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ISSN 0974-5904, Volume 10, No. 02

DOI:10.21276/ijee.2017.10.0248

International Journal of Earth Sciences and Engineering

April 2017, P.P. 450-454

An Experimental Study to Check Compressive Strength of Concrete by Using Jute Fibers as Reinforcement

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Abstract: *An experimental study of jute fiber concrete for compressive strength of concrete is carried out for making a good building material in terms of reinforcement. Jute fiber is environmental-friendly and economical fiber. The slump value and compressive strength of specimens were carried out for three different fractions of jute fiber contents by volume. The slump value decreased sharply with increase in fiber content. The results of the compression test indicated that the presence of jute fiber tends to reduce the compressive strength of concrete at higher fiber content. Despite the reduction in the compressive strength at higher jute fiber content, there is an improvement of compressive strength at low jute fiber content.*

Keywords: *Building material, Jute fiber, Compressive strength, Fibre content.*

1. Introduction

The utmost important property of concrete in hardened state is its strength. As the unreinforced concrete has enough strength for many applications in various structures, but it is relatively brittle material. To overcome this problem fibers are added in the concrete. The various factors which affect the properties of fiber reinforced concrete are fiber type, surface conditions, mixing proportions, forms, geometry and curing method. Jute is a soft, long and shiny vegetable fiber which can be spun into coarse and strong threads. Jute is also one of the most affordable natural fibers and is second only to cotton in amount produced and variety of uses of vegetable fibers [1].

Many investigations have been carried out in the use of various types of fibers to reinforce concrete thereby enhancing the mechanical properties of the same. It has been revealed that concrete reinforced with a permissible amount of Fiber acquires better performance in compression, flexure, shear, toughness, energy absorption and micro-mechanical properties, in which case the degree of improvement relies on the types of fibers.

An experimental study conducted on the compressive strength of concrete is reported in this paper. Various fiber fractions were used as reinforcement which were oriented randomly and distributed uniformly in the matrix. Specimens with varying fiber proportions were tested for compressive strength. The results of this study have shown the feasibility of using jute fibers in developing an economical construction material as jute fibers are available readily.

2. Literature Review

Schrader (1978) [2] in ACI Committee 544 suggested internal vibration is not recommended for FC because of the effect of fiber orientation and lack of consolidation in stiff mix, it may be used for specimens with least dimensions greater than about 102mm reflecting the actual practice in the field. It is also concluded that external vibration promotes preferential fiber alignment and increases the toughness strength.

Soroushian and Marikunte (1992) [3] stated that different types of fibers have been considered as part of concrete making materials natural fibers, synthetic fibers and Ferro-cementitious fibers. Peculiarities in using natural fiber reinforced concrete could be its economic benefits attributed to the ease of production with least energy, being environmentally friendly, high strength-to-weight ratio and allow insulation properties higher than current materials. The debating issue, apart from the advantages, is that natural fibers are biodegradable imparting negative effects on the performance of concrete. This special concern of durability limits the range of applications of natural fiber-reinforced concrete to an extent dictated by engineering analysis.

Reza *et al.* (2003) [4] have shown that under compressive loading the micro cracks in the solids come under a local tension at their tips causing wide and unstable crack propagation due to the interaction between other micro-cracks. When fibers are present in such a body, this phenomenon signifies that fibers can be exploited to increase the compressive strength in a manner analogous to the tensile crack- bridging and in consequence provide a passive confining pressure.

Kim *et al.* (2012) [5] described the effect of volume fraction on the compressive strength of jute fiber concrete. Based on the experimental values, the conclusions are as below:

- Jute fibers do affect the workability.

Received: December 21, 2016; Accepted: February 18, 2017; Published: April 26, 2017
International Journal of Earth Sciences and Engineering, 10(02), 450-454, 2017, DOI:10.21276/ijee.2017.10.0248

- The compressive strength of the jute fiber concrete improved by 55% when compared to the one without fiber.

3. Experimental Program

In order to study the effect of mixing jute fiber with concrete under compression, flexure and split tension, 36 cubes, 36 beams and 36 cylinders were casted for M20 as well as for M25 grade of concrete each. The experimental program was divided into four mixes. Each mix consists of 9 cubes, 9 cylinders and 9 beams, of 15cmx15cmx15cm, 15cm (diameter) x30cm and 10cmx10cmx50cm respectively.

