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# USE AND DEVELOPMENT OF JUTE FIBRE IN REINFORCED CEMENT CONCRETE GRADE M40

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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 labour skill. 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. As India is one of the largest producers of jute, hence its potential application in many branches of engineering should be developed. In the present work the tensile, compressive, mechanical properties of jute fibre without modification and after modification with 0.5% alkali and 0.5% latex polymer has been modified by taking quantity of jute as 1% of cement. This modification of jute fibre improves tensile strength of Jute fiber also water absorption has been reduced. These properties are compared by taking tests on plain, with and without modification of jute fibre casting cube, cylinder and beams after curing of 7 days. From our project we had seen that there is considerable increase in strength of concrete by adding treated jute in concrete.*

***Keywords- Treatment of jute fiber ,Use of jute in concrete, Use of jute in M40 grade concrete, Effect of jute in concrete.***

## I. INTRODUCTION

It is difficult to maintain strength of concrete and increase its durability, so addition of natural fibers is economical way to increase strength of concrete. The type of fibers currently been used include steel, glass, polymers, carbon and natural fibers. Economic considerations have restricted the use of carbon fibers in cementitious composites on a commercial level for their non ecological performance. Natural fibers have the potential to be used as reinforcement to overcome the inherent deficiencies in cementitious materials. Considerable researches are being done for use of reinforcing fibers like jute, bamboo, sisal, akwara, coconut husk, sugarcane bagasse in cement composites mostly in case of building materials. Use of natural fibers in a relatively brittle cement matrix has achieved considerable strength, and toughness of the composite. The durability of such fibers in a highly alkaline cement matrix must be taken into consideration by effective

modifications. A specific chemical composition has to be chosen that can modify the fiber surface as well as strengthen the cement composite.

## II. MATERIALS AND METHADOLOGY

### 2.1 Materials

Portland Pozzolona cement of M40 Grade was supplied by Ultratech Cement Pvt. Ltd. Locally available coarse aggregate (stone chips of size 0 - 20 mm) and sand were used for composite fabrication as per IS:456 -2002.Jute fibers of TD4 grade were collected from Jute Mill, Dindori, Nashik, India.

#### 2.1.1 Jute

Photo 2.1 Jute fiber

Photo 2.2 Chopped jute fiber

India is one of the large jute producing country. Jute is an important bastfibre with a number of advantages. Jute has high specific properties, low density, less abrasive behavior to the processing equipment, good dimensional stability and harmlessness. Jute textile is a low cost eco-friendly product and is abundantly available, easy to transport and has superior drapability and moisture retention capacity. It is widely being used as a natural choice for plant mulching and rural road pavement construction. The biodegradable and low priced jute products merge with the soil after using providing nourishment to the soil. Being made of cellulose, on combustion, jute does not generate toxic gases.

Due to jute's low density combined with relatively stiff and strong behavior, the specific properties of jute fibre can compare to those of glass and some other fibres (Table 2.1).

Table 2.1 Mechanical properties of natural fibres as compared to conventional reinforcing fibres

| **Fibre** | **Density ($g/cm^3$)** | **Elongation (%)** | **Tensile Strength (MPa)** | **Young's Modulus (GPa)** |
|---|---|---|---|---|
| Cotton | 1.5-1.6 | 7.0-8.0 | 287-597 | 5.5-12.6 |
| Jute | 1.3 | 1.5-1.8 | 393-773 | 26.5 |
| Flax | 1.5 | 2.7-3.2 | 345-1035 | 27.6 |

| | | | | |
|---|---|---|---|---|
| Hemp | - | 1.6 | 690 | - |
| Ramie | - | 3.6-3.8 | 400-938 | 61.4-128 |
| Sisal | 1.5 | 2.0-2.5 | 511-635 | 9.4-22.0 |
| Coir | 1.2 | 30.0 | 175 | 4.0-6.0 |
| Viscose(cord) | - | 11.4 | 593 | 11.0 |

