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Experimental Study on Concrete Using Coconut Fibres Grains by Partial Replacement Method

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ABSTRACT
This paper presents an experimental study on coconut fibres grains using partial replacement method. The goal of the project is to improve the strength of concrete and minimize the emission of carbon dioxide. Coconut fibre grains are the natural materials which is plentifully available in tropical region .The coconut fibre grains are replaced with fine aggregate by a percentage replacement of 1 %,3 %,5 % and 7 %.The fresh and hardened properties of Conventional Concrete (CC) and Concrete with Coconut Fibre Grains (CCFG) such as Slump test, Compressive strength ,Split tensile strength and Flexural strength Test of concrete mixes are found for 7 days and 28 days of curing period and results are found and compared with the Conventional Concrete.

Keywords: Coconut Fibre Grains, Flexural Strength, Split tensile Strength

1. INTRODUCTION

The major construction material in construction industry is concrete. Concrete is a compound material made of fine and coarse aggregate and destined together with the cement, water that hardens over time. Humanity is moving towards more environmentally friendly construction that values the environment and the natural world as a result of the lack of non-renewable raw materials and the inappropriate disposal of solid waste. The construction system may partially or fully collapse due to natural factors, design flaws, or component quality issues. Numerous types of concrete are established from the better design of materials and combinations for explicit applications, but they have low tensile strength and ductility.
Cement is major binding materials used for all the types concrete. Cement is a binder, a substance which sets and hardens autonomously, and can bind other material together. Coconut shell is cultivated ecological waste found in most of parts of our country. Of all the natural fibres, coconut fibre is the strongest. Due to its mechanical properties, coconut fibre-reinforced concrete has a higher impact resistance and better flexural behaviour than regular concrete. In addition to providing a solution to the environmental issue of lowering the production of solid waste, coconut shell may present itself as a viable building material for the construction industry. Coconut fibre grains is a product which is extracted from the outer shell of the coconut fruit. Tests are conducted to study the fresh and hardened properties of the concrete with coconut

fibre grains with various percentage replacement with fine aggregates and compare the results with the properties of conventional concrete.

1.1 OBJECTIVES

- To find the slump values of Conventional Concrete and Concrete with Coconut fibre grains to assess the workability.
- To find optimum percentage replacement of coconut fibre grains with fine aggregates among the replacements 1 %, 3 % ,5 % and 7 % for the concrete with coconut fibre grains.
- To find the strength characteristics of Conventional Concrete and Concrete with Coconut fibre grains.

1.2 SCOPE

- Solid waste management is done effectively by using this waste material.
- The light weight concrete is prepared to reduce the initial cost.
- The demand of main resource material fine aggregates is minimized.

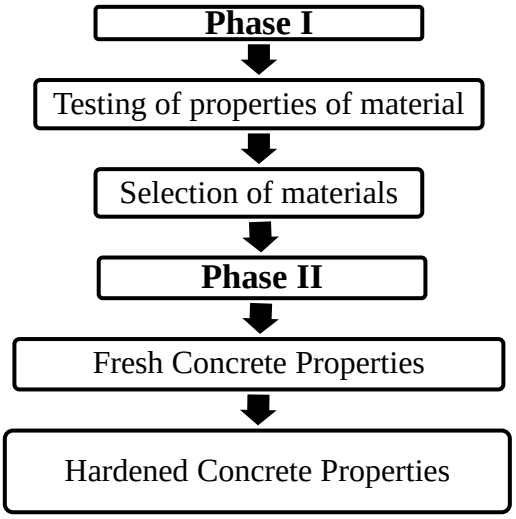
2. Literature Review

Natural fibres are those fibres that are pollution-free, environmentally friendly, and have no negative impacts on the climate. The amount of natural fibre waste produced annually is significant. The use of these natural fibres as construction materials could lead to the conservation of bio-reserves. Their role is to act as a green construction material. Construction requires the use of coconut fibre as the material [1]. The cheapest and durable non-structural elements is composites with coconut fibres [6].They are economical (zero cost), with no chemicals. The concrete with the combination of coconut-fibres and banana fibres improves the hardened properties of concrete such as the compressive strength, tensile strength and flexural strength and to ability to minimize the crack formation to acts as a natural admixture giving additional properties to the ordinary cement concrete [2]. The compressive strength, flexural strength, split tensile strength, and shear strength were determined through various tests and compared to plain concrete. The mechanical properties of coconut fibre reinforced concrete were observed to increase by 25 % to 30 % for fibres 50 mm and 75 mm in length [7]**.** The flexural strength of concrete was enhanced by coconut fibres by around 12 %, and they also provided good bonding in the concrete. Based on the cement weight, the optimal fibre content was determined by the study as 3 % [4].