- The first mix is the control (Plain) concrete with 0% jute fiber (PCC) designated as M20JF0 and M25JF0
- The second mix consisted of jute fibers percentages as 0.75% designated as M20JF0.75 and M25JF0.75
- The third mix consisted of jute fibers percentages as 1.5% designated as M20JF1.50 and M25JF1.50
- The fourth mix consisted of jute fibers percentages as 2.25 % designated as M20JF2.25 and M25JF2.25

3.1 Material Used

3.1.1 Cement

Ordinary Portland cement (43 grade) has been used for the present study confirming to IS 8112:1989. Results of the various tests carried on cement are tabulated as in Table 3.1.

Table 3.1 *Physical Properties of Ordinary Portland cement (OPC 43 grade)*

Physical property	Results	IS: 8112-1989 Specifications
Normal Consistency	31%	-
Initial setting time (minutes)	87	30 (minimum)
Final setting time (minutes)	201	600 (maximum)
Fineness (retained on 90-micron sieve)%	5.1	10 (maximum)
Soundness (mm)	2.2	10 (maximum)
Specific gravity	3.13	-
Compressive Strength (Mpa) 03-Days 07-Days 28 Days	 24.6 35.3 45.1	 23 (minimum) 33 (minimum) 43 (minimum)

3.1.2 Aggregates

3.1.2.1 Fine Aggregates

The locally procured sand used for the experimental programme which conformed to Indian Standard Specifications IS: 383-1970. Table 3.2 shows the various physical properties of the fine aggregate used in the experimental work. Table3.3 presents the sieve analysis results.

Table 3.2 *Physical Properties of Fine Aggregates*

Sr. No.	Properties	Observed values
1.	Bulk Density(Loose).kg/m^3	1550
2.	Bulk Density(Compacted).kg/m^3	1680
3.	Specific gravity	2.63
4.	Water Absorption, %	0.90

Table 3.3 *Sieve analysis of Fine Aggregates Sample taken 1 kg*

I.S Sieve Size(mm)	Weight Retained (Kg)	% Wt. Retained	Cumulative % wt retained	% Passing the sieve				
				Observed	Requirement as per IS383-1970 for grading zone			
					I	II	III	IV
10.0	0	0	0	100	100	100	100	100
4.75	0.035	3.5	3.5	96.5	90-100	90-100	90-100	95-100
2.36	0.073	7.3	10.8	89.2	60-95	75-100	85-100	95-100
1.18	0.166	16.6	27.4	72.4	30-70	55-90	75-100	90-100
0.600	0.193	19.3	46.7	53.3	15-34	35-59	60-79	80-100
0.300	0.370	37.0	83.7	16.3	5-20	8-30	12-40	15-50
0.150	0.139	13.9	97.6	2.4	0-10	0-10	0-10	0-15
Pan	0.024							

Fineness modulus of FA= F/100 = 269.7/100 = 2.697., The sand conforms to grading zone II as per IS383-1970.

3.1.2.2 Coarse Aggregate

Locally procured coarse aggregates maximum size of 20 mm was used in this work. The coarse aggregates were tested as per IS: 383-1970. The results of various tests carried on coarse aggregate are tabulated in Table 3.4 and Table 3.5.

Table 3.4 *Physical properties of Coarse Aggregate*

Properties	Observed values
Bulk Density(Loose),kg/m^3	1440
Bulk Density(Compacted),kg/m^3	1610
Specific Gravity	2.63
Water Absorption%	0.5

Table 3.5 *Sieve analysis of Coarse Aggregate Sample taken: 2kg*

IS sieve	Weight Retained (kg)	% Wt. retained	Cumulative % wt retained	20 mm	10 mm	60 % (20 mm)	40 % (10 mm)	combined	Requirement for 20mm size as per IS:383
40 mm	0	0	0	100	100	60	40	100	100
20 mm	0.053	2.65	2.65	97.35	100	58.41	40	98.41	95-100
10 mm	1.663	83.15	85.8	14.2	83.15	8.52	33.26	41.87	25-55
4.75 mm	0.227	11.35	97.15	2.85	11.35	1.71	4.54	6.25	0-10
Residue check	0.027								

C= 185.6, F.M of CA = (C + 500) / 100 = 685.6/100 = 6.856, The Coarse aggregate conforms to the requirements of IS 383-1970.

3.1.3 Water

Generally, potable water is suitable for use in concrete. In this study tap water is used for casting.

3.1.4 Jute Fiber

The type of fiber that has been considered in the experimental investigation was jute fiber procured from the local market.

