INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 4)
Available online at: www.ijariit.com

Behaviour of natural sisal fibre reinforce concrete beam in pure torsion

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ABSTRACT

This project it has carried out torsional strength for reinforced concrete elements by using sisal fibers. In last around 3 decades, all over the world are finding out potential applications of a natural fiber base reinforced concrete based element. So many countries research and the investigation was carried out to find the various physical and also mechanical properties, the durability of such products reinforced with natural organic fibers. Since last some years, various researchers investigated the use of fibers in construction materials like mortar, concrete etc. However, all properties of concrete may not improve for the same proportions of the different combination. Mechanical behavior of fiber reinforced concrete composite depends on the structure of composite both, properties of concrete and properties of type fiber used in a mix. Hence, for analysis and prediction about the performance of composite at different loading condition, the internal structure of composite must be characterized.

Keywords— *Sisal fiber, Reinforced concrete, Torsional strength, Aspect ratio*

1. INTRODUCTION

We all known concrete is brittle material. A normal concrete and brittle materials, structural cracks develop in structural element before applying load drying shrink aging and other so many problems.

Natural fiber gives post cracking strengthening and toughness to RCC beam. The useful due to its cost as comparatively synthetic fibers is economical, its environmental compatibility and bio durability. So many types in natural fibers are used a composite material in cement base structure such as sisal, jute, cotton, palm life, wood etc.

During the past years sisal used as reinforcement in the concrete structure. The scientific name of sisal tree is “Agave sisalana.” This type of cactus this plant original from Tanzania. Sisal fiber its the type of leaf fiber. Leaf fibers made from the leaf of tree tissues by machine scarping by retting process. The leaf fiber gives high strength as compared to other type natural fibers. Sisal fibers are mostly used in y ropes, rugs, mattresses, and mat and handicraft materials.

Fig. 1: Sisal moist fibre

2. THEORETICAL BACKGROUND

The interaction between fiber and concrete structure fiber reinforced cementations material are most affecting properties of the performance of cement-based fiber composite material. Such consideration include is:

- The matrix composition.
- Length of fibers used.
- Type, geometry and surface characteristic of the fibers.
- The orientation of fibres under the torsional force.

Fiber reinforced composites are successfully used as an engineering application, because of their satisfactory, outstanding performance. So in these last four decades, many of the researches are work to understand the performance of fibres used with reinforced concrete to recognize their use. Fiber mix concrete is composite material contacting fiber in cement mortar in a randomly distributed. Fibre can be added as secondary reinforcement. Fiber work as primary reinforcement in the thin product in the conventional bar is not to be used.

These application, fibres act as secondary reinforcement because we provide TMT steel bars in a concrete beam. Fibres

are added to control cracking induced by temperature variation. Many research has shown that the addition of small closely spaced and uniformly dispersed fibre in concrete would not only act as crack arresters but also improve the torsion strength and other properties of reinforced cement concrete.

3. METHODOLOGY

Perform any research work, the preliminary preparation is necessary. Preliminary planning, procedures, and methods wisely chosen and rigorously implemented. The criteria are assessed properties of ingredients of the mix are based on activities to be planned and preparation is to be done. Hence before starting the present work following steps are decided and followed.

1. Collect required material for a study like cement, sand, aggregate, fiber etc. in required quantity.
2. Perform different laboratory testing quality of each material.
3. Prepare Mix Design for the material used for 7, 28, days target strength 30MPa (M30 Mix) IS 10262.
4. Casting beam using plain concrete M30 mix and testing them for their torsional strength etc. for 7,28and 56 days and collect results obtained.
5. Providing steel reinforcement in a concrete beam.
6. Casting beam for different percentage and various aspect ratio sisal fibre. Testing them for 7, 28 and days against torsional collecting results.
7. Comparing the results obtained.
8. Conclusion regarding the suitability of sisal fibre for reinforcement.

4. MATERIAL USED FOR EXPERIMENTAL WORK

4.1 Cement

Cement uses this experimental investigation Ordinary Portland cement (OPC) 53 grades manufactured by Birla Super Cement.

4.2 Fine Aggregate

Sand used for work is crush stone sand it is produced by local and it is zone II sand was passing through 4.75 mm sieves and remove stone greater than 4.75mm.

4.3 Corse Aggregate (20 mm)

Aggregate passing through 20mm sieves and restrained on 4.75 mm it's tested as per IS: 383-1970.

4.4 Steel Bar

TMT bar use for reinforcement of beam. 10 mm diameter used for the main bar and 6 mm diameter using for stirrups.

