ROLE OF COIR FIBRE IN CRACK REDUCTION IN CONCRETE

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Abstract- The role of coir fibre to reduce the cracks in cement concrete has been evaluated on the basis of performance of coir fibre in the test performed. As the natural fibres are renewable and nonabrasive, the natural fibre can be very promising. The coir fibre, having the highest toughness among all the existing natural fibres and a good shock absorber as well, is used in concrete. Compressive strength, split tensile strength and petrography tests were executed for analysis of crack reduction. It has been found out that cracks are reduced by coir fibre addition in concrete, with almost equivalent compressive and split tensile strength in comparison to the plain cement concrete. It has been deduced that coir fibre concrete showed ductile failure. The petrography test showed no degradation after 28 days in surface of coir fibre even in the alkaline environment of concrete.

Index Terms- Coir fibre, crack, compressive strength, splitting tensile, petrography test

I. INTRODUCTION

Civil structures made of steel reinforced concrete normally suffer from corrosion of the steel by the salt, which results in the failure of those structures. Natural-fibres are bio-derived polymer matrix composites. Failure and damage of the structures can be avoided by the use of coir fibre and thus to minimize economic damage, future deterioration, and in severe cases the loss of human life it can play a crucial role. They have gained interest over the past few decades because of low material costs, high tensile and flexural modulus and environment friendly. Their production energy requirements are also quite low [1]. In comparison with conventional inorganic fibres such as glass fibre and carbon fibres, natural fibres are quite abundant and therefore have comparatively low cost. In addition to this they are flexible in nature which in turn causes less wear and tear to machine while processing. They have minimal health hazards and have low densities resulting in reduction in weight of concrete. Also one can have desirable fibre aspect ratio of fibres [2].

The principal reason for incorporating fibres into a cement matrix is to reduce the cracks in the resultant composite. The important factors regarding composite performance are fibre type, alignment and length, matrix used and interfacial bonding (enables transfer of the applied load to the fibres). The weak interfacial bonding between the fibres and the matrix in natural reinforced composites is a major drawback which limits their application [3]. The renewable and biodegradable characteristics of natural fibres have an advantage of their ultimate disposal by composting or incineration, options not possible with most industrial fibres. Coir Fibre has the highest toughness and water resistance among all the existing fibres and is found to be a good shock absorber therefore can be recommended for earthquake loading [4]. It has very high lignin content that is around 34% and less cellulose content in comparison with other natural fibres which makes it less flexible and stronger. One of the greatest benefits gained by using fibre reinforcement is improved long-term serviceability of the structure [5].

Addition of fibers can reduce plastic shrinkage cracking which stops the spread of micro cracks and also increases the tensile strength of concrete [6]. The development of such low cost materials with elevated durability and high mechanical performance is still a challenge to us. This project deals specifically with the concrete reinforced with the 'coconut fibres'. The main aim of this work is to explore the role of coir fibres in crack reduction and their durability in concrete.

II. MATERIAL AND METHODS

The mix design for M20 grade is done by using IS 800:2007. The cement grade used is OPC 43 with maximum size of 20 mm aggregate is taken. The w/c ratio is taken 0.5 according to 75mm workability. The second step was CFCC (coconut-fibre-cement-concrete) preparation. A fibre length of 5 cm and a content of 3% by cement mass were used for preparing coconut-fibre-cement-concrete (CFCC). The mix design ratio of cement: sand: aggregate was 1 : 1.42 : 3.37. The fibres preparation, casting CFCC and pouring of CFCC into moulds were performed. The basic static properties of CFCC were determined by standard procedures, normally used for plain concrete. It may be noted that the cylinders of 150mm diameter*300mm height and cubes of 150mm width*150mm depth*150mm length were used for this purpose. Table 1 shows all experiments under current study. Fig1 shows the specimens under current study.

III. RESULTS AND DISCUSSIONS

The compressive strength and split tensile strength of both CFCC and PCC are comparable being PCC on somewhat higher side as shown in Fig.4 & 5. This shows that the cementitious material has not properly filled the voids of the concrete (shown in Petrography test Fig.11) and it has not attained a good compaction due to less

workability in CFCC which is shown in Fig.7. The weight reduction in CFCC in comparison to PCC can be clearly observed from Fig.6. This is due to the fact that coir fibre is very less dense than concrete. Though some minor cracks were present but their propagation was restricted by coir fibres and the specimen can take the load after cracks as well.



Figure 1 Coir Fibre



Figure 2 Compression strength test



Figure 3 Split tensile strength test

TESTS	MOULD TYPE	DIMENSION (all in mm)	NO. Of SPECIMEN	TESTING AFTER NO. OF DAYS
Compressive Strength	Cube	150*150*150	12 (6; 3 for each) (6; 3 for each)	7 days 28 days
Splitting Tensile Strength	Cylinder	150 (diameter) 300 (height)	12 (6; 3 for each) (6; 3 for each)	7 days 28 days
Slump Test	Conical Mould	Frustum of Cone with 300mm height	All Respective Samples	Instant
Petrography Test	-	2.5x magnification Ordinary Light and Cross Nickel Light	2 samples; CFCC and PCC	28 days