Figure 3.1: *Locally procured Jute Fibers for the present study*

3.1.5 Admixture (Sika 170 R)

Complies with IS: 9103:1979 and BS: 5075 Part 3 and ASTM-C-494 as a high range water reducing admixture. This is based on Sulphonated Naphthalene Polymers and is packed as brown liquid dispersible in water and effectively formulated to provide high range water reduction up to25% without loss of workability. It is having Specific gravity 1.20 at 30 degree C.

3.2 Mix Design for M20 & M25 Grade Concrete

In this thesis two mix proportions were designated as M20 and M25 Grade. The design procedure was adopted as per IS 10262: 2009.

Table 3.6 *Quantity of materials for M20 grade Concrete for 10 cubes*

Mix	Jute Fiber	Cement in kg	Water in L	Sand in kg	Coarse aggregate in kg		Jute Fiber in Kg	Super-plasticizer in kg
					20 mm	10 mm		
M20JF0	0 %	12.55	6.28	24.44	22.95	15.30	0.00	0.00
M20JF0.75	0.75 %	12.45	6.29	23.29	22.78	15.18	0.39	0.00
M20JF1.50	1.50 %	12.37	6.29	23.10	22.60	15.07	0.76	0.00
M20JF2.25	2.25 %	12.27	6.30	22.91	22.43	14.96	1.14	0.00

Table 3.7 *Quantity of materials for M25 grade Concrete for 10 cubes*

Mix	Jute Fiber	Cement in kg	Water in L	Sand in kg	Coarse aggregate in kg		Jute Fiber in Kg	Super-plasticizer in kg
					20 mm	10 mm		
M20JF0	0 %	12.55	5.03	23.29	24.85	16.57	0.00	0.13
M20JF0.75	0.75 %	12.45	5.03	23.11	24.66	16.44	0.39	0.13
M20JF1.50	1.50 %	12.37	5.06	23.00	24.47	16.32	0.76	0.12
M20JF2.25	2.25 %	12.27	5.07	22.77	24.28	16.19	1.14	0.12

4. Results and Discussion

4.1 Slump Cone Test

Slump tests were carried out to determine the workability of fresh concrete. In this thesis work two grades of concrete are designed namely M20 and M25. In M20 grade concrete no admixture is used whereas for M25 grade concrete admixture is used. The results of slump test is tabulated in table no. 4.1 and plotted in Figure No. 4.1.

Table 4.1: *Slump value for different mixes*

Mix	Jute Fibers (in %)	Slump value (in mm)
M20JF0	0.00	47
M20JF0.75	0.75	04
M20JF1.50	1.50	00
M20JF2.25	2.25	00
M25JF0	0.00	55
M25JF0.75	0.75	14
M25JF1.50	1.50	04
M25JF2.25	2.25	00

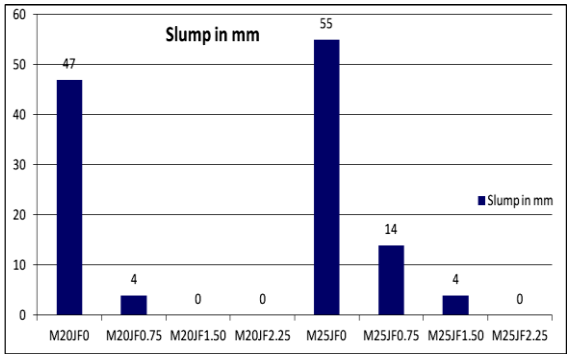

Figure 4.1: *Slump value for all mixes*

4.2 Compressive Strength

After 7, 28 and 90 days of curing, casted cubes were tested on compression testing machine as per I.S. 516-1959. The results of compressive strength test for M20 grade concrete at 7^{th}, 28^{th} & 90^{th} days are plotted in Figure no. 4.2. Also, the results of compressive strength test for M25 grade concrete at 7^{th}, 28^{th} & 90^{th} days are 4.3.

It is seen that at 0.75% volume fraction of jute fibers by volume of concrete, the compressive strength of jute fiber concrete is maximum. It can be seen from Figure No. 4.5 and Figure No. 4.9 for M20 and M25 grade respectively that the maximum compressive strength resulted when fraction of jute fiber by volume of concrete is 0.75%.

