Evaluation of Compressive Strength of Coir Fibre Reinforced Concrete

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Abstract: The coir fibre currently recognized as one of the sustainable fibre composite material, due to some specific mechanical property when compared to artificial fibre. Also, when compared to plain cement concrete, the coir reinforced concrete improves the cracking resistance. Addition of coconut fibre in concrete improves various engineering properties of concrete, because it possesses good binding property in concrete. In this experimental study different dimension of coir fibre is randomly distributed into concrete of M25 grade with water-cement ratio of 0.43. The coir fibre with a length of 10mm, 15mm and 20mm of different percentage as 0.1%, 0.15%, 0.20%, 0.25%, and 0.30% are used respectively. Due to the presence of coir fibre there is a decrease in the workability of concrete. The test on compressive strength for 28 days is carried out for all the selected proportions of coir fibre. And the maximum compressive strength was obtained for a mix having a fibre length of 15 mm and 0.2% of coir fibre content. Based on the experimental study it is noticed that the compressive strength found to be decreases with increasing length and percentage of coir fibre. So, in the field of civil engineering, more importance and encouragement should be given for the use of natural fibres which are locally available materials..

Keywords: Coir Fibre, Composites, Compressive strength

1. Introduction

Natural fibres extracted from the skin of plants, leaves, stems and flesh, such as flax, sugar cane, pineapple, banana, coconut, sisal, jute and oil palm, are mainly composed of cellulose, hemicellulose and lignin. These natural fibres are readily available, recyclable and renewable resource. Unlike synthetic fibres, natural fibres are biodegradable, economical, low density, non-toxic, and can be used globally, energy efficient and environmentally friendly. Brittle materials based on natural fibres show higher technical and economic feasibility than similar materials based on synthetic fibres. In addition, natural fibres have excellent mechanical properties, including high strength and flexibility, which improve the plasticity of irrelatively brittle cement substrates. Therefore, these fibres meet the ecological and sustainability requirements of high-performance reinforced cement.

2. Literature Review

A. Zuraid et al., (2011) [1] evaluates the effect of fibre length on mechanical and physical properties of coconut fibre-enhanced albumin cement compounds. The albumin protein was added as a binder, and 2.5, 5, 10 and 20mm long coconut fibres (control cement composite) were used as a partial replacement for the cement mixture. Resistance to bending, compression, apparent density, moisture content and water absorption were tested. Experimental studies have shown that increasing the fibre length increases the bending strength. However, the inclusion of long fibres in the cement slurry reduces processability and thus introduces low density pores. In fact, this in turn increases the water absorption capacity and moisture content.

Sahaya Ruben et al., (2014) [2] they studied the behaviour of natural fibres in concrete structures. Recently Coconut fibre received an attention as a durable fibre-based composite based on the comparison of certain unique mechanical properties of rayon. Coconut fibre is treated with natural latex before it is used in concrete, so the moisture content of the concrete does not affect it. In this 28-day experimental study, compressive strength and tensile strength were achieved with different percentages (e.g., 0.5%) using coconut fibres of different lengths (20 mm, 25 mm, and 30 mm, respectively). 0.75% and 1%. They also depicted that natural fibres should be encouraged in civil engineering as it is locally available materials.

Abdul Nazeer et al., (2014) [3] they studied the mechanical behavior of the coconut fibre of different lengths (5 mm, 10 mm, 15 mm) reinforced with epoxy resin during 5% NaOH fibre treatment. All samples were made by hand placement and samples were prepared in accordance with ASTM D3039. Samples were analysed according to ASTM D3039 using a Universal Test Machine (UTM). Important research results indicate that NaOH treatment improves the tensile properties, ductility and hardness of the compound. It has been found that an increase in fibre length increases tensile strength. Coconut fibres of 15 mm in length were found to have maximum tensile strength.

Rajan Shikha et al., (2015) [4] they studied the behavioural research on coconut fibre in concrete structures. The addition of coconut fibre to concrete improves several technical properties of concrete. Because it has good adhesion properties in concrete. Before using the coconut fibre in concrete it is treated using natural latex.

