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EXPERIMENTAL STUDY OF JUTE FIBRE REINFORCED CONCRETE

Priyanka Goel[1], Mohd. Usman[2], Sandeep Panchal[3]

[1]*PG Student, Siddhivinayak College of Engineering, Haryana (India)*

[2]*Assistant Professor, Civil Engineering Department, ICL Institute of Engineering and Technology, Ambala, Haryana (India)*

[3]*Lecturer, Civil Engineering Department, NIT Hamirpur, Hamirpur, Himachal Pradesh (H.P.), (India)*

ABSTRACT

Aim of this study to analyse the effect of jute fibre reinforcement on the strength and ductility properties of concrete. Flexural and compression characteristics of the fibre reinforced concrete are measured experimentally. The results of the compression test indicated that the presence of jute fibre tends to reduce the compressive strength of concrete at higher fibre content. Despite the minimal reduction in the compressive strength at higher jute fibre content, there is an improvement of ductility after cracking of concrete. Similarly, the bending test results indicated that the modulus of rupture of concrete increases by 50% at 0.50% jute fibre content. Jute fibre significantly improves the toughness behavior of concrete.

Keywords: Jute fiber, Composite Materials, strength, ductility

I. INTRODUCTION

Concrete is an important construction material. Concrete is weak in tension. So, the improvement of the tensile strength of concrete is necessary. In conventional practice the horse hair, steel fibre etc are used to improve the characteristics of concrete. Fibre reinforcement of the concrete is relatively a new concept (Choi et al; 2007). The fibre reinforcement does not affect the homogeneity of the concrete material and improves its strength properties (Panchal et al; 2017). Fiber reinforcement arrests the crack and stops the propagation of crack in concrete.

The general objective of this thesis is to conduct experimental study on the flexural and compressive strengths of Jute Fibre-reinforced concrete (JFRC) with the hypothesis that "reinforcing concrete with jute fibre significantly improves the flexural and compressive strength of concrete." In view of the general objectives, this thesis has the following specific objectives:

1. To carry out flexural and compressive strength tests on concrete reinforced with locally fabricated jute fibre.
2. To analyze the experimental results so as to determine the flexural and compressive strength properties of JFRC.
3. To assess the efficiency of the jute fibre as a reinforcement by evaluating the contribution in strength of JFRC specimens.

II. MATERIALS AND METHOD

Cement used is ordinary Portland cement of 43 grade conforming to IS: 8112 was used. The cement was tested in accordance to test methods specified in IS: 4031 and results obtained are shown in Table 1.

Table 1 Properties of Cement

S.No.	Name of Test	Experimental value	Requirements as per IS: 8112-1989
1.	Normal Consistency (%)	28	-
2.	Specific gravity	3.15	3.15
3.	Initial setting time (min)	95	More than 30
4.	Final setting time (min)	215	Less than 600
5.	Fineness (%)	5	10
6.	Soundness (mm)	2.55	Less than 10
7.	Compressive strength (MPa)		
(i)	3 days	26.10	Greater than equal to 23
(ii)	7 days	36.69	Greater than equal to 33
(iii)	28 days	46.56	Greater than equal to 43

The material which is passing through 4.75 mm sieve is known as fine aggregate. Locally available natural river sand was used as the fine aggregate. The fine aggregate was used in this study conforming to IS: 383-1970.

The material which is retained on 4.75 mm sieve is known as coarse aggregate. Locally available coarse aggregate having average size of 20 mm was used in this study confirming to IS: 383-1970.

Jute is a kind of fibre obtained from plants known as white corchorus capsularis. The manufacturing process of jute fibre involves hand harvesting of the source plant, drying in the field for defoliation, retting for periods up to a month, stripping and sun drying. The tensile strength and extensibility of jute fibre were determined in the laboratory using texture analyzer. Table 2 shows the characteristics of jute fibre used in this study.

