A comparative Study on Simple Concrete and Coconut Fiber Reinforced Concrete

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Abstract— When it comes to civil engineering, concrete is an inevitable building material. As we all know, concrete is good in compression but weaker under tensile forces, there is a need of concrete composites with better tensile strength. Also with the increasing global warming and pollution, need of the present world is environment friendly natural additives to cast concrete so as to minimize the pollution effect. Among natural fibers, coir fiber has maximum amount of lignin giving maximum tensile strength as well as are durable in nature. This paper presents an experimental study of coir fiber reinforced concrete and its strength comparison with plain cement concrete. Reinforcement of concrete is necessary to enhance its engineering properties. For this study, coconut fibers were used as they are freely available in large quantities. The study comprises of comparative statement of properties of coconut fiber reinforced concrete with conventional concrete based on experiments performed in the laboratory. The use of coconut fibers will also lead to better management of these best fibers. The study found the optimum fiber content to be 3% (by weight of cement) the addition of coconut fibers improved the compressive strength of concrete by about 12%, they also formed good bonding in the concrete. Further work is required by changing the fiber content and aspect ratio to determine the optimum range of fiber content so that fiber reinforced concrete can be used where high compressive and flexural strength required.

Keywords: Compressive strength, Tensile strength, Coir Fiber, Flexural Strength

I. INTRODUCTION

Concrete is one of the most widely and commonly used building material in civil engineering around the world. Concrete is strong in compression, however, is a very brittle material, and has low strain capacity in tension and consequently low toughness. As a result, cracks develop whenever loads give rise to tensile stresses exceeding the tensile strength of concrete. Adding fibers to concrete matrix has been long recognized as a way to enhance the energy absorption capacity and crack resistance of the plane concrete. In fiber reinforced concrete (FRC), by bridging fibers across the cracks a post-cracking ductility is provided, and consequently, the toughness of concrete is considerably enhanced. Consideration of toughness and the fracture energy is important since it determines the ductility and crack resistance of the structure assuring the safety and integrity of the structural element prior to its complete failure.

Concrete is typically reinforced with steel or synthetic fibers like carbon, glass, or aramid. Despite of their advantages, the high material costs, the high energy-consuming process by the production and their adverse environmental impact has initiated the search of new environmental friendly and sustainable alternatives. In the framework of international research, a considerable effort is going on in the exploitation of fast growing, annually renewable, cheap agricultural crops and crop residues as possible fiber reinforcement in concrete. The basic advantage of natural fibers is that they are a low cost and widely available resource in many agricultural areas. They are biodegradable, non-abrasive and there is no concern with health and safety during handling. Natural fiber reinforced materials are environmental friendly materials producing less green-house gas emissions and pollutants. The use of natural fibers as reinforcement is a way to recycle these fibers and to produce a high performance material.

Coir derived from tamil word “kayiru” is a natural fiber obtained from the husk of coconut. Coir possesses about 48% of lignin increasing strength and elasticity of fiber; it also reduced the biological degradation with average life nearly 20 years. Coir is produced in India at a large scale, references says more than 90% of the world coir production is from India. Kerala leads in India with producing more than 60% of the Indian production alone.

Fig. 1: Coconut Fiber

II. LITERATURE REVIEW

In an project performed by Anoop Singh and Tanmay Shah M.tech(Apr. 2016)They used coconut fiber as fiber reinforcement in normal concrete to increase strength of concrete. The designed a PCC cube and coconut fiber cube both also.

Based on the previous research work (before 2016) a comparison of strength properties of fiber reinforced concrete is made with respect to conventional concrete and the influence of shape of fibers of length size 5cm and raw of fiber meshes of size 5cm x 5cm after coating them with coconut oil at varying fibercontets of 4%, 5% and 6%.

Material tests were carried out initially to determine the suitability of material to be used in concrete. The mix was designed as were IS:10262: 2009 at a suitable water content and design mix was obtained. The mixing was carried out according to standard procedure given in IS code with sufficient care to ensure that no bleeding occurred throughout the entire process slump test were carried to ensure that the mix was workable the cubes were then cured for 7 and 28 days and work properly dried in sunlight before testing.

