

Experimental Investigation on Performance of Kenaf Fiber to Enhance the Mechanical Properties of Reinforced Concrete

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ABSTRACT: Kenaf fibre is getting attention of industries and researchers to utilize it in different polymer composites due to environmental awareness of consumers, industries and government regulations in various countries. Kenaf fibres are reinforced with epoxy resin to form fibre reinforced polymeric composites which improves the strength of the composites. This project is experimented to reduce the cost construction and increase strength & durability. The environment has led to studies on various materials which could be used as partial replacement for fine aggregate. In this project, fine aggregate is partially replaced with fly ash and kenaf fibre used to improve both compression and tensile strength of concrete (0%, 0.5%, 1%, 1.5%).

KEYWORDS: Kenaf fibre, Compressive strength test, Tensile strength test.

I. INTRODUCTION

Kenaf is scientifically known as *Hibiscus cannabinus* L. and is closely related to cotton and jute. This is because the crystalline cellulose content and micro fibril angles of the two fibers are fairly similar. Kenaf is cultivated for its fiber and is well suited in India, Bangladesh, United States of America, Indonesia, Malaysia, South Africa, Vietnam, Thailand, parts of Africa, and in specific parts of southeast Europe. China also has actively developed this plant and is now one of the largest kenaf producers in the world. Recently, kenaf in Malaysia has been identified as one of the potential natural raw fibers to replace tobacco in manufacturing a multitude of products for the construction, automotive, textile and advanced technology sectors.

Some researchers have previously investigated the use of natural fibers as reinforcement in polymeric strengthening materials. For instance, Liew (2008) and Chew (2009) investigated the potential of unidirectional oil palm fiber polymer composites as strengthening material. The flexural strength and stiffness of the composite improved significantly when the fiber volume ratio increased. This evidence shows that oil palm fiber polymer composite is a strengthening material suitable for reinforced concrete (RC) beams. The researchers further revealed that oil palm fiber reinforced polymer composites increased the stiffness and ultimate load of ordinary RC beam. Current researches on natural short fiber are not exhaustive, but researches on continuous fibers are considerably lesser.

II. CONSTITUENT MATERIALS AND ITS PROPERTIES

- 1. Fine aggregate:** The particles of granular materials are so fine that they pass through a 4.75mm sieve. It is essential material in concrete consist of manufactured sand. The purpose of fine aggregate is to fill the voids, on coarse aggregate and to act as workability agent. It was screened to remove deleterious materials and tested as per procedure given in IS: 2386-1963. Specific gravity of fine aggregate is 2.7, Grading zone -Zone II, Water absorption-1.8%, Bulk density-1.86 g/cc, Moisture content-nil.
- 2. Coarse aggregate:** Aggregate, which retained in 4.75 mm sieve, is known to be coarse aggregate. Locally available coarse aggregate having the maximum size of 10mm were used in this experiment. Testing of coarse aggregate was done as per IS: 383-1970. Specific gravity of coarse aggregate is 2.7, water absorption-0.3%, Impact value-20%, crushing value-18%.
- 3. Ordinary Portland cement:** cement in concrete acts as a binding material that addition of water. It plays an important role construction sector. In this study the Ordinary Portland Cement (OPC) of 53 grade conforming to

IS: 12269-2013 is used. Various tests were performed on cement they are: Consistency 32%, Specific gravity-3.12, Initial and Final setting time 40 minutes & 360 Minutes.

4. Kenaf fibre:

Kenaf fiber was purchased from online merchants. Kenaf fibers are reinforced with epoxy resin to form fiber reinforced polymeric composites which improves the strength of the composites. It doesn't affect the workability of the concrete.

- a) Physical Properties: Color- It is available in brown color. Diameter-22 Micron, Specific gravity-0.22 to 0.44. Elastic Modulus- 72Gpa. Tensile strength- 1700Mpa.
- b) Chemical Properties: Kenaf fibre are more stable in strong alkalis. Bleaching agent does not cause harm to kenaf fibre and does not change on organic solvents. Possess resistance to UV- Light & biologic and fungal contamination. Sunlight does not change the kenaf fibre properties

- 5. **Water:** Potable tap water available in the laboratory with PH value 6 to 8 and conforming to the requirement of IS: 456-2000 is used for mixing concrete and curing the specimens.



