber

The materials properties off the cement OPC grade, Manufacture sand and Coarse aggregate are used in the table 1.

Table 1 Material Properties

S. No	Materials	Properties
1	Cement	OPC
2	Fine aggregate	M sand
3	Coarse aggregate	Aggregate which are passes through 20 mm IS sieve.
4	Coconut fiber	Washed fiber length of 2 to 4 cm
5	Water	Drinking water
6	Admixture	Superplasticizer

The physical properties of cement are finial setting time, initial setting time, soundness, density value is obtained in the table 2.

Table 2 The properties of cement

S. No	Property	Value obtained	Limit as per IS 4031
1.	Initial setting time, Finial setting time	75 min, 300 min	>30
2.	Soundness	1 mm	<10 mm
3.	Density	3.099 g/cc	3.16
4.	Fineness	7.2%	<10.01%

5.	Initial setting time, Finial setting time	71 min, 300min	>30

The properties of the aggregates are specific gravity; bulk density and fineness modulus and are given in the table 3.

Table 3 Properties of fine aggregate

S. No	Properties	Values Obtained	Limit as per I.S 2386
1.	Specific gravity	2.78	2.60 – 2.80
2.	Bulk density	1.6 (gram/cc)	1.20 – 1.8 (g/cc)
3.	Fineness modulus	2.184	2.2 to 2.6 fine sand 2.6 to 2.9 medium sand 2.9 to 3.2 coarse sand

Mix Design

Mix design of SCC on Coir Fiber in table 4

Table 4 Mix design of SCC

T. No	Mix Constituents (kg/m^3)					Compressive Strength (N/mm^2)
	Cement	Fine aggregate	Coarse Aggregate	Water	SP (%)	28 days
01	500	900	800	190	1.2	50
02	495	720	648	198	1	47
03	490	730	657	196	1	42
04	485	740	666	194	1	40
05	480	750	675	192	1	42.5
06	475	760	684	190	0.8	41
07	470	780	702	188	0.8	40
08	465	820	750	186	0.8	38

Mix properties:

Mix proportion of coir fiber in the table 5

Table 5 mix proportion of coir fiber

M. No	Mix Constituents (kg/m^3)					
	Cement	Coir Fiber (%)	Fine aggregate	Coarse aggregate	Water	SP (%)
SCC_0	465	0	820	750	186	0.8
SCC_0.1	465	0.1	820	750	186	0.8
SCC_0.2	465	0.2	820	750	186	0.8
SCC_0.3	465	0.3	820	750	186	0.8
SCC_0.4	465	0.4	820	750	186	0.8

Experimental Works

Slump flow

The largest spread was then calculated in two different flow regions. By averaging the two diameter of the concrete, the slump flow was estimated. Figure 2 shows the widest range of flow after elevating the slump cone. The flowability of horizontal free flow and the flow rate of SCC in the absence of obstructions are assessed using the slump-flow test. The results demonstrate the ability of SCC to fill openings

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Figure 2 Slump flow

V Funnel

The test shown in figure 3 is V funnel test that confirms the filling ability of concrete. It was developed in Japan. The tool is a funnel with a V form. This test tool has a 70mm hole at the bottom and a V shaped form. The V-shaped funnel's top had a diameter of 75 mm and a 495 mm height. The height of the V-shaped funnel and bottom are 450 mm and 150 mm, respectively. About 12 litres of new SCC are present in this apparatus. Fresh concrete must flow through the test setup for a specific amount of time, which is measured. The time stamp is 8 second. The concrete's capacity for filling is determined by the flow times.

Figure 3 V Funnel

L Box

The L box test is used to evaluate the durability of concrete. The L box device is made up of the "L" shaped components that join a vertical box and a horizontal member is 700 mm, 200 mm by 80 mm. the horizontal member is 700 mm by 200 mm and 160 mm in side. A sliding gate is provided at the point where two box members intersect. Additionally, there are three 12 mm-diameter rebars in this connector, located 35 mm apart. The concrete flow and degree of reinforcing obstruction are both measured during the test. The device consists of a rectangular box with a "L" from separated into vertical and horizontal pieces by a sliding gate.

