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A Comparative Study on Toughness using Hair and Coir Fibres in Self Compacting Concrete

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***Abstract*:- The properties of hardened concrete can be significantly improved by fibres. Self compacting concrete is an innovative concrete that is able to flow under its own weight, completely filling the form work and achieving full compaction without vibration. This paper deals with the comparison of toughness potential between hair and coir fibre reinforced self compacting concrete. Fresh and hardened properties were studied to characterize the concrete reinforced with hair and coir fibre having a volume fraction of 0.5% and 0.75%. Slump flow test was conducted for evaluating the fluidity of the fresh concrete. Compressive strength and flexural strength tests were conducted for evaluating the hardened properties. Toughness was evaluated using a software Graph (ver.4.4.2). Absolute toughness and post crack toughness parameters were investigated.Results indicate that the coir fibre with 0.75% volume faction is having more toughness than the hair fibre reinforced concrete. Absolute toughness of 0.75% coir fibre is two times the absolute toughness 0.75% hair fibre and Post crack toughness of 0.75% coir fibre is three times the post crack toughness of 0.75% hair fibre.**

Keywords: Self compacting concrete, Hair fibre, Coir fibre, Toughness.

1. INTRODUCTION

Self Compacting Concrete (SCC) is a new generation high performance concrete, which is highly flowable and can spread in place under its own weight and achieve good consolidation in the absence of vibration without having the defects due to segregation and bleeding.Considerable research on Fibre Reinforced Concrete (FRC) has shown that the addition of fibres to concrete makes it more homogenous and isotropic and can significantly increase the tensile strength and ductility(Naveen et al.2015).When concrete cracks, the randomly oriented fibres arrest micro cracking and limit crack propagation thus substantially improving the toughness, tensile strength and ductility.Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres, each of which lend varying properties to the concrete. In addition, the character of fibrereinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities.The amount of fibres added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction".As an innovation to the field of Fibre Reinforced Concrete, usage of Human Hair as a Fibre gained its importance.It has a high tensile strength which is equal to that of a copper wire with similar diameter.Coir or coconut fibre, is a natural fibre extracted from the husk of coconut. Coir will not have any risk of getting corroded like steel.The most common method to assess the flexural performance of fibre reinforced concrete is by conducting bending test. Experimental test methods and characterization of toughness is available in various standards ASTM C-1018, ACI-544guidelines, JCI specifications, RILEM draft recommendations, EFNARC specification.The focus of the present study is to investigate experimentally the influence of hair and coirfibres on flexural properties and toughness capacity in self compacting concrete, giving more emphasis to absolute toughness and post crack performance(Basheerudeen et al.2016).SCC with volume fraction of 0.5% and 0.75% of hair and coir fibres were considered for the study.

2. EXPERIMENTAL INVESTIGATION

Flexural and toughness characteristics were studied on SCC with 0.5% and 0.75% hair and coir reinforcement..The mix design methodology, mix proportions and mixingsequene of SCC mixtures adopted for the present study is taken from author(Nanthagopalan et al.2010).

TABLE 1: COMPOSITION OF CONCRETE MIXTURES

Type of Fibre	V_f	Weight of cement(Kg)	Weight of water(l)	Weight of fibre(g)	Weight of CA(Kg)	Weight of FA(Kg)
No fibre	0%	2.97	1.14	0	6.94	5.5
Hair fibre	0.5%	2.97	1.14	22.5	6.94	5.5
Coir fibre	0.5%	2.97	1.14	16.75	6.94	5.5
Hair fibre	0.75%	2.97	1.14	32.8	6.94	5.5
Coir fibre	0.75%	2.97	1.14	25.12	6.94	5.5

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2.1 MATERIALS

The materials used for the present investigation are Cement, Coarse aggregate, Manufactured sand (M-sand), Super plasticizer, coir fibres, hairfibres&water. Pozzolana Portland cement (PPC) was used for all the mixes, confirming to IS specifications. The fineness of the cement was 300 m^2/kg with a specific gravity of 2.90. The specific gravity of coarse aggregate of 12.5 mm size is 2.7. Locally available M-sand was used for the study, well graded sand falling under Zone-II category as per Indian specifications. The specific gravity and bulk density were found to be 2.58 and 15.1 kN/m3. Ceraplast 200 is used as the superplasticizer which is present in liquid form. The specific gravity is 1.15 + .03.Hair fibre of length 50 mm and coir fibre of specific gravity 1.15 and 50 mm length were used for the study. Potable water free from chlorides and sulphates was used for mixing as well as for curing the concrete.