Table 1 Testing Methodology

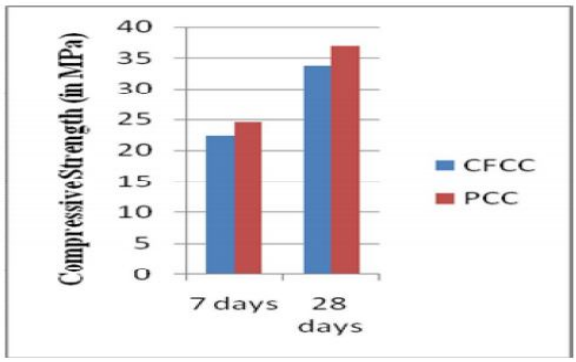


Figure 4 Comparison in compressive Strength

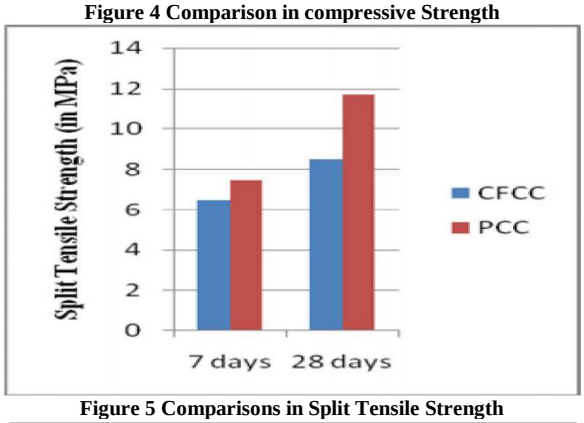


Figure 5 Comparisons in Split Tensile Strength

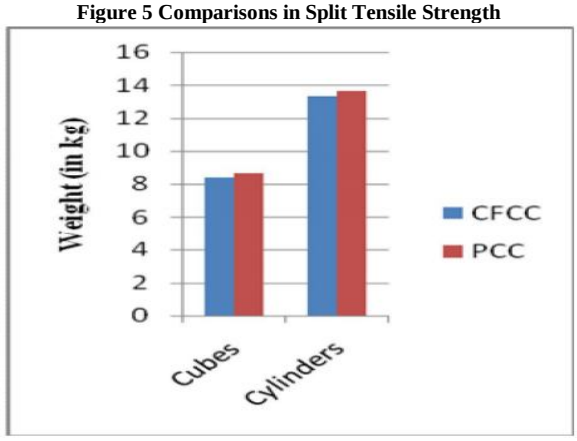


Figure 6 Comparisons in Weights

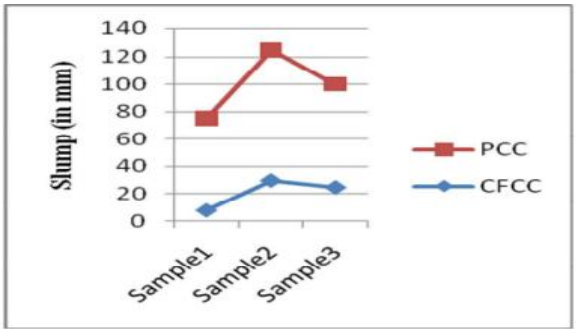


Figure 7 Slump test

All the photographs are in 25x magnification. The colour of the fibre is dark brown colour and cementitious groundmass is black in colour. The presence of coir fibre running across the petrography can be easily observed in Fig.9 & 10. The else materials are sand minerals and coarse aggregates which can be seen in polarised light (Fig.8). It can be seen from Fig.10 that the periphery of the fibre is not infilled with the cementitious material. This may be due to less bond strength between coir fibre and concrete due to smooth surface of coir fibre. Also another observation is the number of voids is quite high in CFCC in comparison to PCC, by comparing Fig.8 & 9. Also from Fig.10 it can be deduced that fibres with small length is infilled with cementitious material but the larger one isn't.



Figure 8 PCC in cross nickel light

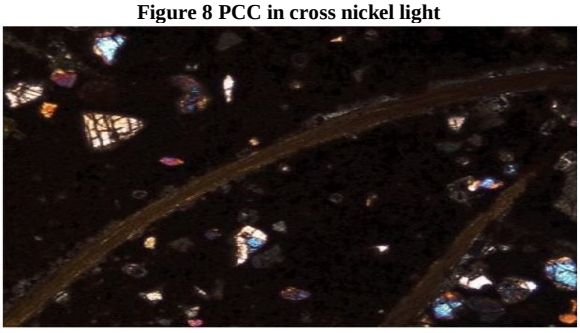


Figure 9 CFCC in cross nickel light

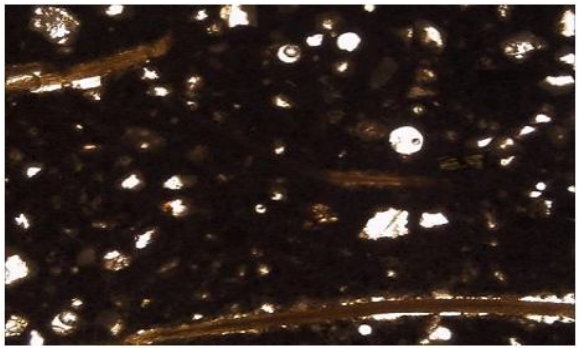


Figure 10 CFCC in ordinary light

CONCLUSION

Coir fibres can be well used for crack reduction. The experiments showed that compressive strength and split tensile strength of both CFCC and PCC are comparable. The tests even reported that the use of fibre can increase ductility of concrete. The slump test showed that CFCC is very less workable compared to PCC. The petrography tests gave a clear report of the properties of fibre in concrete with reduction in cracks in CFCC. The durability of fibres can be a subject to further study. The immersion of the fibre in silica fume, silane coating of fibres, using pulped fibres etc. can be various measures to improve durability performance of natural fibre reinforced concrete. The workability of coir fibre concrete was found to be very less in comparison to plain cement concrete. Hence it has been concluded that coir fibre concrete can be effectively used in the structures with less workability requirement as well as in earthquake prone areas.

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