Table 2 Characteristics of Jute Fibre

S/No	Cross-section (mm)		Area (mm2)	Breaking Load (N)	Extension (mm)	Stress (MP)	Extensibility (%)
	Width	Depth					
1	0.11	0.36	0.0396	19.10	2.50	482.32	1.67
2	0.22	0.22	0.0484	21.00	3.00	433.88	2.00
3	0.16	0.29	0.0464	23.00	1.50	495.69	1.00
4	0.13	0.27	0.0351	17.00	2.00	480.23	1.33
5	0.10	0.36	0.0360	14.80	2.00	411.11	1.33
6	0.22	0.24	0.0528	20.50	2.00	388.26	1.33
Average-values						448.58	1.44

Super plasticizer STRUCTURO 100(M) (Fosroc chemicals) is used as admixture. Structuro100 (M) combines the properties of water reduction and workability retention. The fibre is mixed in various proportions upto 1% . The quantities in the mix are shown in the Table 3.

III. RESULTS AND DISCUSSION

Compressive strength test is initial step of testing concrete because the concrete is primarily meant to withstand compressive stresses. Compressive strength tests were carried out on 150 x 150 x 150 mm cubes with compression testing machine of 3000 KN capacity.

Table 3 Mix Quantities per Cubic Meter of Concrete for Different Fibre Contents

Mix materials	Mass of materials per cubic meter of concrete (kg)			
	0.00%	0.25%	0.50%	1.00%
Cement	307	306	306	304
Water	134	135	135	135
Gravel	962	960	957	952
Sand	860	858	856	851
Fibre	0	4	8	15

Table 4 Effect of Jute Fibre Reinforcement on Unit Weight

Test series	Quantity of fibre	Specimen code	Dimensions (cm)			Weight (kg)	Average unit weight (kg/m3)
			Length	Width	Height		
1	0%	CJ 1-1	15.0	15.0	15.0	7.995	2374.16
		CJ 1-2	15.0	14.9	15.0	8.040	
		CJ 1-3	15.0	15.0	15.0	8.071	
2	0.25%	CJ 2-1	15.2	14.9	15.1	7.970	2351.04
		CJ 2-2	14.9	15.1	15.1	7.970	
		CJ 2-3	15	14.9	15.0	7.935	
3	0.50%	CJ 3-1	14.9	15.0	15.0	7.775	2319.14
		CJ 3-2	15.0	14.8	15.0	7.855	
		CJ 3-3	15.0	15.0	15.0	7.920	
4	1.00%	CJ 4-1	15.0	15.0	15.0	7.700	2231.66
		CJ 4-2	15.1	15.1	15.2	8.085	
		CJ 4-3	14.9	15.2	15.5	7.860	

flexural strength test is essential to estimate the load at which the concrete members may crack. the specimens cast for this test were of shape of a square prism of side 100 mm and axis length of 500 mm. specimens were tested at 28 days of casting.

Table 5 Effect of Jute Fibre Reinforcement on 28 days compression strength

Test series	Quantity fibre	Specimen code	Maximum stress (MPa)	Average Strength	Failure Mode
1	0%	CJ 1-1	16.84	17.39	Cone
		CJ 1-2	17.64		Cone
		CJ 1-3	17.71		Cone
2	0.25%	CJ 2-1	17.80	17.60	Cone
		CJ 2-2	17.40		Cone
		CJ 2-3	17.60		Cone
3	0.50%	CJ 3-1	17.92	17.80	Cone
		CJ 3-2	17.71		Cone
		CJ 3-3	17.81		Cone
4	1.00%	CJ 4-1	16.70	16.75	Cone
		CJ 4-2	16.30		Cone
		CJ 4-3	16.50		Cone