4.5 Sisal Fibre (with different aspect ratio)

A natural sisal fibre used with mechanical performance as reinforcement a cement base composite beam. Cutting the size of sisal with respect to its aspect ratio as 50, 75, and 100. Sisal fibre added in concrete is percentage 1.5%, 2% with respect to the weight of cement.

Characteristics of sisal:

Fiber Type = Sisal
Diameter (mm) = 0.3 – 0.2.
Density (g/cm³) = 1.45.
Moisture content (%) = 11.
Ultimate Tensile Strength (MPa) =568-640.
Modulus of Elasticity (GPa) = 15.2 – 15.8.
Elongation (%) = 14.8.

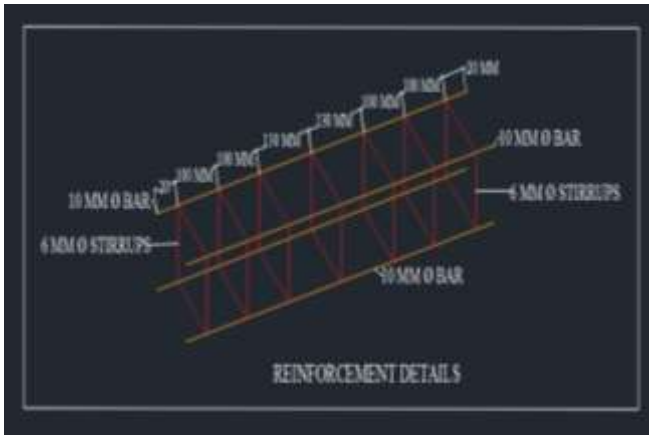

Fig. 2: Reinforcement detail

A. Mix design of M 30 concrete (IS 10262)

Summary:

a) Plain concrete

Weight of cement = 428.60 kg
Weight of fine aggregate = 671.33kg
Weight of coarse aggregate = 1170.75kg
Weight of water = 193 lit

Therefore, final mix proportion without fibre is (1:1.47:2.96:0.46)

b) Fibre reinforced concrete

Weight of cement = 428.60 kg
Weight fine aggregate = 671.33 kg
Weight of coarse aggregate = 1170.75 kg
Weight of water = 231lit

Therefore, final mix proportion with fibre is (1:1.47:2.96:0.48)

B. The casting of Reinforced Concrete beam Specimen

Two batches are costing which is depends percentage of sisal fibre add in concrete beam 1.5 %, 2% of sisal fibre. Again each batch carried out with an aspect ratio of 50, 75, and 100. Beam mould is cast separately on bases aspect ratio and corresponding batches. 9 moulds of each combination are casted for testing after 7th, 28th day casting.

Sizes of moulds are:

Beam moulds of dimensions (150 x 150 x 700) mm. Before fresh concrete placed in moulds, all concrete moulds are clean and oil for moulds may be demoulded easily.

Table 1: Number of moulds for testing

% of sisal fibre	1.50%			2%			Total Quantity
Aspect ratio	50	75	100	50	75	100	
Beam	6	6	6	6	6	6	36

5. TESTS ON HARDENED CONCRETE SPECIMENS

Concrete is strong material in compression. It can resist high static crushing loads. It is weak for torsion. The torsion strength of concrete generally ranges between 8 to 10 percent. The concrete easily fails and cause cracks when subjected to tension and bending. In order to increase, the torsion strength of concrete is modified by reinforcing it by using sisal with steel reinforcement different percentage and aspect ratio.

The characteristic of concrete generally is used the relation to quality for any construction purpose. It is important to find out the properties of concrete as they indicate potential qualities to the required purpose.

Nevertheless, Strength, durability should not consider as essential material properties. Factors such as specimen geometry preparation, and temperature, moisture content, loading rate, and type and method of testing will affect mechanical behavior of concrete. Properties of concrete were used in laboratory work, and especially in research. Each test and methodology is outlined and discussed here. The test procedure to measure a hardened property of concrete in this project includes torsional strength test.

6. RESULTS OF TORSIONAL LOADING OF REINFORCED CEMENT CONCRETE BEAMS

For torsion leading applying tasting 60 steel reinforced beams are cast. Twelve different combinations used as, M30 concrete with no of insertion of sisal (0%), M30 concrete with 1.5% sisal fibre mixed in M30 concrete 50, 75, 100 A.R. And for 2% sisal fibre mixed in M30 reinforced concrete mix for 75, 100 A.R. respectively. Each beam is undergone destructive testing. For normal plan concrete beam three beam is tested after 7^{th} day pond curing next three beams are tested after 28^{th} day pond curing, so total 9 beams tested for the M30 concrete beam. Similarly 6 concrete beam are tested for each normal M30 concrete mix with sisal fibre as:(A) 1.5% - 50 A.R, 1.5% - 75 A.R, 1.5% - 100 A.R (B) 2.0% - 50 A.R, 2.0% - 75 A.R., 2.0% - 100 A.R. Table 2 gives the torsional load test result of 7^{th} and 28^{th} days.