Figure 4 L-Box

Mechanical Properties

Compressive Strength

Cubical specimens of 150 mm x 150 mm x 150mm were used to calculate the compressive strength of concrete. The cubes were de-moulded after 24 hours. After receiving initials, they immediately submerged themselves in clean water till the day of the test. Compressive testing in line with IS 456-2000 was done for 28 days. A set of three cubes were cast on every testing day. The compressive strength of a cube was calculated using the following equation (1).

$$\text{Compressive strength} = \text{load} / \text{area} \quad (1)$$

Figure 5 Compressive strength

Split tensile Strength

The test is carried out using a cylinder specimen dimension 150mm diameter and 300mm length. The cylindrical specimen is placed in the compressive testing machine and the load is applied as shown in figure 6.

Figure 6 Split tensile strength test

Results and discussion

Slump flow

In the flow ability test adding 0.3 to 0.4% of coir fiber in concrete due to that the value obtained up to 680 mm. Thus, it shows that the obtained value is in the particular range. The particle size of coir fiber is 2 cm to 5 cm it plays a major role in the flow ability of the concrete as shown in figure 7

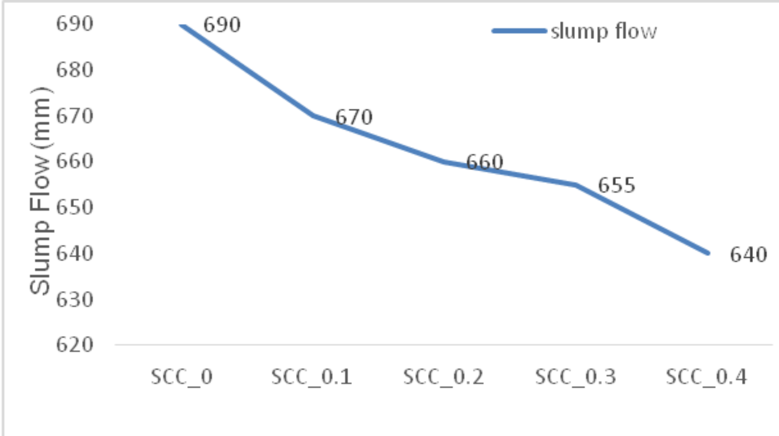

Figure 7 Slump flow

L box:

The L box value is obtained by adding coir fiber and superplasticizer is in the expected range. The figure 8 shows that the flow level is in the good range for the self- compacting concrete. The maximum value obtained for L Box in the concrete by adding coir 0.4% and superplasticizer 0.8 %.

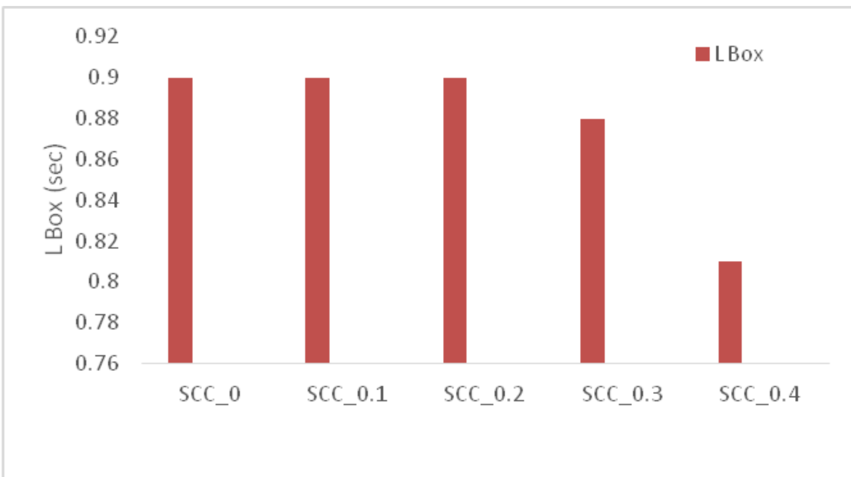

Figure 8 L Box

V Funnel

The V Funnel value obtained by adding coir 0.4% is 13 seconds. Thus, it shows that the value obtained is in the expected range. It is because of flow able properties in the test. The time obtained for the V Funnel is good in range as expected for the self-compacting concrete.

