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Effect of Jute Fibre Orientation and Percentage on Strength of Jute Fibre Reinforced Concrete

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Abstract*: The demerits of plain concrete are its lesser tensile strength, not significant ductility and poor resistance to cracking. Due to propagation of internal micro cracks in plain concrete causes decrease in tensile strength, hence leads concrete to brittle fracture. Addition of fibres behaves like crack arrester and enhances the dynamic properties of concrete. In India natural fibres such as bamboo, coir, jute, sisal, pineapple, banana, ramie etc are high available. Jute is a useful natural fibre for concrete reinforcement due to its easy availability and low cost. In this research, the experiments related to Jute fibre reinforced concrete (JFRC) are done by taking different fibre percentage and the compressive strength and modulus of rapture value observed. This JFRC can replace plain concrete and wood in many cases for example in door and window panels, inclined roof slabs, partition walls etc

Keywords: Concrete, Jute, Jute fibre reinforced concrete, JFRC

I. INTRODUCTION

In the nineteenth century, when concrete came into existence, it was used merely as a covering material to steel, to safe guard against the weathering effects. At that time, it was not supposed to take any stresses. The requirements of good concrete and factors influencing the properties of concrete were also not known then. After world war-I, more stresses were laid on use of cheap constructional material. Due to this, more researchers devoted themselves to investigate the different properties of concrete and its constituent materials. As the plain concrete is low in resisting cracking due to its lesser tensile strength and poor ductility, addition of small fibre distributed closely and uniformly can enhance the dynamic properties by arresting the cracks. The concrete in which fibres are used as reinforcement termed as fibre reinforced concrete (FRC). The recent researchers have done works on both natural and artificial fibres. The natural fibres like ramie, coir, bamboo, sisal, jute, banana, pineapple etc are highly available in India. Among these due to low cost and availability, jute can be used as fibre reinforcement in concrete. Jute has high specific modulus and low specific gravity. so it can replace partially or fully the glass fibre.In this current study an attempt has been made to check the influence of Jute Fibre with 0.15%, 0.25%, 0.35%, o.5% by weight of concrete mix on properties like compressive strength and modulus of rapture.

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M30 grade of concrete with different percentage of fibre and without addition of fibres are considered for investigation. The orientation of jute fibres were taken as random and continuous. The tests are carried out as per IS codes recommendation.

II. LITERATURE REVIEW

Various authors have been studied on jute fibre concrete and also some have summaries as review in their researches; some of the most relevant papers are studied and various conclusions are drawn as per the test results.

Jumana P and Hariharan (2019) studied on concrete with jute as admixture and rubber as aggregate and found out that compressive and Flexural strengths of concrete replaced with tyre chips is improved by 23% and 6.3% respectively.

Gopi Raval and Umang Patel (2018) have done study on properties if concrete after addition of jute fibres and found out that by adding jute fibres the split tensile strengths and compressive strengths are increased to 10% and 33% respectively and with higher fiber aspect ratio leads decrease of the strength characteristics.

Dayananda N, et al. (2018) have studied on results of Compression tests Attributes of Reinforced Cement Concrete with Jute Fiber Composites and found the compressive strength results of normal concrete specimen is increased from 8.8 N/mm^2 to a maximum of 44.44 N/mm^2, due to the addition of jute fibres.

Priyanka Goel, et al.(2017investigated on Reinforced Concrete with jute fibre and reached in the conclusion that after cracking the ductility of concrete improved due to transfer of stress across the cracks and the rapid crack propagation by the fibres which increases the strain life to continue beyond the limit.

Rahul R. Kshatriya, et al.(2016) has done study on the uses and development of jute fiber in reinforced cement concrete grade M40 and found out that when the raw jute is added in concrete by 1% weight of cement then the strength in compression of concrete cube increased by 17.5% and by adding modified jute compressive strength increase by 26.5%.

III. EXPERIMENTAL ANALYSIS

3.1 Cement:

For the current study PPC cement of 53 grade having 25% of fly ash by weight is used. The cement properties are mentioned in Table-I.