Therefore, the moisture of the concrete does not affect it. Adding coconut fibre can increase the compression, bending and tensile strength of concrete. The study showed an optimum fibre content of 1% to 2% to 3% by weight of cement. For M25 and M30 grade concrete cubes, the compressive strength was evaluated for 7 days, 14 days and 28 days. These results indicate that coconut and coconut concerts can be used for construction as it provides better Western fibre management as coconut fibre, and it is also organic.

3. Objectives

- Understand the effect of adding coconut on the compressive strength of concrete.
- Coir reinforcement is provided in lengths of 10mm,15mm, and 20mmin percentages of 0.1%,0.15%,2.0%, 2.5% and 3.0% for M25 grade of concrete.
- To compare the compressive strength of conventional concrete and Coir fibre reinforced concrete with varying length and percentage of coir fibre and to find economic and eco-friendly concrete.

4. Materials And Methodology

Cement

One of the most significant building materials is cement which acts as a good binder that adheres and hardens to cling to building segments, for example, stones, blocks, tiles, and such. Cement is typically a fine powdered substance comprising of limestone (calcium) and sand or then again earth (silicon), bauxite (aluminum) and iron mineral which includes shells, chalk, potting soil, shale, clay, blast furnace slag, slate. The raw materials are processed and burnt in a cement plant to form a hard rock like material, which is then ground into a fine powder available for sale. When cement is mixed with water, a chemical reaction undergoes and forms a collected and hardened paste that joins the different structures of the building material.

Fine Aggregate

The fine aggregate adopted in the present study is sand M. made of gravel, granite and hard stone. It has a cubic particle shape with overlapping edges that have been cleaned and classified to use as an alternative for river sand. The most advanced and advanced technology is used to make thin particles and shapes similar to river sand. The quality of M sand is better than that of river sand. Codes guarantees to classify Zone II according to IS 383 (1970).

Coarse Aggregate

Coarse aggregates can be defined as inert particulate materials such as gravel, gravel and sand. It is one of the fundamental components of concrete production except water and cement. It accounts for about 60% to 75% of the total concrete production and is composed of particles larger than 4.75 mm, but is usually between 9.5 and 37.5-mm.

Coir Fibre

Coir fibre is a natural fibre obtained from coconut shells used in carpets, wipers, brushes, mattresses and concrete. Coconut fibre obtained from coconut shells is inexpensive and can be purchased locally in many tropical and semi-tropical countries. Compared to other natural fibres, coconut fibre can withstand 4 to 6 times the tension. In recent years, the potential of using coconut fibre to improve the performance of cement-based materials has attracted the attention of researchers. Coconut fibre is widely used in sheet, roof, concrete and other building materials. Cement mixtures reinforced with coconut fibres and castings of 1 to 2 MPa are currently used as inexpensive roofs. Coconut is a fibrous substance involving the hard-inner shell and outer layer of coconut. 10mm, 15mm and 20mm long fibres were used in this test.as shown in the fig. 1.

Fig. 1 Coconut fibre of 10mm, 15mm & 20mm Length.

Water

The amount of water in the concrete controls various fresh and hardened properties of the concrete which includes workability, compressive strength, permeability, durability and atmospheric conditions, shrinkage and

cracking during drying. For these reasons, limiting and controlling the amount of water in the concrete is important for both structural capability and service life.

Metodology

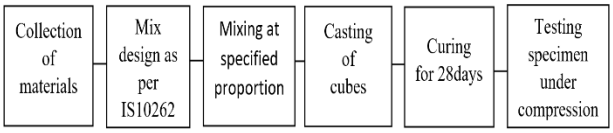

Fig.2 Flowchart representing Methodology.

5. Results And Discussions

The compression test is the most common test for hardened concrete. The cube sample measures 150 x 150 x 150 mm used for compression testing. These samples were tested using a compressor after 28 days of curing. The compressive strength test of the hardened concrete was carried out on a 1000kN compressive strength testing machine. Table 1 illustrate the results of 28 days Compressive strength of coir fibre reinforced concrete having length 10mm. Different volume fraction of coir fibre is added varies from 0% to 0.3% and the maximum peak load is found in 0.2% of coir fibre is 761.0kN and compressive strength is 33.80 N/mm^2.

