International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Study of Behavior of Jute Fiber Concrete including Glass Fiber Reinforced Polymer Rebar's

Vivek Saini[1] , Abhishek Tiwari[2*] and Abhinav Singh[3]

[1]MTech Scholar, [2,3]Assistant Professor, Dept of Civil Engineering, Swami Vivekananda Subharti University, Meerut, Uttar Pradesh, India.

Received 26 July 2021, Accepted 23 Aug 2021, Available online 25 Aug 2021, **Vol.11, No.4 (July/Aug 2021)**

Abstract

Glass Fiber strengthened chemical compound Rebar's (GFRP) has associate rising various solution of steel reinforcement for concrete structures thanks to its upgraded properties like high durability, light-weight, and corrosions resistance. The general purpose of this study is to interchange longitudinal steel with GFRP rebar in Fiber reinforced concrete (FRC) for pier to boost its performance. During this study the proportion of cement sand aggregate and water is 1:2:3:0.60, with the addition of fifty five jute fibers by mass of cement, having forty five millimeter length is used. The mechanical properties (splitting tensile and compressive strengths), are investigated during this study. We have found that compressive strength and split tensile of JFRC specimen is decreased but flexural strength is increased as compared to normal concrete but the axial strength of prototype pier including glass fiber reinforcement is decreased.

Keywords: *Plain Reinforced Concrete, Fiber reinforced concrete, Jute Fiber Reinforced Concrete, Compressive Strength, Split Tensile strength, Flexural strength, axial loading.*

1. Introduction

The study of diverse failing structures, notably bridges throughout the earthquake, unconcealed that a lot of those low strength concrete piers were structural defects like low containment and poor construction methodologies. Once subjected to such giant lateral deformations, the load carrying capability was drastically reduced. It had been determined that in plain concrete cracks area unit developed because of fragile behavior and environmental changes. The jute fibers were utilised to boost the mechanical properties of concrete. The steel rebars have high density and corrosion issues, therefore, leading to a degradation of concrete structures. The Glass Fiber Reinforced Polymer Rebar's was product of high-strength, vinyl organic compound resin-reinforced fiber.

The FRP had varied preferences over conventional steel bars, as well as a density of one-quarter to fifth part that of steel, larger strength than steel, and no erosion even in chemical environments Ahmed *et al.* Therefore, to attain spare strength for the piers, embedded GFRP rebar inside JFC is to be investigated in current analysis. The overall aim of this analysis program is to interchange longitudinal steel rebars with GFRP rebars in JFRC for pier application to boost the performance, practicality and sturdiness.

"In this analysis work, associate degree investigation has been administered to check the behavior of example vertical members having totally different range of GFRP rebar's in JFRC for application of piers below.

2. Literature Review

1. Zakaria *et al.* (2017) investigated the performance of jute fibers for concrete material strengthening. 2 completely different combine style proportion 1:2:4 and 1:1.5:3 with the volumetrically fraction of jute fibers having varied length 10 - 25mm were used. It had been terminated that the compressive strength, rending lastingness and flexural strength was improved meaningfully.

2. Elsaid *et al.* (2011) investigated the mechanical properties of fiber particularly kenaf fiber concrete. an entire of fifty 3 samples of traditional size ar casted among that twenty 2 samples for compressive strength take a glance at, twelve samples for split- ting strength and nineteen samples for modulus of rupture. 1.2% and 2.4% fiber content by volume fraction of concrete was thought of. The results indicate that kenaf fiber concrete necessary improvement in cacophonous strength, higher cracking behavior and thrice toughness than plain concrete.

3. Liu *et al.* [2013] investigated the mechanical behavior of jute fiber bolstered cement-based materials.

*Corresponding author's ORCID ID: 0000-0003-3614-8077
DOI: https://doi.org/10.14741/ijcet/v.11.4.9

2 teams square measure wont to establish the jute fiber behavior. within the initial cluster, the proportion of fibers was fastened whereas fibers length was modified step by step 10-50mm length and within the second cluster, the length of the fibers was fastened whereas the proportion of fibers was modified step by step zero.5-0.6 kg-m- 3. it had been terminated that the proportion increase of the compressive strength of assorted grade of jute fiber concrete is twenty.44% and therefore the share increase of flexural strength is fifty three.47%.