Table-I: Cement properties

Sl. No.	Properties	Results
1	Confirming to	IS: IS:12269
2	Sp. Gravity	3.15
3	IST	95 min
4	FST	280 min

3.2 Fine Aggregates:

For the current study river sand is used and its properties are mentioned in Table-II.

Table-II: Fine Aggregates properties

Sl. No.	Properties	Results
1	Sp. Gravity	2.61
2	Absorption of water	1.0%
3	Silt Content	2.8%
4	Conforming to Zone	Zone-II
5	Fineness Modulus	2.86

3.3 Coarse Aggregates:

Coarse aggregates prepared from crushed stones which available in local market are used in this research work. Its properties are given below table.

Table-III: Coarse Aggregates properties

Sl. No.	Properties	Results
1	Sp. Gravity	2.74
2	Absorption of water	0.5%
3	Sieve Analysis	Confirming to IS:383:1970
4	Maximum Size	20mm

3.4 Water:

Normal drinking water is used throughout the experiments. The PH of the water used is 6.8.

3.5 Water Reducing admixture:

Sika Plastocrete super is used as water reducing admixture. It is highly effective liquid integral water proofing admixture for all types of concrete. It is marked with IS: 9103. Its dosage is 0.2% by weight of cement used. Its aspect is brown liquid. Specific gravity of tjis admixture at 30^0C is 1.05.

3.6 Jute Fibre:

The jute fibre is collected from local hardware shop. The In the current study the jute fibre is used in two ways- Randomly and Continuously. The different percentage of jute fibre used is 0.15%, 0.25%, 0.35% and 0..50% by weight of total concrete mix.

3.6.1 Randomly distributed jute fibres: The diameter of each jute fibre is 0.25mm. The jute cut into 3cm length each. So, The aspect ratio = l/d=30mm/0.25mm=120

3.6.2 Continuous Jute Fibe: For aligning continuous fibre of jute, Nets are prepared by taking different bunches of jute, the diameter of each bunch maintained same(2cm). The stress strain curve of continuous jute fibre is given in Fig.1

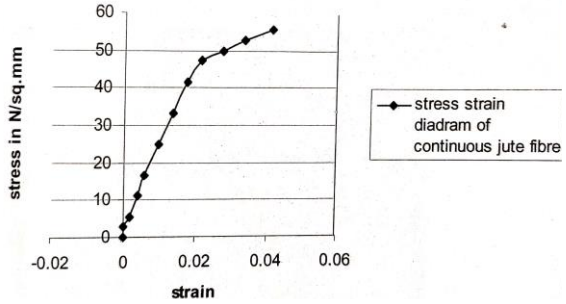

Fig. 1. Stress-strain diagram of Continuous Jute Fibre.

3.7 Concrete Mix:

In this current study M30 grade Concrete is used. Various Trial mixes are prepared and the most suitable proportion is considered for further study. The adopted ingredient distribution for M30 concrete mix is shown in Fig.-2. The different percentage of jute fibre used is 0.15%, 0.25%, 0.35% and 0.50% by weight of total Concrete mix for preparation of JFRC.

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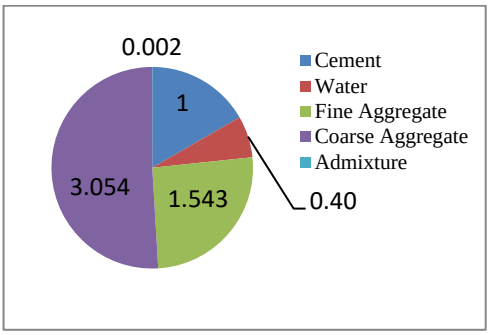

Fig. 2. Ingredient distribution for M30 concrete mix

3.8 Specimens for Test:

JFRC is prepared for different trials for different percentage of jute present in concrete mix. The five types of JFRC denoted as JF*C-I*, *JFC-II*, *C-III*, *JFC-IV*, *JFC-V* are prepared by adding different percentage jute, shown in Table-IV.