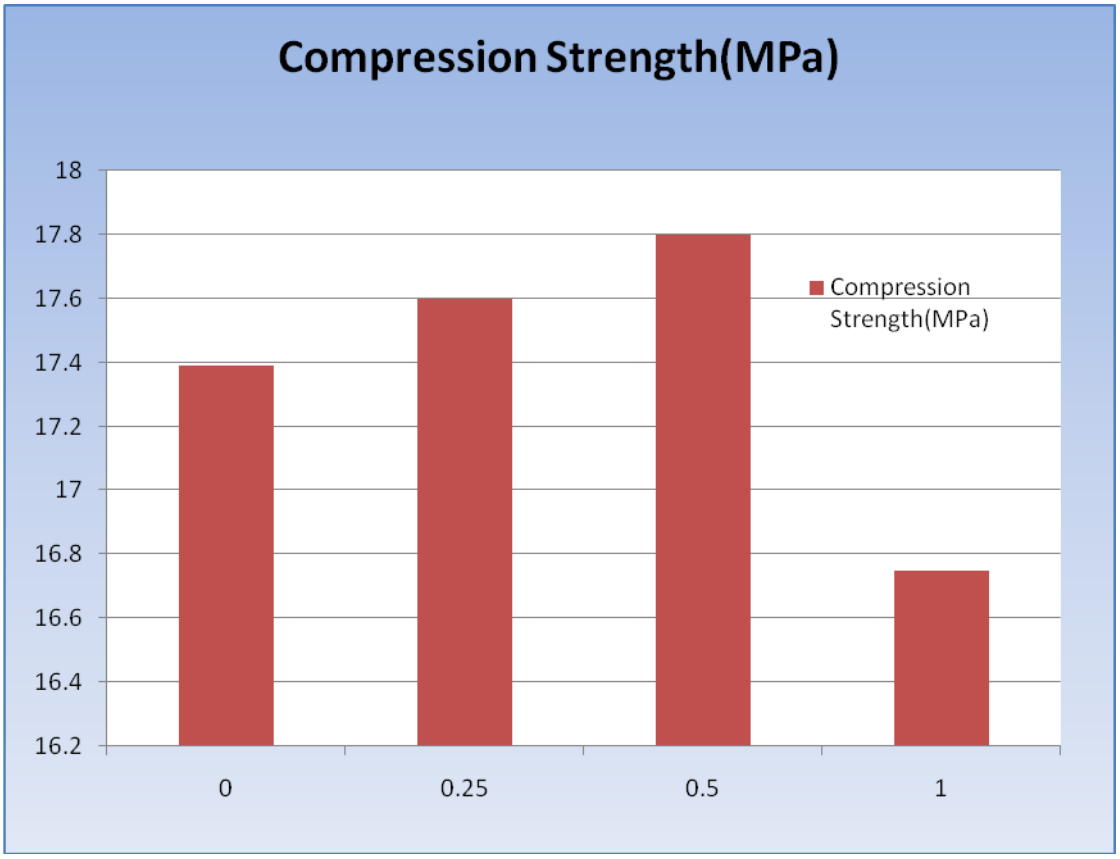

Figure 1 Compression Strength Vs Fibre Content

The various tests are performed on the four kind of sample. The effect of addition of fibre on unit weight is given in table 4. It is observed that the unit weight first decreases as the amount of fibre is increased but as the amount of fibre reaches near 1%, unit weight starts increasing. Figure 1 shows the variation of unit weight with increase of amount of fibre.

Table 5 shows the variation of compression strength with respect to the amount of fibre. The compression strength increases slightly first and decreases then. Figure 2 shows the variation of compression strength with respect to amount of fibre. Table 6 shows the results of flexure test.

Table 6 Effect of Jute Fibre Reinforcement on Flexural strength

Test series	Quantity of fibre	Specimen code	Cracking load (kN)	Ultimate load (kN)	Failure Mode
1	0%	BJ 1-1	4.70	4.70	Flexural
		BJ 1-2	4.80	4.80	Flexural
		BJ 1-3	Defected	Defected	
2	0.25%	BJ 2-1	5.90	5.90	Flexural
		BJ 2-2	6.00	6.00	Flexural
		BJ 2-3	6.50	6.50	Flexural
3	0.50%	BJ 3-1	6.90	6.90	Flexural
		BJ 3-2	6.80	7.50	Flexural
		BJ 3-3	Incorrect loading	Incorrect loading	
4	1.00%	BJ 4-1	5.90	5.90	Flexural
		BJ 4-2	5.30	5.50	Flexural
		BJ 4-3	6.60	6.80	Flexural

IV. CONCLUSION

The incorporation of jute fibre as a constitutive material of concrete affects the rheological properties of the fresh concrete. High fibre content in the concrete matrix reduces workability and unit weight. Reduction in the compressive strength of concrete has been observed at higher fibre content. Despite the reduction in the compressive strength of jute fibre reinforced concrete, there is an improvement of ductility after cracking of concrete through stress transfer across the cracks and the fibre arrests the rapid crack propagation and prolongs the strain life to continue beyond the ultimate.

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