### 2.1.2Cement

Cement is material which generally use for bonding in concrete in construction industries.We used the Portland Pozzolanacement of 53 grade for our whole work. Before using some tests are carried on it. Some physical characteristics of cements are given in table 2.2

**Table 2.2 Physical characteristics of cement**

| IS Code | Fineness (sq.m/kg) min | Soundness by | | Setting time | | Compressive strength | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Lechatlier (mm) max | Auto clave Max (%) | I Initial (mts) min | Final (mts) Max | 7 days Min Mpa | 7 days Min Mpa | 7days Min Mpa | 8 days Min Mpa |
| (IS 269- | 225 | 10 | 0.8 | 30 | 600 | N | 6 | 22 | 3 |

### A) Test-Soundness of cement-

This test is performed to ascertain the soundness or unsoundnessofcement,which affects durability of the structure. The soundness of cement depends on its ingredients. Excess of lime and/or magnesium oxide present in the cement cause unsoundness .The test is designed to accelerate the expansion in the cement paste by application of heat.

Original distance between the pointers, $d_1 = 6$mm

Distance between the pointers after boiling, $d_2 = 10$mm

As per IS 269-1987, the expansion of cement should not be more than 10mm Portland pozolona cement expansion of cement = 4mm there for cement is sound.

### 2.1.3 Fine aggregate

The river sand was used as fine aggregate conforming to the requirement of IS 383:1970. The river was washed and screened, to eliminate unwanted deleterious material and over size particles.

The test for determination of specific gravity was carried out. The surface dry aggregate were used for test. These properties of aggregate are necessary to decide proportions of the concrete mix.

### Specific gravity of fine aggregate

Specific gravity (G) is defined as the ratio of weight of a given sample at standard temperature to the weight of equal volume of distilled water at the same temperature. Both weights are taken in air. Specific gravity of very

coarse fraction (gravels, pebbles etc.) is calculated by using voluminometer and pycnometer is used to find the specific gravity of the particles of sand.

**Table 2.3 Observation table**

| Sr. No. | **Observation** | **1** | **2** |
|---|---|---|---|
| 1 | Pychnometer no. | 1 | 2 |
| 2 | Mass of emptypychnometer ($M_1$) gm | 650 | 650 |
| 3 | Mass of emptypychnometer + Sand ($M_2$) gm | 1190 | 1100 |
| 4 | Mass of emptypychnometer + Sand + Distilled ($M_3$) gm | 1830 | 1835 |
| 5 | Mass of emptypychnometer + Distilled ($M_4$) gm | 1510 | 1520 |
| **6** | **Specific gravity =($M_2$-$M_1$)/[( $M_2$-$M_1$)-( $M_3$-$M_4$)]** | **2.45** | **3.33** |

The average specific gravity of sample is 2.8

### 2.1.4 Course aggregate

The coarse aggregate of 20mm from crushed ballast rock, conforming to IS 383:1970 were used. The aggregates were free from adherent coating, injurious amount of disintegrated pieces, alkali, vegetable matter and other deleterious substances. Care was taken that the aggregate do not contain high concentration of flaky, elongated shapes and organic impurities which might affect the strength or durability of concrete.

### Aggregate impact value

Toughness is the property of material to resist the impact. The aggregate impact value gives a relative measure of resistance of an aggregate to sudden shock or impact. This resistance of aggregates is different from its resistance to gradually applied load. The impact test consist of giving the repeated impact to the smple of aggregates ,by a hammer weighing 14 kg and falling from a height of 380±5mm. The quantity of finer material passing through 2.36mm I.S sieve indicates the toughness of the sample.

**Table 2.4 Record of observation for impact value**

| **Description** | **Sample 1** |
|---|---|
| Total weight of dry sample taken = $w_1$gm | 780 |
| Weight of portion passing 2.36 mm sieve = $w_2$gm | 40 |
| Aggregate impact value = $w_2/w_1$ x 100 % | 5.12 |

The mean aggregate impact value is 5.12% hence, the aggregate is classified as exceptionally strong.

