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Experimental Study on RC Beam using Coconut Fibre Reinforced Concrete with Various Fibre Orientations

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Abstract: *Engineering properties of concrete can be enhanced by reinforcement of various materials. In this study coconut fibers were used as they have many advantages such as easily available and cost effective. An experimental study is held for study on properties of concrete reinforced with coconut fiber. A good bonding in the concrete is observed due to its flexural strength by addition of coconut fibres. The major aim of this study is to create awareness among the society about the importance of coconut fiber as construction material. The concrete beams are casted and tested with uniformly distributed and randomly distributed coir fibres. The comparative study is done with conventional beam and beams with different fibre orientations.*

Keywords: Coconut fiber, Uniformly distributed, Randomly distributed, Flexural strength

I. INTRODUCTION

Fiber reinforced concrete (FRC) is a concrete comprising fibrous material which increases its structural integrity. Concrete is the most widely used construction material in the world. Concrete is weak in tension and flexure so it is reinforced with steel reinforcing bars. With increasing developments in civil engineering such as high-rise buildings and long-span bridges, concrete with higher compressive strength was required. However, in some cases, compressive strength is not as important or necessary as other properties such as low penetrability, durability and workability etc. Various types of fibres were used in concrete to it make more strong, more durable, and economical. Natural fibre such as coconut having physical and mechanical characteristics that can be used in the development of reinforced concrete material. These coconut fibres are easily available in large quantity and are also cheap. The introduction of fibres is a solution to develop concrete with enhanced properties, which is a new form of binder that could combine Portland cement in bonding with cement. The influence of 0.6% of fibre content by volume of concrete and fibre length of 5cm is mixed with concrete. The beams are casted with concrete grade of M30 along with different orientation of fibres such as unidirectionally oriented, bidirectionally oriented and randomly distributed fibre beam.

II. MATERIAL PROPERTIES

2.1 Coir Fibre

Coir fiber is the natural fiber extracted from the husk of the coconut. The coir fiber is the thickest and most resistant of all commercial natural fibers. Low decomposition rate is the key advantage for making durable products. The coir fiber's high strength is the main reason for the rope production for centuries. Coir fiber is one of the most lignin-rich natural fibers.

Figure: Coir Fibre

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A. Properties of Coir Fibre

S. No.	Description	Result
1	Length of single fibre	2 to 8 inch
2	Diameter	16 micron
3	Breaking Elongation	30%
4	Water absorption(%)	104.2
5	Specific Gravity	0.87
6	Lignin Content	45.84%
7	Ash	2.22%

III. EXPERIMENTAL TEST

3.1 Flexural Test on Beam

Flexural testing measures the force required to bend a beam of plastic material and determines the resistance to flexing or stiffness of a material. Flex modulus is indicative of how much the material can flex before permanent deformation.


Loading Frame (50T)

Types of orientation of beams tested

- TYPE 1 – Conventional concrete beam,
- TYPE 2 – Unidirectionally oriented fibre reinforced concrete beam,
- TYPE 3 – Bidirectionally oriented fibre reinforced concrete beam,
- TYPE 4 – Randomly oriented fibre reinforced concrete beam.

IV. RESULTS

4.1 Load Deflection for Various Beams

Load	Type 1	TYPE 2	TYPE 3	TYPE 4
1	0.18	0	0.12	0
2	0.31	0.15	0.24	0.35
4	0.66	0.52	0.68	0.65
6	1.09	0.79	1.03	0.95
8	1.54	1.05	1.47	1.32
10	2.03	1.46	1.75	1.85
12	2.5	1.95	2.3	2.42
14	2.96	2.35	2.86	3.03

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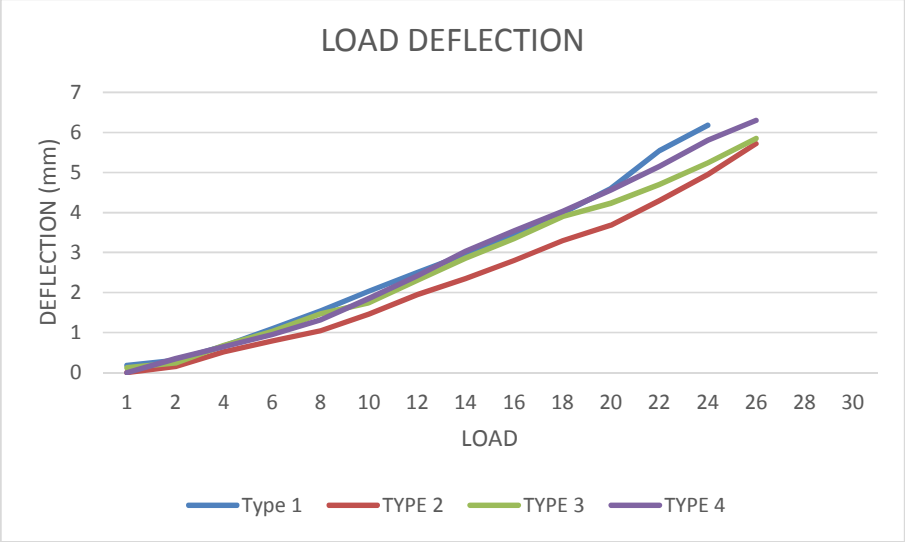
16	3.45	2.8	3.35	3.54
18	3.98	3.3	3.9	4.03
20	4.6	3.68	4.23	4.56
22	5.54	4.3	4.7	5.15
24	6.18	4.95	5.24	5.8
26	0	5.72	5.85	6.3