Table.1 Compressive strength of coir fibre reinforced concrete having length 10mm

Sl. No.	% of coir fibre added	Peak load (kN)	28days compressive strength (N/mm^2)
1	0%	670.0	29.77
2	0.10%	708.5	31.50
3	0.15%	731.0	32.50
4	0.20%	761.O	33.80
5	0.25%	724.0	32.20
6	0.30%	701.5	31.20

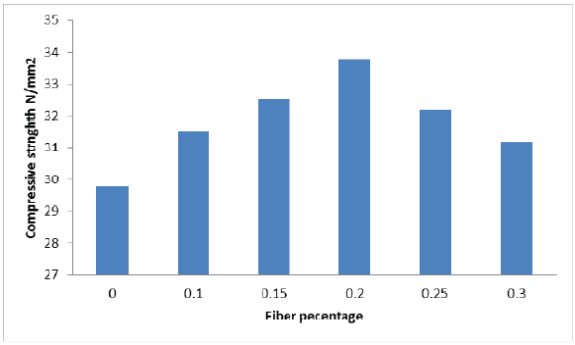

Fig.3 Compressive strength of cubes using 10mm coir fibre

From above figure 3 shows graphical representation of Compressive Strength of Cubes using 10mm coir fibre. The 28 days compressive strength varies from 29.77N/mm^2 to 31.20N/mm^2 of different volume fraction of coir fibre (0%,0.1%,0.15%,0.2%,0.25% and 0.3%).The compressive strength of coir fibre reinforced concrete gradually increase from 0.1% to 0.2% addition of coir fibre, further addition of coir fibre results in decreasing the compressive strength of coir fibre reinforced concrete. The compressive strength decreased from 33.80N/mm^2 to 31.20N/mm^2.

Table.2 Compressive strength of coir fibre reinforced concrete having length 15mm

Sl No.	% of coir fibre added	Peak load (kN)	28days compressive strength (N/mm^2)
1	0%	670.0	29.77
2	0.10%	722.5	32.10
3	0.15%	760.5	33.80
4	0.20%	785.0	34.90
5	0.25%	752.0	33.45
6	0.30%	730.0	32.40

Table 2 illustrate the results of 28 days Compressive strength of coir fibre reinforced concrete having length 15mm. Different volume fraction of coir fibre is added varies from 0% to 0.3% and the maximum peak load is found in 0.2% of coir fibre is 785.0 kN and compressive strength is 34.90 N/mm^2.

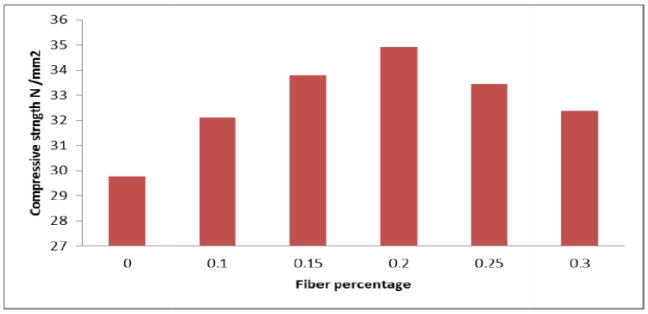

Fig.4 Compressive Strength of Cubes using 15mm coir fibre

Figure 4 shows graphical representation of Compressive Strength of Cubes using 15mm coir fibre. The 28 days compressive strength varies from 29.77N/mm^2 to 32.40N/mm^2 of different volume fraction of coir fibre (0%,0.1%0.15%,0.2%,0.25% and 0.3%).The compressive strength of coir fibre reinforced concrete gradually increase from 0.1% to 0.2% addition of coir fibre, further addition of coir fibre results in decreasing the compressive strength of coir fibre reinforced concrete. The compressive strength decreased from 34.90N/mm^2 to 32.40N/mm^2.

Table.3 Compressive strength of coir fibre reinforced concrete having length 20mm

Sl No.	% of coir fibre added	Peak load (kN)	28 days compressive strength (N/mm^2)
1	0%	670.0	29.77
2	0.10%	680.0	30.20
3	0.15%	701.5	31.30
4	0.20%	705.0	32.10
5	0.25%	680.0	30.20
6	0.30%	672.0	29.80

Above table 3 illustrate the results of 28 days Compressive strength of coir fibre reinforced concrete having length 20mm. Different volume fraction of coir fibre is added varies from 0% to 0.3% and the maximum peak load is found in 0.2% of coir fibre is 705.0kN and compressive strength is 32.10 N/mm^2.