### 2.1.5 Concrete

It is a mixture of sand, cement, water, course and fine aggregate. We carried above tests on materials and above values concrete mix design is made and proportion is as follows. Admixture is use as per suitability of conditions.

**Concrete mix design: Grade M40**

| Water | Cement | Sand | Coarse aggregate |
|---|---|---|---|
| 0.4 litre | 1 Kg | 1.44 Kg | 2.35 Kg |

### 2.2 Methodology

### 2.2.1 Problem statement

The properties of various fibers were identified and jute fiber is chosen as a natural fiber to replace by 1% weight of cement. And also it was treated with alkali and polymer latex such that the properties of jute fiber will change. And comparing in M40 grade plain cement concrete, raw jute cement concrete and modified jute cement concrete for compressive, split tensile and flexural strength.

### 2.2.2 Mixing process

The jute fiber reinforced concrete samples of mix design 1:1.44:2.35 (cement: sand: coarse aggregate, by weight) were fabricated by following process, for untreated and treated jute fiber reinforced concrete. Initially the chopped fibers of 6 cm length were immersed for 24 h in half of the total volume of water required for concrete preparation in a container. Next the half of the total amount of cement required was added to wet jute in that container with constant stirring to obtain jute-cement slurry. The jute cement slurry was then slowly poured into the pan-mixer with stirring provision and the pan-mixer was run for 2 min. Sand and rest of cement was mixed with this jute-cement slurry. The remaining amount of water, sand and aggregate was then added and the pan-mixer was run for further 5 min. The fresh cement concrete thus obtained was cast immediately in molds and allowed to setting.

All the specimens were demolded after 24 h of casting and water cured for 7 days respectively. At the specified date they were removed from water, surface dried and tested. Each test result represented the mean of at least three specimens.

### 2.2.3 Treatment on jute fiber

a) Treatment with alkali

The jute fibers were cut to ~6 cm of length and soaked in 0.5% (w/v) NaOH solution at ambient temperature maintaining a fiber to liquor ratio of 1:30. The fibers were kept immersed in the alkali solution for 24 h. The alkali treated fibers were then washed several times with distilled water to remove excess alkali from the fiber surface. The final pH was maintained at 7.0. The fibers were then air dried at room temperature for 24 h followed by oven drying at 55$^{o}$C for 24 h.

b) Treatment with polymer latex

Commercially available aqueous emulsion of carboxylated styrene-butadiene copolymer based polymer latex was used to modify the jute fibers. The solid content of undiluted polymer

latex was found to be 41%. Alkali treated jute fibers were dipped into 0.5% (v/v) polymer latex for 24 h, maintaining a liquor ratio 1:30 at ambient condition. The fibers were then air dried at room temperature for 24 h followed by oven drying at 55° C for 24 h.

### 2.2.4 Test to be carried out on specimen for different composite

**Sizes of specimen-**

Cube- 150 mm X 150 mm X 150 mm.

Cylinder- Height- 300mm,Daimeter- 150mm

Beam- 700mm X 300mm X 150mm

**Table 2.5 Test to be carried out on specimen for different composite for 7 days.**

| Sr. No. | Type of concrete composite | Test to be taken | Specimen | | |
|---|---|---|---|---|---|
| | | | Cube | Cylinder | Beam |
| 1 | Plain cement concrete | Compression, tension | 3 | 3 | 3 |
| 2 | Raw jute cement concrete | Compression, tension | 3 | 3 | 3 |
| 3 | Treated jute cement concrete | Compression, tension | 3 | 3 | 3 |

## III. RESULTS AND DISCUSSIONS

### 3.1 Introduction

Generally we taken compressive, split tensile and flexural strength on members. While the different tests are carried on cement, fine aggregate and course aggregate. The split tensile strength where obtain by following formula