4. Ramakrishna and Sundararajan *et al.* (2005) The variations in chemical composition and strength of 4 natural fibers, i.e. coconut, sisals, jute and kenaf fibers, were investigated by in different wetting and drying, continuous immersion in water for sixty days, saturated lime and hydroxide. thanks to immersion within the solutions thought of, the chemical composition of all fibers had modified. The loss of lastingness resulted in continuous immersion. However, all told the check conditions, coconut fiber was best reported to retain an honest percent- age of its original lastingness.

5. Maranan *et al.* (2015) evaluating the flexural strength and serviceableness performance of geopolymer concrete beams having fiber bolstered chemical compound (GFRP) rebar's beneath four point bending check. It had been terminated that, supported experimental results, the enactment of a beam improved once the reinforcement magnitude relation of fiber enhanced. The bending capability of the GFRP strong geopolymer concrete beams shows up to be beyond GFRP fortified concrete beams essentially thanks to the improved mechanical properties of the geopolymer concrete than the orthodox concrete of constant review. Increase within the reinforcement magnitude relation of GFRP rebars resulted in improved performance, as well as post-crack stiffness, load capability or deformation.

3. Methodology and Material Used

During the preparation of PC and JGFRC constituents which are utilized coarse aggregates, sand, ordinary Portland cement, fresh water, jute fibers, steel and glass fiber reinforced polymer rebar's. The maximum size of the coarse aggregates was 12 mm. GFRP rebar's having 0-6mm diameter and 400mm lengths which are shown in Figure 1. Jute fibers are available in a raw form which is prepared by hand at the rate of 45mm length shown in Figure 2. The ingredient proportion of 1:2:3:0.6 (C:S:A:w/c) is used for the formation of plain concrete and JFC except for 5% jute fiber by mass of cement, having 45mm length. All ingredients are calculated by mass excluding water in liter. JFRC and PC are prepared by using the non-tilting rotary type drum concrete blender. For the preparation of PC, all ingredients are poured in the drum of the mixer along with water, and the duration of mixing in the blender is three minutes. Jute fibers are immersed for 24 hours into the water, to absorb the required amount of water. Then, left into the air for a half hour. After that, ingredients are placed into the blender layer by layer.

After entire insertion of materials into the blender drum, initially, about 33% of total water is spread on all material. The remaining water (67%) is added slowly and gradually during the rotation of the machine. The blender is rotated for 6 minutes (2 minutes for each layer) to get a homogenous concrete.

Fig.1 Glass Fiber Reinforced Polymer Rebar's

Fig.2 Raw Jute Fiber

Table 1 Mix Design Proportion for PC and JGFRC (1:2:3:0.6)

Category	Cement (KG)	Fine Agg. (KG)	Coarse Agg. (KG)	Water (LTR.)	Fiber (KG)
PC	25	50	75	15	
JGFRC	25	50	75	15	1.15

4. Result and analysis

The compressive strength, flexural strength and split tensile strength of jute fiber concrete were analyzed at 28 days for the mix design proportion *1:2:3:0.60.* The results are as follow:

Table 2 Compressive strength of JFC at 28 days for mix design proportion *1:2:3:0.60.*

Sample	Compressive Strength at 28 days(MPa)		Average strength (MPa)	
	PC	JFC	PC	JFC
SP-1	24.54	23.40	25.063	22.45
SP-2	25.20	21.50		
SP-3	25.45	22.45		

Table 3 Split tensile strength of JFC at 28 days for mix design proportion *1:2:3:0.60.*

Sample	Split tensile Strength at 28 days(MPa)		Average strength (MPa)	
	PC	JFC	PC	JFC
SP-1	3.25	2.60	3.30	2.85
SP-2	3.50	3.10		
SP-3	3.15	2.85		

Table 4 Flexural strength of JFC at 28 days for mix design proportion *1:2:3:0.60.*

Sample	Flexural Strength at 28 days(MPa)		Average strength (MPa)	
	PC	JFC	PC	JFC
SP-1	6.96	7.95	7.24	8.21
SP-2	7.55	8.20		
SP-3	7.20	8.50		

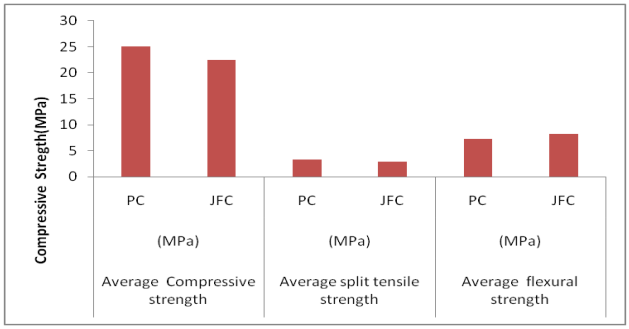

Fig 3 Average strength of specimen

During this study we have also calculated the axial strength of jute fiber including glass fiber reinforced concrete. For this purpose, different specimens were casted. In the specimen we have changed the longitudinal bars with glass fiber reinforced rebar. Experimental Results (stress-strain) of tested prototype specimens with varying longitudinal glass fiber reinforced rebar's and Shear Steel Reinforcement.