The presence of discrete discontinuous fibres in the body of the concrete can be expected to improve the resistance of conventionally reinforced structural members to cracking, deflection and other serviceability conditions. Fibres were incorporated into concrete at a volume fraction of 1.25. The stub column with different percentages of coconut fibre was compared in terms of its load carrying capacities. The CFRC in-filled columns that contain a 1.25 % volume fraction of fibre exhibit superior strength and ductility compared to the other two volume fractions of fibres studied (0.75 % and 1 %) [3].

The concrete was enriched with coconut fibres in the range of 2.5 %, 5 %, and 7.5 %. In addition, M-20 grade concrete was made using 5 %, 10 %, and 15 % plastic waste instead of fine aggregate. Tests like the slump test to determine workability, tensile strength test, and compressive strength test were performed. The research indicates that increasing coconut fibre percentage leads to a boost in strength and a decrease in workability, while increasing plastic waste leads to a decrease in strength and workability. Optimal strength of concrete was achieved by adding 7.5 % coconut fibre by mass of cement and replacing fine aggregate with plastic waste at a rate of 5 % [5].

3. Methodology



4. Materials

This section explores the properties of materials used in this research. The materials were obtained from the local resources.

4.1. Cement

The Ordinary Portland cement of grade 53 conforming to **IS 8112-1989** was used. The tests were conducted and its properties of cement are tabulated in Table 1.

Table1.Physical Properties of cement

Property	Value
Standard consistency test	32 %
Initial setting time	35 min
Fineness	10 %
Specific gravity	3.15

4.2. Sand

The fine aggregates passing through 4.75 mm sieve was used. The tests of fine aggregate were done as per **IS 2386 (Part 1).** The sand is belonging to Zone II. The specify gravity (G) was 2.45 and the fineness modulus was 3.86. The fine aggregates were purchased from local resources. The tests results are tabulated in Table 2.

Table 2. Properties of Fine Aggregate

Property	Value
Specific gravity	2.5
Bulk Density	1600 kg/m^3
Fineness modulus	4.3

4.3. Coarse Aggregate

The coarse aggregates from local quarry were used. The maximin size of the aggregates was found to be 20mm.The property of coarse aggregate were tested as per **IS-2386(Part-3)** and the results are tabulated in Table 3.

Table 3. Test result of coarse aggregate

Property	Value
Specific gravity	1.00
Water Absorption	1710 kg/m^3
Fineness modulus	8.40

4.4. Water

The water conforming with IS-456:2000 was used. The water used was clean and free from any visible impurities.

4.5. Concrete mix proportion

The mixes were done in accordance with **IS 456 – 2000**. The mixing proportion are tabulated in Table 4.

Table 4. Concrete Mix Proportion

Grade	Cement	Fine Aggregate	Coarse Aggregate	Water (%)
M25	1	1.32	2.76	0.45

4.5 Coconut Fibre Grains

The straw-like part of the coconut husk is where coconut fibre grains are extracted from. The hard inner shell and outer covering of a coconut contain coir, which is a fibrous substance. There are two types of coir. The first one is brown coir made from ripe coconut and second one is White coir, harvested from unripe coconuts. The coconut fibre grains passing through 4.75 mm sieve were taken for the experimental investigation and are shown in Figure 1.

Figure.1 Coconut Fiber Grains:

Table: 5 Physical and Chemical Properties

Physical Properties	**Values**
Density	1.23 g/cc

Moisture content	11.2 %
Chemical Properties	**Values**
Water -soluble	5.25 %
Pectin and related compounds	3.00 %
Hemicellulose	0.25 %
Lignin	45.84 %
Cellulose	43.44 %
Ash	2.22 %