Tensile strength = ( $\frac{2 X Load}{\pi X Diameter}$ )

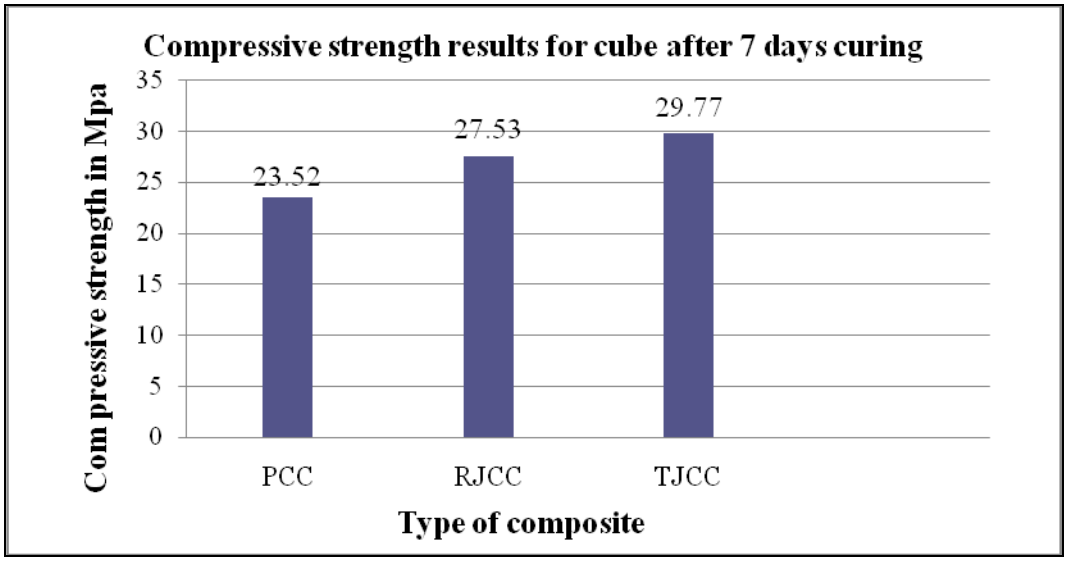
### 3.2 Test results of different specimen

**Table 3.1 Test results of plain cement concrete**

| Mixture | Avg. Compressive strength(Mpa) | Avg. Split tensile strength(Mpa) | Load carried by beam in single point load test (KN) |
|---|---|---|---|
| Plain cement concrete | 23.52 | 3.92 | 214.75 |
| Raw jute cement concrete | 27.53 | 4.22 | 216.79 |

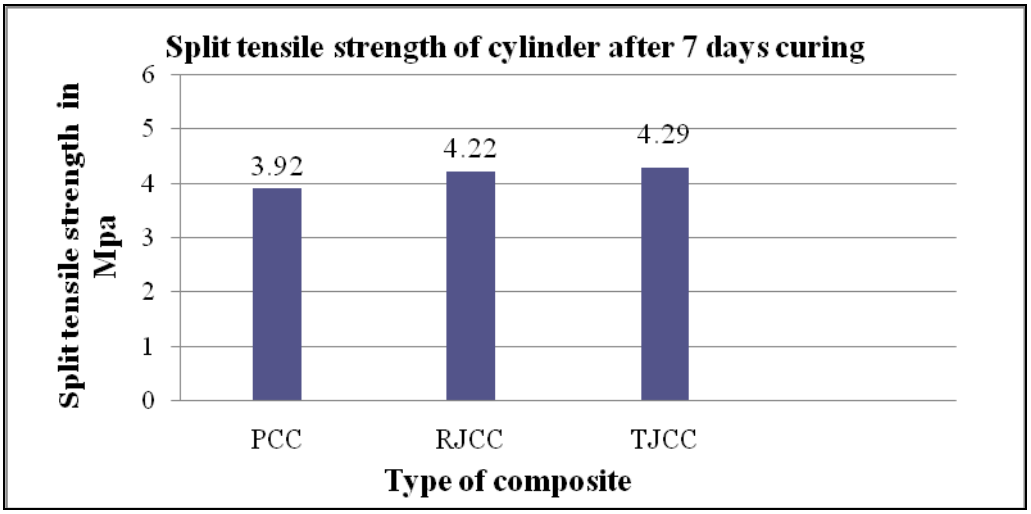
| | | | |
|---|---|---|---|
| Treated jute cement concrete | 29. 77 | 4. 29 | 223. 4 |