2.2 SPECIMENS

Flexural performance was conducted on specimen of size 500x100x100mm on a Universal Testing Machine and the deflection was measured using a dial guage. Due to the restrained effect, pure bending will take place at the mid span and the experimental values obtained from this set up will offer an accurate load-deflection.The compressive strength was conducted on specimens of size 150x150x150 mm on a compressive testing machine.The specimens were prepared in a concrete mixer. Two samples were prepared with each volume fraction of hair and coir fibres and also without fibres.The casting surface was levelled and finished using a trowel, after filling the mould. The specimens were demoulded after 24hrs and are immersed in water for curing under controlled environment until tested.

2.3 INVESTIGATED PARAMETERS

The slump value was obtained using a slump cone apparatus.The time of flow and approximate diameter of flow were measured.The flexural performance of toughness parameters were obtained by testing a simply supported beam under third point loading according to the ASTM C 1609 standard. The test was conducted on a flexural testing machine having flexural capacity of 100kN and a displacement rate of 0.5 mm/min.True mid span deflections were recorded with a dial gauge. From the load-deflection curve; Absolute toughness and Post crack toughness were calculated.

Fig 1 Slump cone apparatus

Fig 2 Test set up for Flexural studies

3. EXPERIMENTAL RESULTS & DISCUSSION

3.1 FRESH PROPERTIES

The optimal volume fraction of hair and coir fibre that will be introduced to the self compacting concrete will be selected by conducting the slump test.

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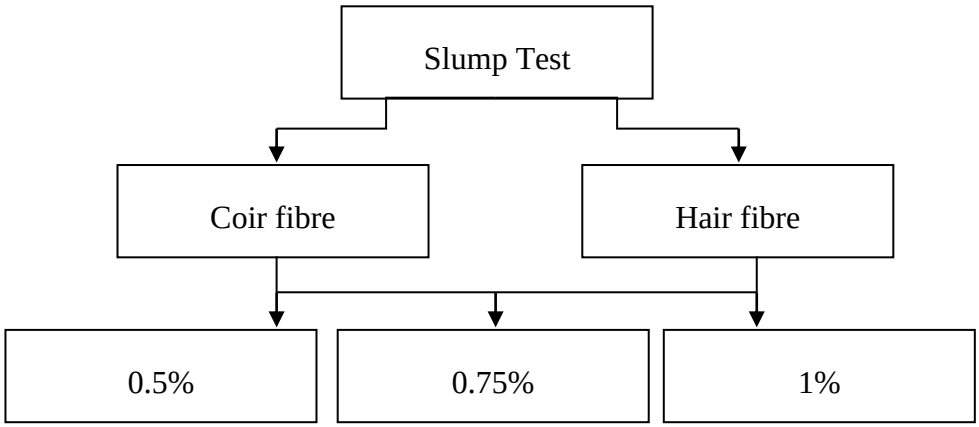

Fig 3 flow chart

Table 1 slump flow diameter

Sl N0	Fibre content	Slump flow diameter (mm)
1	0%	750
2	0.5% hair	720
3	0.75% hair	680
4	1% hair	600
5	0.5% coir	730
6	0.75% coir	700
7	1% coir	600

Fig 4 Slump test with 0.75% coir fibre

The result of the slump flow test showed that 0.75% coir fibre has a good flow diameter of 700 mm which satisfies the EFNARC specification as compared to hair fibre.

3.2 Toughness Properties

Table 2 present the results obtained from compressive strength test and toughness values at 28 day.