Fig 1. Kenaf fibre

III. EXPERIMENTAL INVESTIGATION

The experimental investigation is done to know its mechanical property, which is induced by its microstructure of Kenaf fibre reinforced concrete. The following tests were conducted on the Kenaf fibre reinforced concrete specimens are

- 1. **Compression test (conforming to IS 516):** This test was performed on 150 mm x 150 mm x 150 mm sized Kenaf fibre concrete cubes casted for M25 grade to determine the compressive strength of the mix. The compression test on cube specimens was performed in the compression testing machine.
- 2. **Split tensile test (conforming to IS 5816-1999):** To determine the tensile strength of Kenaf fibre reinforced concrete mix for M25 grade, split tensile test was done on the cylindrical test specimens of 150mm x 300mm using the compression testing machine. This method consists of applying a diametric compressive force along the length of a cylindrical specimen.



(a)



(b)



(c)

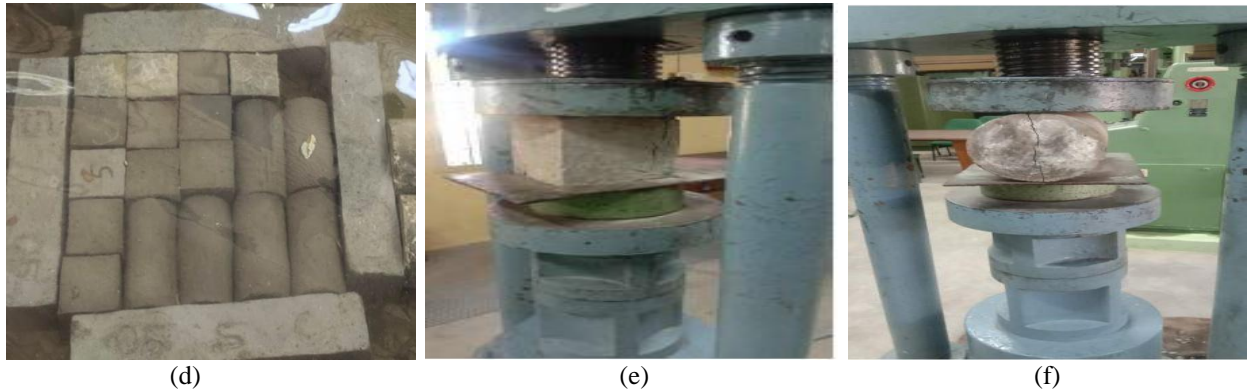


Fig 2. Testing of mechanical properties and casting of specimens (a) Batching (b)KFRCCube specimen (c)KFRCC cylindrical specimens (d) Curing of cubes and cylinders (e) Compression strength test (f) Split tensile strength test

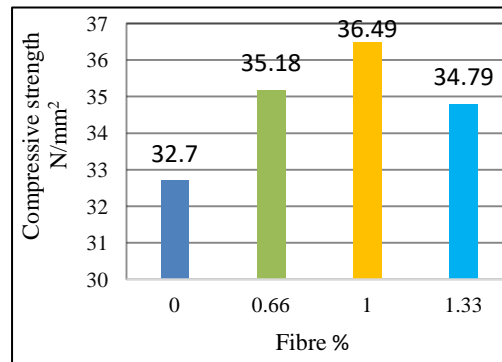
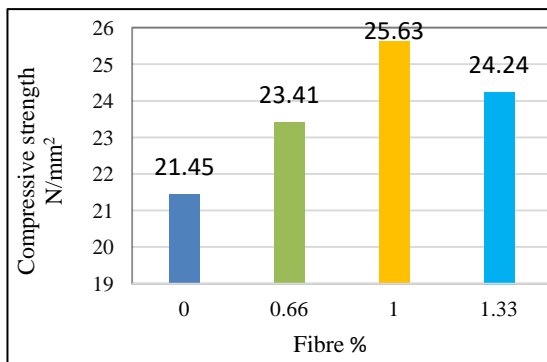
IV. EXPERIMENTAL RESULTS