III. MATERIALS AND TEST METHODOLOGY

Materials: M-20 grade concrete was adopted for casting CRFC and PCC. Cement opted is PPC 53: J K Lakshmi Cement with specific gravity 3.15 g/cc. Fine aggregates are confirming to zone 1, specific gravity 2.65 g/cc. and coarse aggregates are 20 mm in size with specific gravity 2.63 g/cc. Coir fibers adopted for study are of size 2mm with 3 different % by weight of cement viz. 1%, 3% and 5% respectively.

A. Test Methodology:

The mix design is carried out on the basis of IS 10262: 1982. The mix proportion obtained as per mix design is water: cement: fine aggregates: coarse aggregates = 0.48: 1.00: 1.69: 3.13. The proportion for casting remains same for both PCC and CFRC. Only difference in the methodology for casting CFRC was that cement, aggregates and random chopped coir were mixed in a dry state (dry mixing) followed by addition of water so that uniform mixing can be achieved whereas PCC was casted by conventional concrete mixture method.

Fig. 2: Simple Concrete Cube

Concrete cubes, cylinders and beams were casted for both PCC and CFRC at different proportions of coir and several tests were performed the result of which can be discussed in next segment.

Fig. 3: Coconut Fiber Reinforced Concrete

IV. RESULT AND DISCUSSIONS

Firstly, diameter of coir fiber for two different samples were evaluated using semi-graphical method in which micro image of coir fiber was captured with the help of Nicon eclipse TS 100 inverted microscope; diameter was calculated in pixels using SPIP (Scanning Probe Image Processor) and finally converting the pixels into mm analytically with the help of AutoCAD software. The values for fiber 1 and fiber 2 were 0.8899 mm and 1.020 mm respectively. Both values were close to 1 mm (theoretically available in different references). Compressive strength test, splitting tensile test and flexural strength test were performed on cubes, cylinders and beams for PCC and CFRC of different fiber proportions viz. 1%, 3% and 5% respectively.

Fig. 4: Compressive Strength Test

Fig. 5: Tensile Strength Test

Fig. 6: Flexural Strength Test

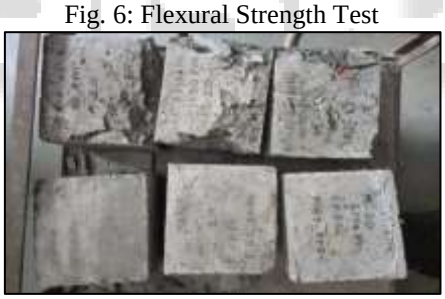

Fig. 7: Cubes of CFRC and PCC

The best results were obtained for 1% fiber content at 2 mm avg. length of fiber. The results can be tabulated as below:

Tests	PCC	CFRC	% Variation in strength
Compressive strength (28 days)	28.34 N/mm^2	31.79 N/mm^2	12.69 (+ve)
Split tensile strength (7 days)	1.10 N/mm^2	1.60 N/mm^2	38.90 (+ve)
Flexural strength test (7 days)	30.75 N/mm^2	35.25 N/mm^2	14.70 (+ve)

Expected split tensile strength for PCC is1.90 N/mm^2 for 28 days as per available literature review. Thus expected split tensile strength at the end of 7 days should be 1.16 N/mm^2 (60%). Experimental results for split tensile strength of PCC was 1.18 N/mm^{2}and for CFRC 1.64 N/mm^2. This shows the increase in tensile strength of concrete.

V. CONCLUSION

1) The compressive strength of Coir fiber reinforced concrete (CFRC) is nearly 13% more than that of a Plain cement concrete (PCC).
2) The tensile strength of CRFC is nearly 40% more than the PCC. This is a significant strength increment.
3) The flexural strength of CFRC is 15% more than that of PCC.
4) The addition of coir in concrete also suggests that if the strength value is to be kept same for both CFRC and PCC, nearly 5% cement by weight can be saved. Thus CFRC can be cost effective compared to PCC and can help reduce pollution from environmental point of view.
5) Rate analysis show difference of approximately Rs. 175 between PCC and CFRC which mean CFRC are costlier than PCC but the cost-to-benefit ratio is significantly high.
6) CFRC helps in resisting cracks under the action of compressive and abrasion forces. This phenomenon can be well explained by the figure shown below. The image was captured after the cubes were tested for compressive strength.

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