Type of fibre	V_f	Compressive strength (N/mm2)	Absolute toughness(Nm)	Post crack toughness(Nm)
Hair fibre	0.75%	18.66	18.18	7.4
Coir fibre	0.75%	20.88	36.16	22.95

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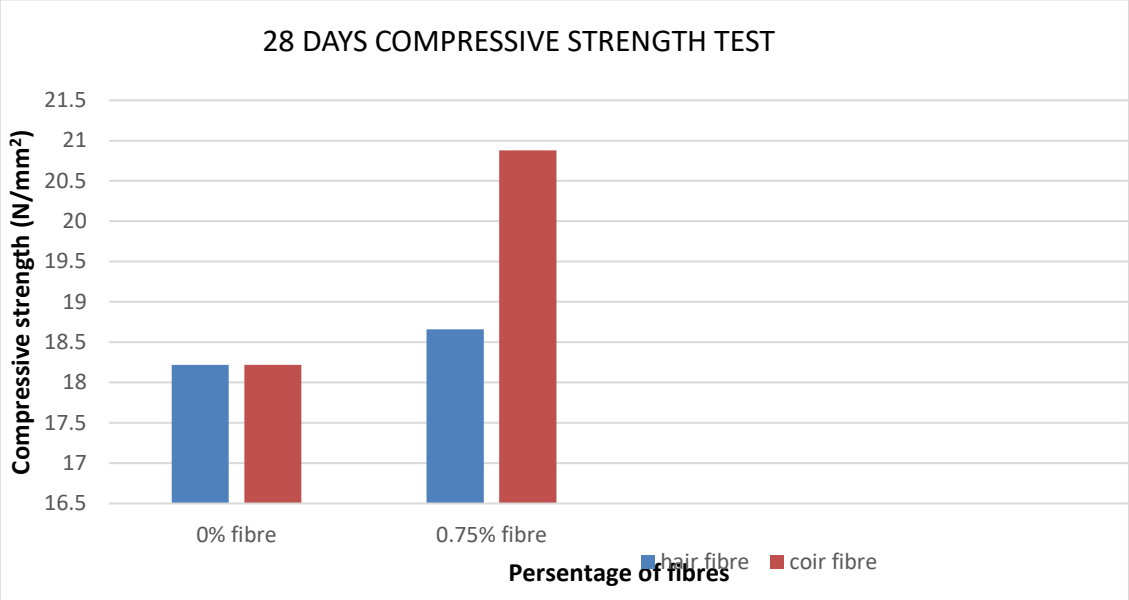

Fig 5 Compressive strength comparison of with and without fibre

3.2.1. Absolute Toughness

Absolute toughness represents the area under the load-deflection curve up to failure load. The area below the load- deflection plot (figure 2)which is the gauge of energy absorption capacity, was increasing on fibre addition. The absolute toughness of 0.75% coir fibre is two times the absolute toughness of 0.75% hair fibre..