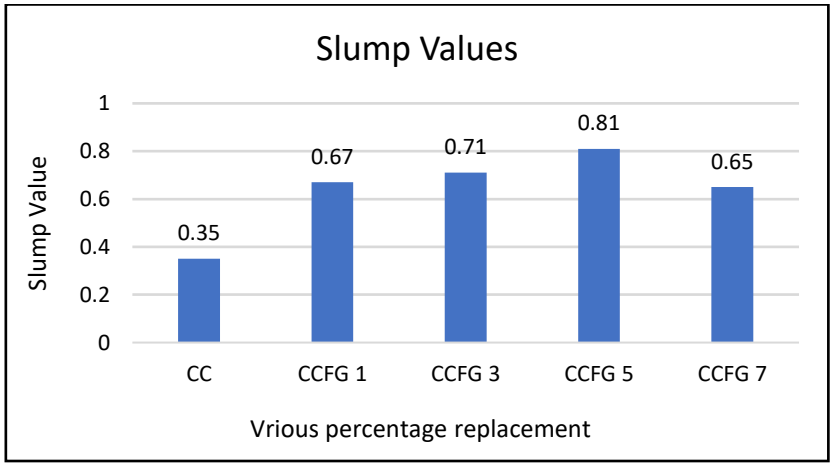
6. RESULT AND DISCUSSIONS

6.1 Fresh Concrete Properties

6.1.1 Workability Test

The concrete with 0 % ,1 %, 3 %, 5 %, and 7 % replacement with coconut fibre grains by fine aggregates with sample ID CC, CCFG 1, CCFG 3, CCFG 5 and CCFG 7 were prepared to analyse the fresh and hardened concrete properties. Workability in teams of fresh concrete mix was found for the various percentage replacements of coconut fibre grains with fine aggregates. The slump values for the various samples are shown in the Figure 2.

Figure.2 Slump Values of CC and CCFG



6.2 Hardened Concrete Properties

6.2.1 Compressive strength

The compressive strength is defined as resistance of concrete to axial loading. The samples of conventional concrete (CC) and concrete with coconut fibre grains (CCFG) were tested in compressive testing machine and reading were recorded of the final crack. The strength of the samples depends on the quality of the ingredients. The cubes of 150 mm x150 mm x 150 mm were cast and cured for the curing period at 7 days and 28 days. The experimental set up is shown in Figure 4. The compressive strength samples at 7 days and 28 days for various samples are tabulated in Table 6 and its comparison is shown in Figure 3.

Table-6 Compressive Strength at 7 days and 28 days

SL.NO	Percentage Replacement in (%)	COMPRESSION STRENGTH (N / mm^2)

		7 Days	28 Days
CC	0	16.10	32.12
CCFG 1	1	16.54	32.45
CCFG 3	3	16.89	32.67
CCFG 5	5	17.12	32.87
CCFG 7	7	17.43	31.24

Figure.3 Compressive Strength oh CC and CCFG

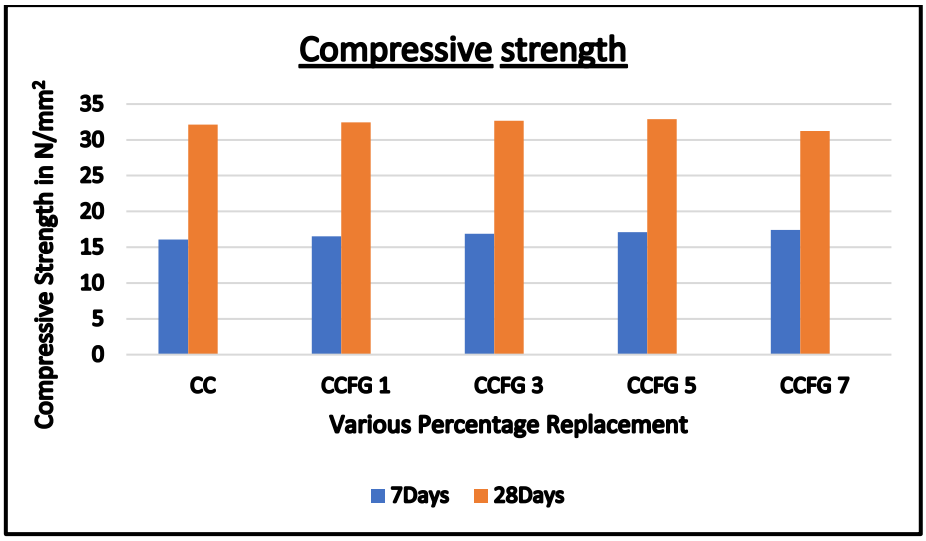


Figure.4 Experimental Setup for Cubes

6.2.2 Spilt Tensile Strength Test

Split tensile strength is additional mechanical property of concrete. The formation of crack and crack sizes are related to the tensile strength. Therefore, the samples of conventional concrete (CC) and concrete with coconut fibre grains (CCFG) were made. The procedure based on the **IS 5816-1999** was used. They were tested in the compression testing machine for its 7 days and 28 days strength and the observations were

tabulated in Table 7 and Split tensile strength graph is shown in Figure 5. The experimental set up is shown in Figure 6.