### 3.3 Graphs



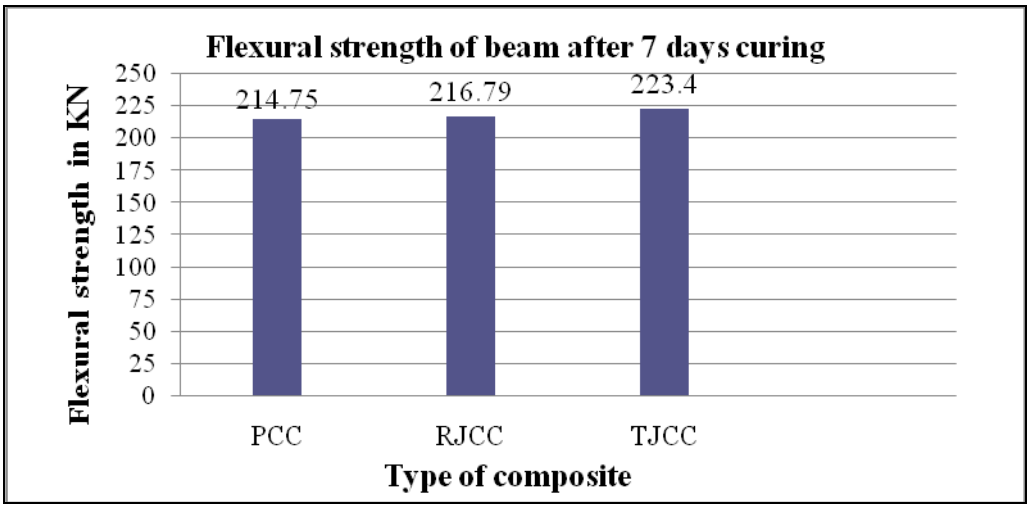

**Graph 3.1 Compressive strength results for cube after 7 days curing**

From the graph, it is observed that the compressive strength of concrete is increased by 17.5% by adding raw jute and 26.5% by adding modified jute in concrete.




**Graph 3.2 Split tensile strength results for cylinder after 7 days curing**

From the graph it is observed that the split tensile strength of concrete is increased by 7% by adding raw jute and 9% by adding modified jute in concrete.




**3.3 Flexural strength results for beam after 7 days curing**

From the graph it is observed that the flexural strength of concrete is increased by 1% by adding raw jute and 4% by adding modified jute in concrete.

## IV. CONCLUSIONS

1) It was observed that when the jute is chemically treated then its degradation decreases.

2) It was observed that when the raw jute is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 17.5% and by adding modified jute compressive strength increase by 26.5%.

3 ) It was observed that when the raw jute is added in concrete by 1% weight of cement then the split tensile strength of concrete cylinder increased by 7% and by adding modified jute split tensile strength increase by 9%.

4) It was observed that when the raw jute is added in concrete by 1% weight of cement then the flexural strength of concrete cube increased by 1% and by adding modified jute flexural strength increase by 4%.

5)Hence, it is proved that modified replacement proportion is beneficial to use in practice as it gives workable concrete with more compressive, flexural and tensile strength.

6) It was observed that it is difficult to mix or spread jute in concrete also it is difficult to maintain water cement ration.

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