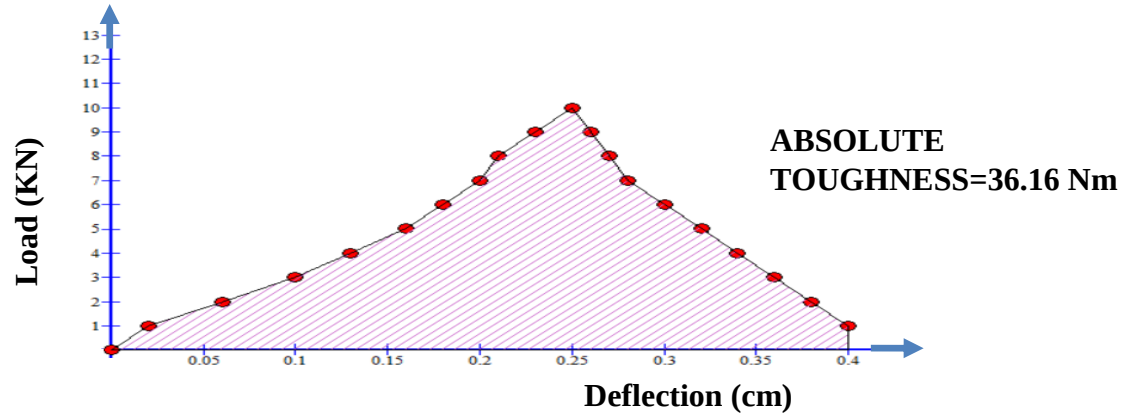

Fig 6 Absolute toughness of 0.75% coir fibre

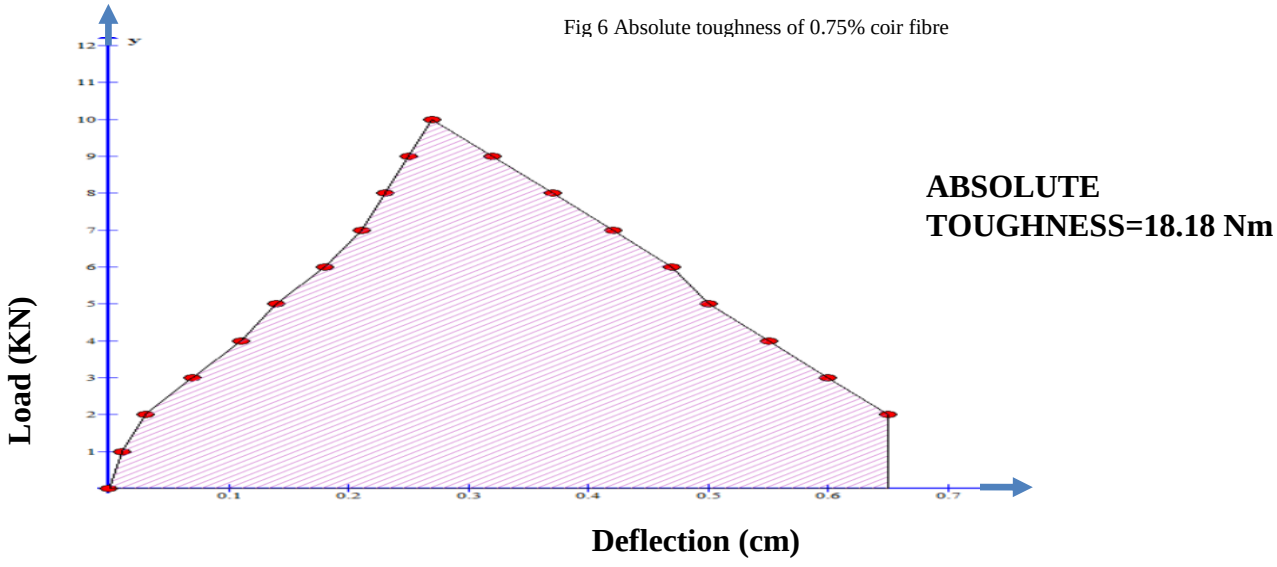

Fig 7 absolute toughness of 0.75% hair fibre

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3.1.2 Post crack Toughness

Post crack toughness is defined as the area under the load-deflection curve from the ultimate load to theload at failure. The post crack toughness of 0.75% coir fibre is three times the post crack toughness of 0.75% hair fibre..