Table 5 Experimental Results (stress-strain) of tested prototype specimens with varying longitudinal glass fiber reinforced rebars and Shear Steel Reinforcement.

Specimen Name	Axial Strength (MPa)		Average Axial Strength (MPa)
	PC	JGFRC	
4P65 (1)	25.85		26.15
4P65 (2)	26.15		
4P65 (3)	26.45		
4J65 (1)		21.24	22.69
4J65 (2)		23.50	
4J65 (3)		23.35	
4P77 (1)	25.25		25.01
4P77 (2)	24.95		
4P77 (3)	24.84		
4J77 (1)		22.65	22.90
4J77 (2)		22.80	
4J77 (3)		23.25	

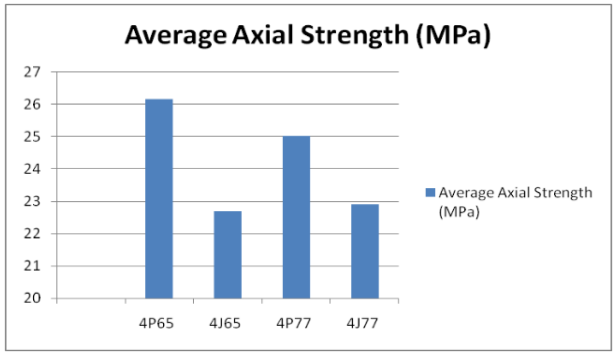

Fig 3 Average Axial strength of specimen

Conclusions

The following conclusions were drawn from this study.

1) The improved properties of JFRC enhance the sturdiness of concrete that favors its utility for the structural application like pier and any load bearing structure.
2) The compressive strength and split tensile strength of JFC samples reduced. The reason of decline in strength may be air gap between the jute fiber and other constituent materials.
3) When we increased the longitudinal main GFRP rebars in the specimen the axial load capability reduces.
4) The crack-arresting mechanism of jute fibers has resulted increase in flexural strength.
5) Reduction of the confine steel reinforcement spacing from seventy six to sixty four millimeter has led to an sweetening in axial load capability of the PRC and JFRC specimens.

References

M. Zakaria, M. Ahmed, M. M. Hoque, and S. Islam 2017,Scope of using jute _ber for the reinforcement of concrete material," *Textiles and Clothing Sustainability*, vol. 2, pp. 11.

Elsaid, M. Dawood, R. Seracino, and C. Bobko, 2011 "Mechanical properties of kenaf fiber reinforced concrete," *Construction and Building Materials*, vol. 25, pp. 1991-2001.

Liu, L. Z. Zhang, Q. X. Liu, and T. Ji , 2013 "Study on behaviors of jute fiber reinforced cement based materials," in *Applied Mechanics and Materials*, pp. 508-511.

G. Ramakrishna and T. Sundararajan, , 2005 "Studies on the durability of natural fibres and the effect of corroded fibres on the strength of mortar," *Cement and Concrete Composites*, vol. 27, pp. 575-582.

G. Maranan, A. Manalo, B. Benmokrane, W. Karunasena, and P. Mendis , 2015 "Evaluation of the flexural strength and serviceability of geopolymer concrete beams reinforced with glass-fibre-reinforced polymer (GFRP) bars," *Engineering Structures*, vol. 101, pp. 529-541

H. Tobbi, A. S. Farghaly, and B. Benmokrane, 2014, Behavior of Concentrically Loaded Fiber Reinforced Polymer Reinforced Concrete Columns with Varying Reinforcement Types and Ratios," *ACI Structural Journal*, vol. 111.

M. Ali, A. Liu, H. Sou, and N. Chouw, 2012, Mechanical and dynamic properties of coconut fiber reinforced concrete," *Construction and Building Materials*, vol. 30, pp. 814-825.

L. Zhang, S. Feih, S. Daynes, S. Chang, M. Y. Wang, J. Wei, *et al.* 2018 Energy absorption characteristics of metallic triply periodic minimal surface sheet structures under compressive loading," *Additive Manufacturing*, vol. 23, pp. 505- 515,