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MECHANICAL PROPERTIES OF CONCRETE WITH JUTE FIBRE

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ABSTRACT
As concrete is weak in tension and has brittle character. The concept of using fibres to improve the characteristics of construction materials is very old. Use of continuous reinforcement in concrete (reinforced concrete) increase strength and ductility, but requires careful placement and skilled labour. Alternatively introduction to fibres in discrete form in plane and reinforced concrete may provide better solution. When concrete cracks, and randomly oriented fibres start functioning, arrest cracks formation and propagation, and thus improve strength and ductility. In the present work the tensile and compressive properties of jute fibre can be known. The problem of high rate of absorption of jute fibre can be reduced by soaking jute in water for 24 hours and drying it for 30 minutes Moreover the fibres being natural in origin is ecologically sustainable and can bring down the global carbon footprint quiet effectively.This study aimed at analysing the variation in strength of jute fibre reinforced concrete at varying fibre percentages and then comparing it with that of conventional concrete. Concrete cues and cylinders are casted with 0.5%, 1%, 1.5% of jute with respect to the cement. Cubes are tested at 7 days, 28 days of curing period for compressive strength test. Cylinders are tested at 7 days and 28 days of curing for split tensile test. The test results obtained for jute fibre cement concrete are compared with conventional concrete.
Keywords –jute fibre,ductility,compressive strength, split tensile strength

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I. INTRODUCTION

The construction industry is revolutionizing in two major ways. One way is the development of construction techniques, such as using automated tools in construction. The other is the advancement in high-performance construction materials, such as the introduction of high strength concrete. Among these high-performance materials, fibre reinforced concrete (FRC) is gradually gaining acceptance from civil engineers. In recent years, research and development of fibres and matrix materials and fabrication process related to construction industry have grown rapidly. Their advantages over other construction materials are their high tensile strength to weight ratio, ability to be moulded into various shapes and potential resistance to environmental conditions, resulting in potentially low maintenance cost. These properties make Fibre reinforced concrete composite a good alternative for innovative construction. Their application in construction includes both upgrading existing structures and building new ones, which can apply to various types of structure, for example offshore platforms, buildings and bridges.

major roadblock towards development of high performance concrete using steel fibres is the high costs involved, availability and also problem of corrosion. Jute fibre being the most ductile among all natural fibres has the potential to be used as a reinforcement material in concrete. It is biodegradable so the impact on environment will be minimal. They are also non-abrasive in nature and easily available. This is believed to be a cost-effective solution to earthquake-resistant housing.

The aim of this study was to identify the improvement in strength characteristics of concrete with the addition Jute fibre. In the study, Jute fibre is added to concrete and Ordinary Portland Cement (OPC) concrete is used as reference to study its effect on compressive and tensile strength properties. Fibre is soaked in water for 24 hours so as to decrease the water absorption. Some of the advantages being observed are low density, reasonable specific strength, less abrasive behaviour to the processing equipment, good dimensional stability and harmlessness.

II. NEED FOR STUDY

Jute fibre with a tensile strength is very high and it is the toughest among all natural fibre. They are capable of taking strains 4–6 times higher than other fibres. Jute fibre has major hindrance towards its wide scale use is the high rate of water absorption, which can be reduced by soaking it in water for 24 hours and drying it for 30 minutes.

The advantages of jute fibre are : reasonable specific strength, low density, ease of availability, enhanced energy recovery, less abrasive behaviour to the processing equipment, biodegradability, ability to be recycled in nature in a carbon neutral manner, resistance to fungi moth and rot, excellent insulation to sound, flame, moisture and dampness, toughness, durability, resilience.

III. OBJECTIVES AND SCOPE

The aim of this study is to investigate the effect of jute fibre on physical properties of concrete**,** The objectives of this work are:

1) To find out variation in compressive and tensile strength of Jute fibre reinforced concrete with the conventional concrete.

2) To determine the influence of percentage of fibre on strength of concrete.

The scope of this project is limited to rural residential constructions.