COMPRESSIVE TEST

A test result is the average of at least three standard cured strength specimens made from the same concrete sample and tested at the same age. In most cases strength requirements for concrete are at an age of 28 days of curing. The concrete cubes, after 28 days were tested for their compressive strength in the following manner. After cleaning of bearing surface of compression testing machine, the axis of the specimen was carefully aligned with the center of thrust of the plate. No packing was used between faces of the test specimen and of testing machine. The load was applied without shock and increased continuously at a rate approximately 140 Kg/cm²/min until the resistance of the specimen to the increasing load broke down and no greater load could be sustained. The compressive stress calculated in N/mm² from the maximum load sustained by the cube before failure.

Table 1 Compressive strength test of GFRC

S.No	Grade	Glass fibre %	Compressive strength N/mm ²	
			7 days	28 days
1	M30	0	21.45	32.7
2	M30	0.66	23.41	35.18
3	M30	1	25.63	36.49
4	M30	1.33	24.24	34.79



(b)

Fig 3. Graph of Compressive strength test of GFRC (a) 7 days compressive strength (b) 28 days compressive strength

SPLIT TENSILE TEST:

This method consists of applying a diametric compressive force along the length of a cylindrical specimen. This loading induces tensile stresses on the plane containing the applied load. Tensile failure occurs rather than compressive failure. Plywood strips are used so that the load is applied uniformly along the length of the cylinder. The maximum load is divided by appropriate geometrical factors to obtain the splitting tensile strength. A diametric compressive load is applied along the length of the cylinder until it fails. The cylinder will typically fail due to horizontal tension and not vertical compression.

Table 2 Split tensile strength test of GFRC

S.No	Grade	Glassfiber %	Tensile strength N/mm ²	
			7 days	28 days
1	M30	0	2.69	3.95
2	M30	0.66	2.73	4.14
3	M30	1	2.80	4.40
4	M30	1.33	2.75	4.19

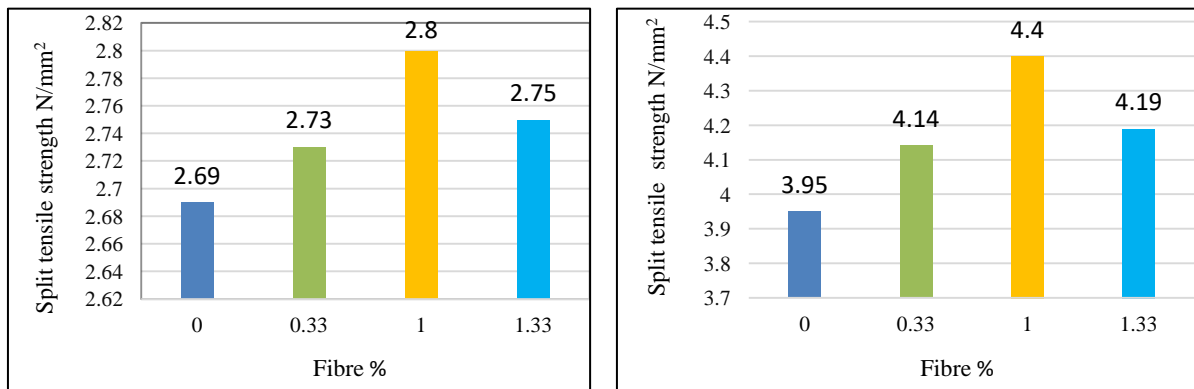


Fig4. Graph of Split tensile strength test of GFRC (a) 7 days Split tensile strength (b) 28 days Split tensile strength

V. CONCLUSION

Based in experimental investigation carried out in this work the following conclusion can be drawn:

1. Optimum value for glass fibre arrived at 1%.
2. Addition of 1% of glass fibre results in increase of compressive strength by 10.38%.
3. Addition of 1% of glass fibre results in increase of split tensile strength by 10.22%.
4. It was found from the failure pattern of the specimens, that the formation of cracks is more in the case of concrete without fibers than the glass fibre reinforced concrete.
5. It shows that the presence of fibre in the concrete acts as the crack arrestors.

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