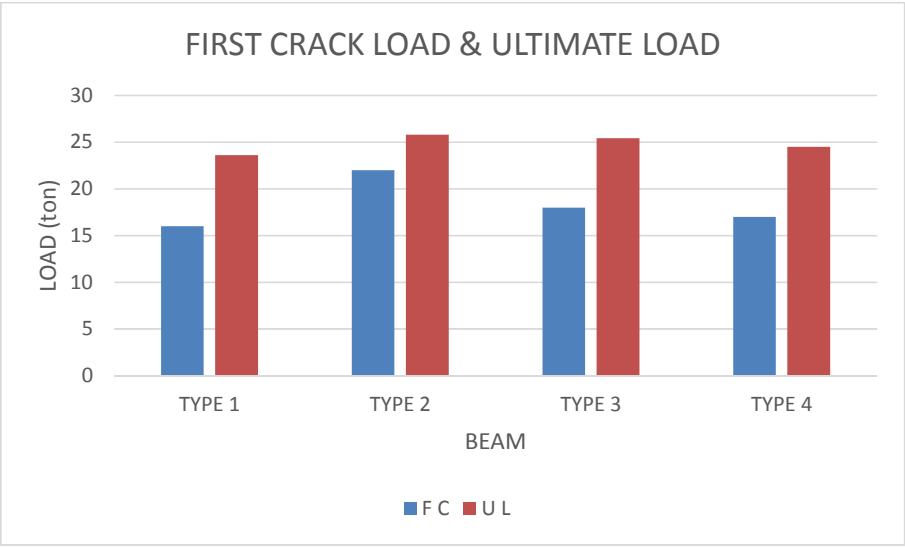
Graph



4.2 First Crack and Ultimate Load of Various Beams

BEAM	TYPE 1	TYPE 2	TYPE 3	TYPE 4
First Crack	16	22	18	17
Ultimate load	23.6	25.8	25.4	24.5

Graph



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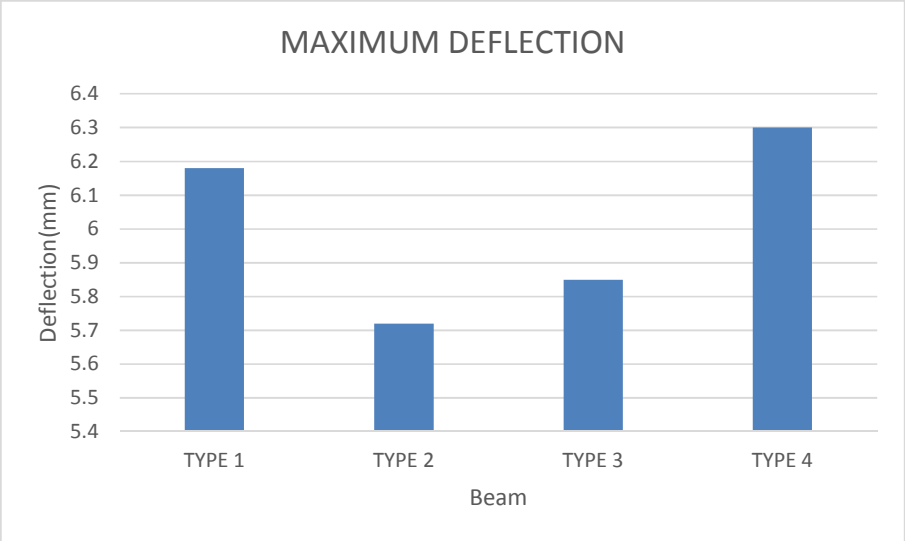
4.3 Maximum Deflection of Various Beams

BEAM	TYPE 1	TYPE 2	TYPE 3	TYPE 4
DEFLECTION	6.18	5.72	5.85	6.3

Graph



V. CONCLUSION

- For conventional concrete (**TYPE 1**) first crack appeared at the load of 16 tons and the maximum deflection is 6.18 mm for the ultimate load of 23.6 tons.
- For unidirectionally oriented fibre (**TYPE 2**) concrete first crack appeared at the load of 22 tons and the maximum deflection is 5.72mm for the ultimate load of 25.8 tons.
- For bidirectionally oriented fibre concrete (**TYPE 3**) first crack appeared at the load of 18 tons and the maximum deflection is 5.85mm for the ultimate load of 25.4 tons.
- For randomly oriented fibre concrete (**TYPE 4**) first crack appeared at the load of 17 tons and the maximum deflection is 6.3mm for the ultimate load of 24.5 tons.
- Hereby, the unidirectionally oriented coir fibre reinforced concrete beam (**TYPE 2)** has high flexural strength compared to other types.

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