IV. EXPERMENTAL PLAN

In order to achieve the above task and to verify the assumptions made, general objectives is divided into the following stages. The research studies comprises of following stages:

Stage 1: Literature survey of Jute, previous research of concrete based on Jute fibre and effects on the important properties of concrete such as workability and strength will be studied.

Stage 2: In this phase, concrete samples will be prepared in laboratory. Specimens will be cast for testing the compressive strength and split tensile strength of concrete. After 7&28 days, the compressive strength of cube specimens will be tested. Split tensile strength for cylinders will be tested at 7 and 28 days. Mix design proportions as designed using IS: 10262-2009 and IS: 456-2000 is 0.43 : 1 : 1.4 : 3.3. These results will be used to find the variation in strength of concrete by using different proportion (0%, 0.5%, 1% and 1.5%) of Jute fibre added with respect to cement with respect to ordinary Portland cement tests will be conducted within estimated time.

Stage 3: Experimental work will be executed, taking into consideration the physical properties of constituent's materials. Laboratory tests and results are reported. Analysis of test results and observations are drawn, all results are completed in the form of tables. Based on this comparative study of this experimental work, conclusions and recommendations are presented in order to establish guideline for future.

V. JUTE FIBRE

Jute is an important bast fibre with a number of advantages .India is one of the large jute producing country. It has high specific properties , low density, enhanced energy recovery, biodegradability, ability to be recycled in nature in a carbon neutral manner, resistance to fungi moth and rot, excellent insulation to sound, flame, moisture and dampness, toughness, durability, resilience, less abrasive behavior to the processing equipment, good dimensional stability and harmlessness.Jute should be used only after soaking it for 24 hours in water and drying it for 30 minutes. It is low costly eco - friendly product and is abundantly available.

Fig 1:Jute

VI. MIX PROPORTIONS

Cement : 400 Kg/m3
Coarse aggregate : 1343 Kg/m3
Fine aggregate : 562 Kg/m3
Water : 172 Kg/m3
Water to cement ratio (w/c): 0.43

VII. TEST RESULTS

- **7 days compressive strength for 0%, 0.5%, 1%, 1.5% of Jute**

Table 1: Compressive strength result for 7 days curing

S.NO	CUBE	COMPRESSIVE SRENGTH N/mm^2			
		0%	0.5%	1%	1.5%
1	A	21.20	26.84	29.21	22.95
2	B	22.54	27.26	29.32	22.16
3	C	22.38	26.80	29.75	20.12
4	AVG.	22.04	26.96	29.42	21.73

- **28 days compressive strength for 0%, 0.5%, 1% and 1.5% of Jute**

Table 2: Compressive strength results for 28 days curing

S.NO	CUBE	COMPRESSIVE STRENGTH N/mm^2			
		0%	0.5%	1%	1.5%
1	A	37.92	41.26	45.10	37.23
2	B	36.54	40.83	45.72	37.64
3	C	37.35	41.90	45.37	38.19
4	AVG.	37.27	41.33	45.39	37.69

- **7 days split tensile strength for 0%, 0.5%, 1%, 1.5% of Jute**

Table 3: Split tensile strength result for 7 days curing

S.NO	CYLINDER	SPLIT TENSILE SRENGTH N/mm^2			
		0%	0.5 %	1%	1.5%
1	A	2.23	2.43	2.60	2.12
2	B	2.42	2.51	2.61	2.03
3	C	2.29	2.58	2.75	1.98
4	AVG.	2.31	2.50	2.65	2.04

- **28 days split tensile strength for 0%, 0.5%, 1%, 1.5% of Jute**

Table 4: Split tensile strength result for 28 days curing

S.NO	CYLINDER	SPLIT TENSILE SRENGTH N/mm^2			
		0%	0.5 %	1%	1.5%
1	A	3.79	3.84	4.23	3.30
2	B	3.72	3.86	4.12	3.12
3	C	3.84	3.90	4.15	3.10
4	AVG.	3.78	3.87	4.17	3.17