Table-IV: JFRC with different percentage of Jute

Trials for Different JFRC	Percentage of Jute Fibre (%)
JFC-I	0
JFC-II	0.15
JFC-III	0.25
JFC-IV	0.35
JFC-V	0.5

For Compression test results of cubes 150mm x 150mm x150mm size and cylinder of length 300m with 150mm diameter and for Flexural strength, beams of size 500mmx100mmx100mm and slabs of size 900mmx150mmx25mm are considered. 72 Nos. from each are casted by taking different percentage of jute. The cubes, cylinders, beams and slabs are casted by adding jute fibres randomly and continuously separately. Tests are conducted at 7-days and 28-days.

IV. RESULT AND DISCUSSION

The Compressive strength results of cubes and cylinders, Modulus of Rapture values of beams and cylinders for continuously oriented JFRC are given in Table-V and for randomly oriented JFRC are given in Table-VI. Compression test results of Cubes and Cylinders with different percentage of Continuously and Randomly oriented Jute Fibre at 7 days and 28 days are shown in Fig.3.Flexural strength of Beams and Slabs with different percentage of Continuously and Randomly oriented Jute Fibre at 7-days and 28-days are shown in Fig.4.

Table -V Test Results of Continuous JFRC

Trials	Percentage of CA Replaced (%)	Avg. Compressive Strength of Cube (MPa)		Avg. Compressive Strength of Cylinder(MPa)		Modulus of Rapture of beam (Mpa)		Modulus of Rapture of slab (Mpa)	
		7-days	*28-days*	*7-days*	*28-days*	*7-days*	*28-days*	*7-days*	*28-days*
C-I	0	37.0	55.2	29.87	43.6	4.6	6.7	4.5	5.8
C-II	0.15	32.7	45.7	24.49	35.25	4.9	7.2	6.1	8.2
C-III	0.25	34.6	50.7	25.91	37.23	5.5	7.8	8.7	10.8
C-IV	0.35	27.7	39.9	22.08	30.72	4.5	6.6	5.8	7.9
C-V	0.5	26.2	37.8	19.25	28.31	4	6.1	4.5	6.3

Table-VI: Test Results of Continuous JFRC

Trials	Percentage of CA Replaced (%)	Avg. Compressive Strength of Cube (MPa)		Avg. Compressive Strength of Cylinder(MPa)		Modulus of Rapture of beam (Mpa)		Modulus of Rapture of beam (Mpa)	
		7-days	*28-days*	*7-days*	*28-days*	*7-days*	*28-days*	*7-days*	*28-days*
C-I	0	37.0	55.2	29.87	43.6	4.6	6.7	4.5	5.8
C-II	0.15	26.1	38.6	22.08	29.59	4.7	7	5.3	8.7
C-III	0.25	27.3	40.3	22.23	30.29	5	7.1	7.1	10.3
C-IV	0.35	21.2	31.6	19.11	24.35	3.9	6.4		9.5
C-V	0.5	20.4	29.7	16.42	22.93	3.9	6.1	3.9	5.6