Table 7. Spilt Tensile strength Test

SL.NO	Percentage Replacement in (%)	Split Tensile Strength (N / mm^2)	
		7 Days	28 Days
CC	0	1.21	2.43
CCFG 1	1	1.19	1.87
CCFG 3	3	1.10	2.49
CCFG 5	5	1.32	2.54
CCFG 7	7	1.17	2.28

Figure.5 Flexural Strength of CC and CCFG

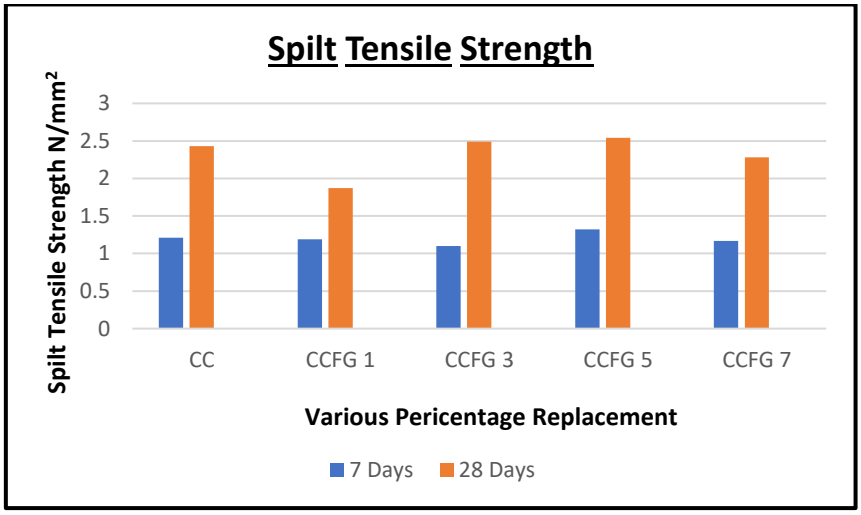


Figure.6 Spilt Tensile Strength Test

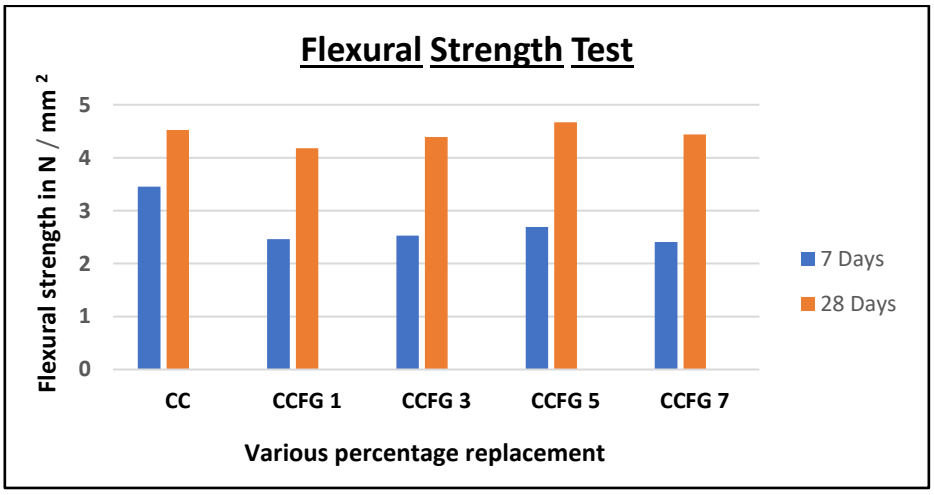
6.2.3 Flexural Strength Test on Prisms:

Flexural Strength of conventional concrete and Concrete with Coconut Fibres Grains (M25 grade) were also tested and the observations are tabulated in Table 8 and its comparison is shown in Figure 7.

Table 8. Flexural Strength of CC and CCFG

SL.NO	Percentage replacement in (%)	Flexural Strength (N/mm^2)	
		7 Days	28 Days
CC	0	3.45	4.52
CCFG 1	1	2.46	4.18
CCFG 3	3	2.53	4.39
CCFG 5	5	2.69	4.67
CCFG 7	7	2.41	4.44

Figure.7 Flexural Strength of CC and CCFG



6. CONCLUSION

From the experimental investigation, the specimens with 5 % replacement of coconut fibre grains by fine aggregates gained maximum compressive strength, split tensile strength and flexural strength compared to other replacements and concrete with 0 % replacement. The use of coconut fibre grains as a partial replacement of fine aggregate should be encouraged for sustainable and economic construction. By the utilization of agricultural waste materials in concrete tends to low-cost construction and waste management. The results conclude that the concrete with fine aggregate partially replaced with coconut fibre grains gains the increase in the strength of the concrete.

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