When we compare 7 and 28 days results for M20 grade concrete as shown in Figure No. 4.2, it is seen that maximum compressive strength achieved at 1.50% volume fraction of jute fiber while 90 days results shows that maximum compressive strength achieved by 0.75% volume fraction of jute fiber. Similar trends are seen from Figure No. 4.3 for M25 grade concrete. It is seen that at 0.75% volume fraction of jute fiber 5 to 6% increase in compressive strength at 90 days with respect to control mix. It can also be seen that at 90 days compressive strength goes on decreasing with increase in jute fiber content in both of the mixes i.e. M20 and M25 grade concrete.

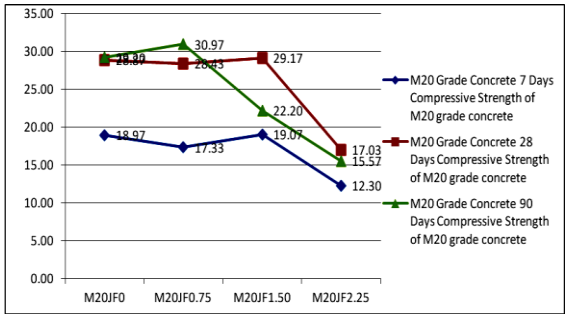

Figure 4.2: *Compressive strength of M20 grade concrete at 7^{th}, 28^{th} and 90^{th} days*

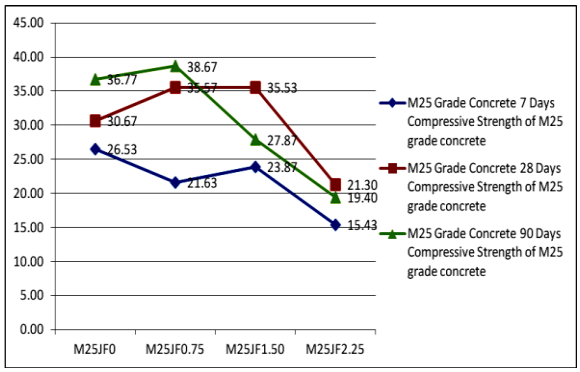

Figure 4.3 *Compressive strength of M25 grade concrete at 7^{th}, 28^{th} and 90^{th} days*

5. Conclusions

5.1. Slump Value

Slump decreases with adding fiber in concrete with respect to reference mix. Maximum slump was recorded for mix M25JF0 and M20JF0 having 0 % jute fibers. In case of M20 grade concrete as no admixture was used zero slump was recorded in M20JF1.50 and M20JF2.25. Although an admixture was used in M25 grade concrete still zero slump was recorded in M25JF2.25. Hence it can be concluded that admixture should be used to maintain workability.

5.2 Compressive Strength

- It is seen that at 0.75% volume fraction of jute fibers by volume of concrete, the compressive strength of jute fiber is maximum.
- In case of M20 as well as M25 grade concrete the maximum compressive strength is achieved at 1.50% volume fraction of jute fiber when tested at 7 and 28 days.
- But the compressive strength is maximum at 0.75% volume fraction of jute fiber in case of M20 as well as M25 grade concrete when tested at 90 days.
- Compressive strength of 90 days is less than the 28 days compressive strength at 1.50% and 2.25% volume fraction of jute fiber in both mixes i.e. M20 and M25 grade concrete.

- Reduction in the compressive strength of concrete has been observed at higher fiber content.

References

[1] Aziz, M.A., Paramasivan, P., Lee, S.L., "Prospects for natural fiber reinforced concrete in construction", International Journal of Cement Composites and Lightweight Concrete, 3(2), PP. 123-132, 1981.

[2] Schrader, E. K., "Formulating guidance for testing of fiber concrete in ACI Committee 544, in *Testing and Test Methods of Fiber Cement Composites"*, The Construction Press UK, PP. 9-21, 1978.

[3] Soroushian, P., and Marikunte, S., "Long-term durability and moisture sensitivity of cellulose fiber reinforced cement composites", 4th RILEM International Symposium on Fiber Reinforced Cement and Concrete, London, PP. 1166-1184, 23 July, 1992. ISBN: 9780419181309.

[4] Reza,F., Batson, G.B., Yamamuro, J.A., Lee, J.S., "Resistance changes during compression of carbon fiber cement composite", Journal of Materials in Civil Engineering, 15(5), PP. 476-483, 2003.

[5] Kim, J., Park, C., Choi, Y., Lee, H., Song, G., "An investigation of mechanical properties of jute fiber-reinforced concrete" Springer Netherlands, Vol. 02, PP. 75-82, 2012, Print ISBN: 978-94-007-2435-8, Online ISBN: 978-94-007-2436-5, DOI: 10.1007/978-94-007-2436-5_10.