VIII. DISCUSSIONS OF TEST RESULTS

It was observed that 7 days compressive strength of normal concrete that is with 0%Jute fibre to be 22.04 MPa and that of 0.5% Jute fibre concrete to be 26.96 MPa with increment of 22.32 %.On adding the jute fibre of 1% with respect to cement, strength was found to be 29.42 MPa We with increment of 33.48% compared to 0% jute fibre concrete. The 7 days compressive strength of 1.5%Jute fibre concrete was 21.73 MPa with decrement of 1.41% only. Further increase in jute fibre content i.e. after 1% addition of Jute fibre cubes showed decrease in strength Value compared to normal concrete. This shows that addition of jute fibre with respect to cement must be limited to 0.5-1 % addition of 1 %Jute fibre showed maximum increase in strength compared to normal concrete.

It was observed that 28 days compressive strength of normal concrete with 0%Jute fibre was 37.27 MPa and that of 0.5% Jute fibre was 41.33 MPa with increment of 11.1% compared to normal concrete. For 1% Jute fibre, the strength was 45.39 MPa with increment of 21.78% compared to normal concrete .Further increase in jute fibre up to 1.5% with respect to cement, the 28 days strength was 37.69 MPa which was increased in strength by 1.12% compared to normal concrete which is very less when compared with other percentage of jute fibre added to concrete. Hence, maximum increment of 21.78% was seen for 1% jute fibre concrete and further increase in jute fibre above 1% showed decrease in strength.

It was observed that 7 days split tensile strength of normal concrete with 0% Jute fibre was found to be 2.31 MPa and that of 0.5%Jute fibre concrete was 2.50 MPa with increment of 8.25% compared to that normal concrete. For 1% Jute fibre concrete, the split tensile strength at 7 days was 2.65 MPa with increment of 14.71 % compared to normal concrete. For 1.5% Jute fibre concrete, strength was found to be 2.04 MPa with decrement of 9.91% compared to that of normal concrete. The test results showed maximum increment of 14.71% for 1%Jute fibre concrete and split tensile strength decreases for 1.5%jute fibre concrete added with respect to cement.

It was observed that 28 days split tensile strength of normal concrete with 0% glass powder was found to be 3.78 MPa and that of 0.5%Jute fibre concrete was 3.87 MPa with increment of 2.3% compared to that of normal concrete. For 1%Jute fibre concrete, the split tensile strength at 28 days was 4.17 MPa with increment of 10.3% compared to normal concrete. For 1.5%Jute fibre, strength was found to be 3.17 MPa with decrement of 16.13% compared to that of normal concrete. The test results showed maximum increment of 10.3% for 1%Jute fibre concrete and split tensile Strength decreases for 1.5% addition of jute fibre with respect to cement.

IX. CONCLUSION

The major conclusions from this study are

At 1% addition of jute fibre with a water cement ratio of 0.43, compressive strength tests yielded best results. However, the compressive strength decreased on further fibre addition. This must be due to the fact that when the fibres are initially added to concrete, the finer sized fine aggregates enter into the surface pores in the fibre creating a better bonding between the fibre and mix, however further addition of fibres resulted in formation of bulk fibre in the mix which will lead to decrease in bonding. Hence there is an optimum

value of fibre to cement ratio, beyond which the compressive strength decreases. Hence 0.43 was taken as the optimum water cement ratio and optimum fibre content was taken as 1%.

When the fibre content is increased there is an increase in split tensile strength with a maximum at 1%. However when the fibre content is increased beyond this value a reduction in tensile strength is observed. This is due to the fact that tensile failure occurs due to the dislocation of atoms and molecules present in concrete. However when the fibre is added it acts as a binder holding them together.

The tensile properties and cracking pattern of JFRC shows that it can be particularly useful in construction activities in seismic zones due to its high tensile strength and post peak load behaviour, which offers sufficient warning to the inhabitants before complete collapse of the structure.

Due to its relatively higher strength and ductility, It can be a good replacement for asbestos fibres in roofing sheets, which being natural in origin pose zero threat to the environment.

It can also be used as the reinforcement material in cement fibre boards which can act as a good backing to tiles thereby improving its impact resistance and also in faux ceilings. The advantage of cement fibre boards is its ability to survive under moist environments unlike paper based gypsum boards.

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