Fig. 3: Torsional load testing

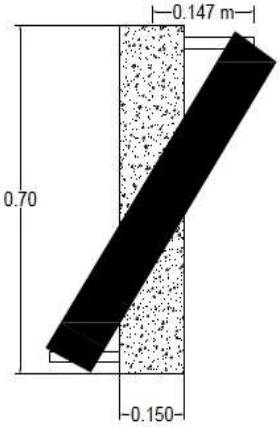

Fig. 4: Plan of testing setup

Table 2: Average torsional load

Details of sisal insertion	7 day torsion load (kN)	28 day torsion load (kN)
0% RCC M30 concrete	35.46	57.15
1.5% - 50 A.R,	50.83	77.18
1.5% - 75 A.R,	51.99	79.15
1.5% - 100 A.R	52.06	81.55
2.0% - 50 A.R,	44.52	71.35
2.0% - 75 A.R.,	48.26	73.83
2.0% - 100 A.R	41.31	72.88

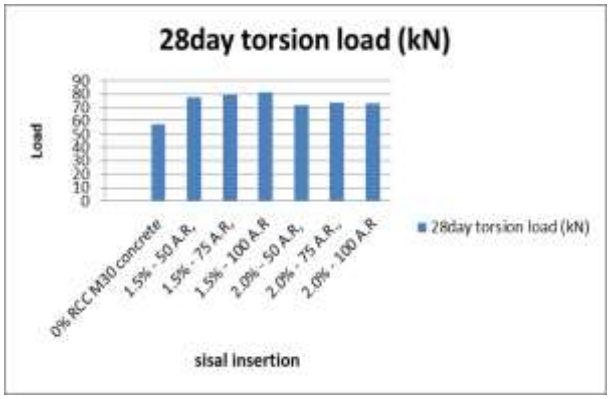

Fig. 5: Graph showing variation in torsional Torque at 28 day

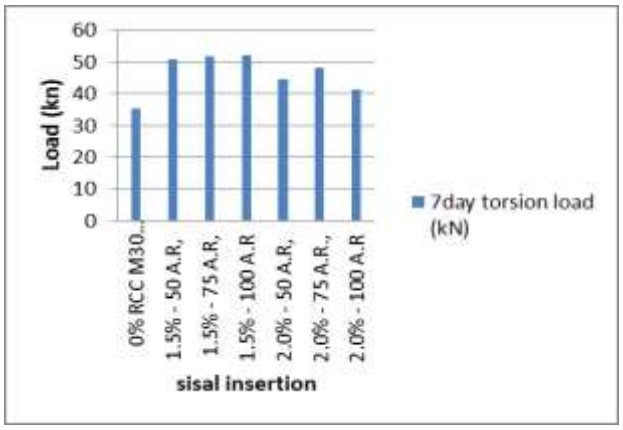

Fig. 6: Graph showing variation in torsional load at 7 day

7. CONCLUSION

7.1 General

This chapter set out to a conclusion on applying torsional load on sisal fibre reinforced concrete beam. Lastly, recommendation for farther studies is suggested with the use of sisal fibre in concrete to study more on its mechanical properties. It is founded that increase percentage and also by changing the length of fibre have shown an increment in torsional load carrying capacity of sisal reinforced concrete beam.

7.2 Conclusion base on the test result

It is found that the use of sisal fibre in concrete decrease workability of the fresh concrete to some extent. Thought workability decreases, torsion loading parameter has shown varying promising results. Following are conclusive findings of tests.

Torsional loading

In most of the studies where fibre is aligned with long filament length, the torsional load is seen to be decreasing or if increased, the improvement is very low, which is cannot be considered; in the present study, fibres are mixed with

concrete in a random manner that's why considerable increment in load is observed. Following points are conclusions and finding those are taken for considerations.

1. The obtained results for various combinations have shown that torsional loading of loading is seen to be reduced gradually after some adding different percentage of sisal.
2. Also if compare results on aspect ratio parameter length of sisal on 100 A.R torsional loads is seen maximum. It reduced as fibre length increased from A.R 75 to A.R. 100 and again torsional load is seen to be increased by 1.5% of 100 A.R
3. The maximum torsional load is observed at 1.5% fibres on aspect ratio 100 with the average torsional load without fibre.
4. The minimum torsional load is observed at 2% fibre with aspect ratio 100. Its show that after 1.5% adding of sisal in concrete torsional load can be started reducing.

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