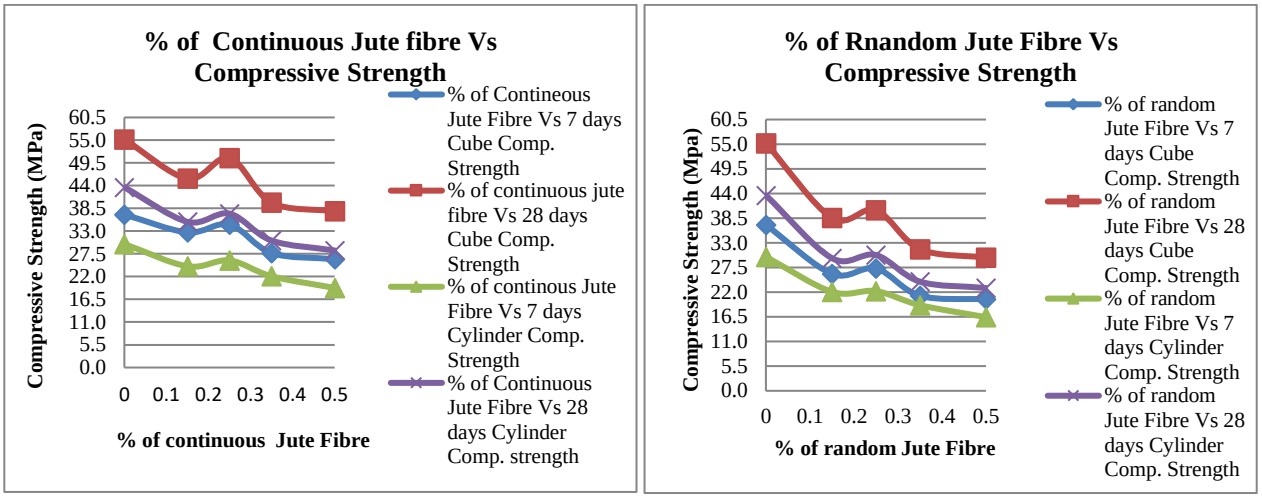

Fig. 3. Compressive strength results of Cubes and Cylinders with different percentage of Continuously and Randomly oriented Jute Fibre at 7 days and 28 days.

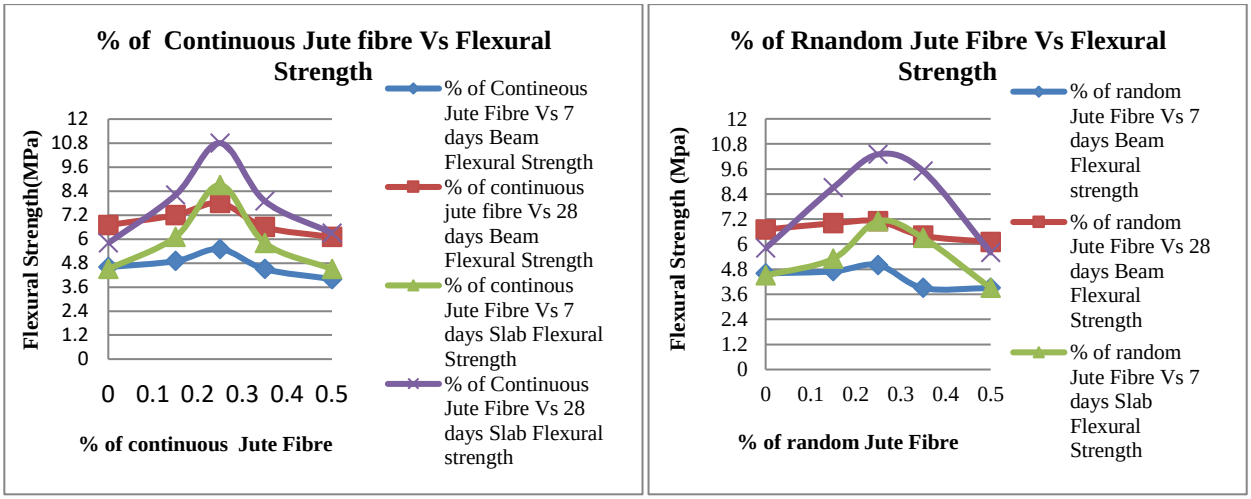

Fig. 4. Flexural strength results of Beams and Slabs with different percentage of Continuously and Randomly oriented Jute Fibre at 7 days and 28 days

V. CONCLUSION

From the graphs of compression test results of cubes and cylinders, it is seen that with jute fibre the compressive strength value more or less changed with respect to plane cement concrete. With addition of jute fibre modulus of rapture (MR) value is increased. In case of beam with addition of 0.25% continuous jute fibre the MR value enhanced by 15% and in slab with addition of 0.25% continuous fibre the MR value is enhanced by 49% than plane cement concrete. It is clearly seen that addition of jute fibre enhances the flexural strength and hence the tensile strength. So this jute fibre reinforced concrete can be used as partition walls, door and window panels, inclined roofs etc.

FUTURE WORKS

From the above analysis it is found that the modulus of rapture is lower at 0.15% and 0.35% of jute fibre. So the value is maximum when the percentage of jute fibre is in between 0.15% and 0.35%. to know the accurate percentage of jute fibre experiments can be conducted in future for lesser fraction values of fibre. More keen analysis is required to know better application of jute as fibre for other works, behavior of fibres, durability, chemical affinity etc. Analysis can be carried out with respect to different aspect ratio of fibres.

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