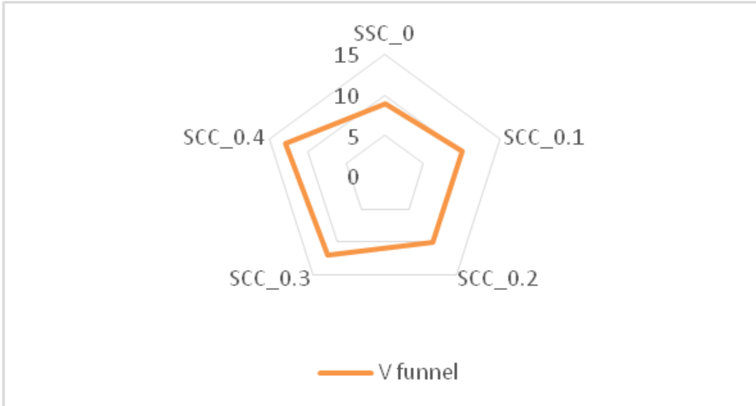

Figure 9 V Funnel

Compressive strength

The findings demonstrated that concrete's compressive strength only rises by 0.2% fiber. It does so because it fills in the gaps with this amount of fiber. Additionally, it has been shown that concrete compressive strength substantially decreases after the fiber content exceeds 0.2%.

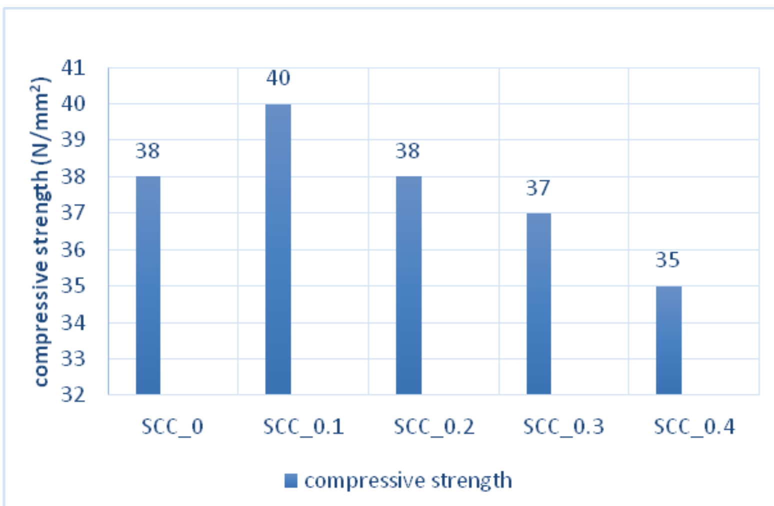

Figure 10 Compressive Strength

Spilt tensile strength:

The spilt tensile strength, concrete has low tensile strength. The strength is an additional crucial element for design purposes. The technique used to determine the tensile strength as shown in graph. The strength may vary between 3.2 N/mm^2 to 4.5 N/mm^2. It is generally lower in comparison go specimens with untreated coir.

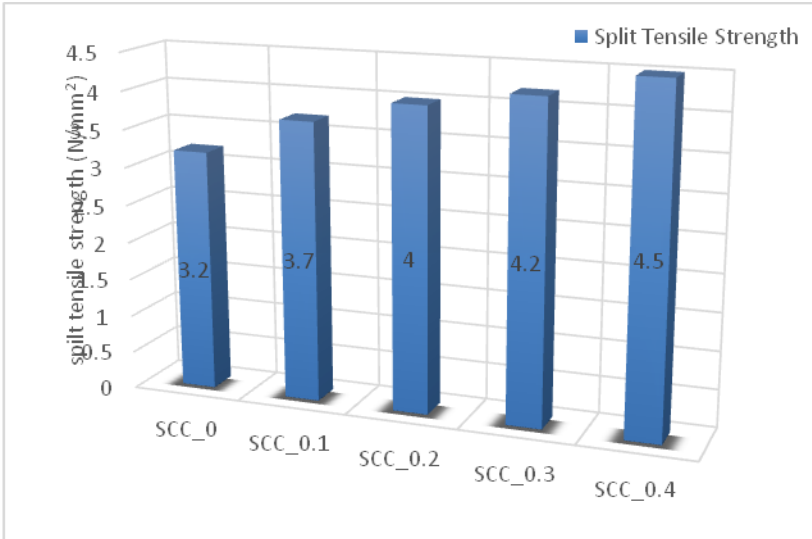

Figure 11 Split tensile Strength

Conclusion

1. The workability properties of SCC such as slump flow L box and V funnel values decreased with increase of the addition of percentage of coir fiber.
2. The compressive strength obtained with the addition of coir fiber seems to be maintained, showing the addition of fibers has no drastic effect on the compressive strength of concrete.
3. The spilt tensile strength of SCC showed greater improvement with the addition of fiber added concrete.
4. The addition of fiber has more advantage of it in concrete.

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