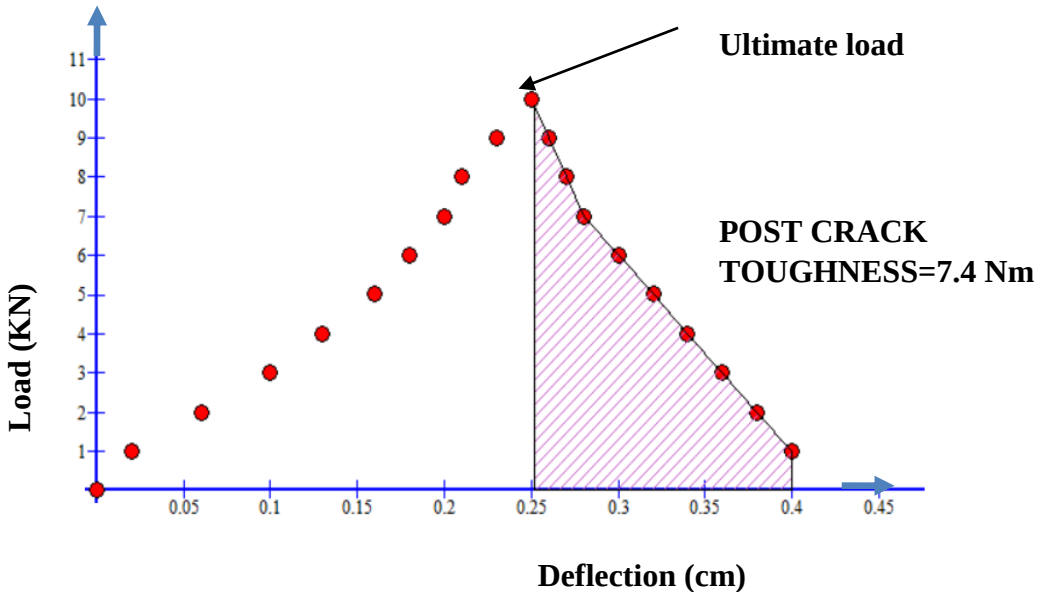

Fig 8 Post crack toughness of 0.75% hair fibre..

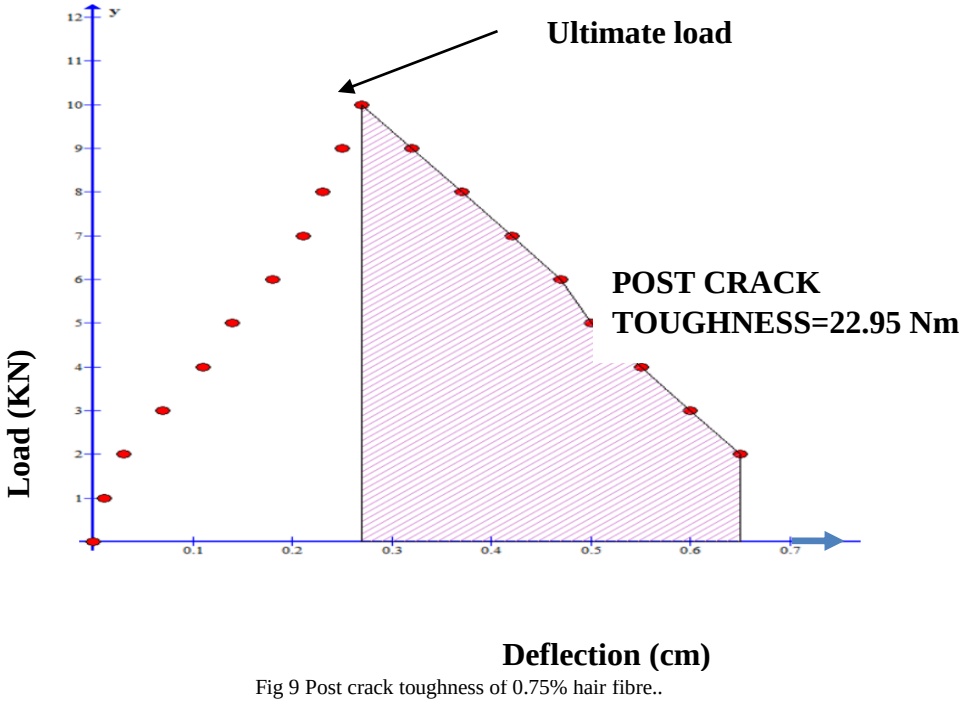

Fig 9 Post crack toughness of 0.75% hair fibre..

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Fig 10 Typical failure patterns for concrete prisms after flexural loading.

4. CONCLUSION

The present study was aimed to investigate the benefits of incorporating hair and coir fibres in self compacting concrete by conducting experiments. Flexural and toughness test were performed and the result obtained can be summarized as follows:

1. The best mix in terms of slump diameter is 0.75% coir fibre
2. The absolute toughness for coir is 36.16 Nm and for hair fibre is 18.18 Nm
3. The Post crack toughness for coir is 22.95 Nm and for hair fibre is 7.4Nm
4. It is observed that the maximum deflection is taken by0.75% coir fibre and hence coir fibre has the maximum toughness when compared to hair fibre.

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