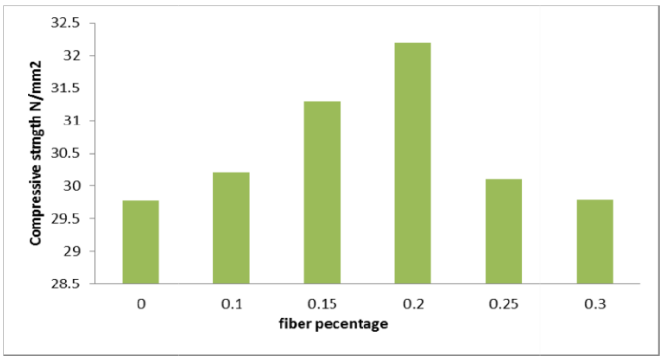

Fig.5 Compressive Strength of Cubes using 20mm coir fibre

Figure 5 shows the graphical representation of Compressive Strength of Cubes using 20mm coir fibre. The 28 days compressive strength varies from 29.77 N/mm2 to 29.80 N/mm^2 of different volume fraction of coir fibre (0%, 0.1%, 0.15%, 0.2%, 0.25% and 0.3%).The compressive strength of coir fibre reinforced concrete gradually increase from 0.1% to 0.2% addition of coir fibre, further addition of coir fibre results in decreasing the compressive strength of coir fibre reinforced concrete. The compressive strength decreased from 32.10 N/mm^2 to 29.80 N/mm^2.

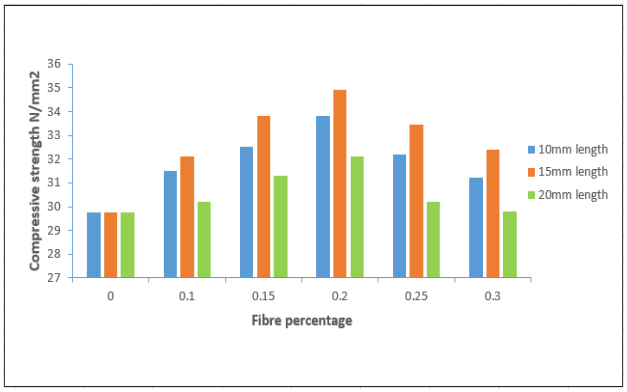

Fig. 6 Comparison of Compressive Strength by varying the length of coir fibre

The above figure 6 shows the comparison of 28 days compressive strength of M25 grade concrete for different volume fraction of Coir fibre (0.1%, 0.15%, 0.20%, 0.25%, 0.30%) with different length (10mm, 15mm,2 0mm) at a water cement ratio of 0.43. From the graph it is noticed that, initially there is a gradual increase in the compressive strength up to 0.20% of coir fibre, and then later the strength is decreased for 0.25% and 0.3% of coir fibre. The maximum compressive strength of 34.90 N/mm^{2}is obtained for 15mm length fibre with 0.20% addition of coir fibre. Compressive strength decreases with further addition of coir fibre because generally lower the density causes lower strength. As volume percentage of coir fibre increases the density of concrete decreases and hence it leads to a less compressive strength. The minimum strength of 29.77 N/mm2 was attained at 0% of coir fibre. It is observed that the compressive strength of concrete goes on decreases with an increase in the percentage and length of coir fibre in the concrete mix.

6. Conclusion

- The low density of fibre coconut fibres reduces the overall weight of the fibre reinforced concrete. Therefore, it can be used as a lightweight structural concrete. We can reduce environmental waste by using reinforced coconut fibre to reinforce concrete. Adding coir fibre can also prevent micro cracks present in concrete.
- The results show that the strength of coir fibre reinforced concrete is higher than that of plain concrete.
- Add 0.2% coconut fibre, the water-cement ratio is 0.43, and the compressive strength test results are the best. However, as the fibre is added, the compressive strength is lowered because generally lower density results in lower strength.

Using 15mm length of fibre showing best result compare to alternative length of fibre. However, length of fibre increases whereas decreasing the strength of coir fibre reinforced concrete.

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