Effect of Sisal Fibre on Engineering Properties of Cement Concrete

Pankaj Raj Chouhan[1] Sachin Kumar Dangi[2] Dr. Aslam Hussain[3]
[1]PG Student [2,3]Assistant Professor
[1,2,3]Department of Civil Engineering
[1,2,3]UIT-RGPV Bhopal, India

Abstract— The present research was designed to check the workability and strength properties of sisal fiber reinforced concrete with different percentage of fiber addition. The materials were chosen to improve the various strength properties of the structure to obtain sustainability and better quality structure. Short discrete vegetable fiber (sisal) was examined for its suitability for incorporation in cement concrete. Fibers were brushed, lined up and cut to obtain 5cm length. The study consists of preparation of three different types of mixes. First type is control specimen of M30 grade concrete. Second of S1 type contain 1% sisal fibre and third is of S2 type containing 2% sisal fibre. The mix design is performed according to IS 10262:2009 – the Indian Standard code of practice for mix design. The sisal fibre is varied from 1% to 2% percent weight of cement. The laboratory tests performed on concrete are workability (slump cone test), compressive strength and flexural strength. The slump test results, as is expected from inclusion of fibre, there is marked decrease in slump value. The compressive strength test results showed slight increase in concrete with sisal fibre. There is about 6% increase. The flexural strength increase is very high comparative to control specimen but overall the magnitude of flexural strength is very less. The increase is about 35%.

Key words: Sisal Fibers, Workability, Sustainability, Mix Design, Compressive Strength, Flexural Strength

I. INTRODUCTION

Concrete is one of the most useful materials in the construction industry. It is the basic building block of almost every construction in the world. It is interesting to note that concrete is made up from basic materials which are cheap as well as abundant. Cement, which is integral part of concrete, can be mixed with any granular material to give a solid structure. The demand of concrete is expected to keep growing in near future thus increasing the depletion of natural resources used in manufacturing of cement.

In recent years, there has been marked awareness on lowering the carbon footprint in construction industry. The main contributor to carbon dioxide in particular and environmental pollution in general is cement production. Therefore various techniques are implemented all over the world to reduce the use of cement so that production is decreased and thereby environmental pollution is reduced. Waste utilization is a major concern in today's world and safe disposal of these wastes is essential for the sustainable development and overall growth of the society. Alternatively, researchers are also exploring the possibility of utilization of these wastes in various civil engineering construction activities. Several waste products, such as, rubber tyre, plastic, fly ash, fibres etc. have been effectively utilized.

One such technique of reducing cement use is to partially replace it with other material of similar properties. The fly ash, ground granulated blast furnace slag, rice husk ash etc. are some of the materials which are successfully used in cement concrete. On the other hand, researches are being made to improve performance of concrete in terms of compressive strength, tensile strength etc. One such method is to include various types of fibres like steel fibre, glass fibre, sisal fibre etc as a partial replacement to cement in preparing concrete.

A. Sisal Fibre

Sisal fiber is a species of Agava. It is botanically known as Agave sisalana. The material is chosen to improve the various strength properties of the structure to obtain sustainability and better quality structure. Short discrete vegetable fiber (sisal) was examined for its suitability for incorporation in cement concrete. The physical property of this fiber has shown no deterioration in a concrete medium. Leaves are dried, brushed and baled to form fiber. Concrete is a mixture of glue and fillers, cement and water act as glue and coarse and fine aggregate are the fillers. This concrete is strong in compression and 8 to 10 percentage weaker in tension. Reinforcement is introduced in concrete to improve its property and fibers have always been considered promising as reinforcement of cement.

The main disadvantage is that it is of high price. Addition of fiber reduces workability. Sisal fiber reinforced concrete should be hand mixed.

Sisal fiber reinforced concrete is the concrete with randomly distributed fibers. The failure strength and modulus of elasticity depends on the amount of cellulose and the orientation of the micro-fibers.

This study is done to fine the physical properties of conventional concrete and sisal fiber reinforced concrete and to enhance the properties of concrete using sisal fiber by replacing cement with respective percentage of fiber and finding the strength variation on concrete in different mix proportions.

Fig. 1 Sisal Fibres Used In Present Study

B. Objectives

The following are the objectives of present study:

1) To additionally use sisal fibres of varying percentage 1 and 2% of the weight of cement to enhance the properties of hardened concrete.

2) To carry out the various mechanical tests- workability (slump cone method), compressive strength of cubes and flexural strength of M30 grade of concrete.

II. MATERIAL & METHODOLOGY

Fiber was brushed, lined up and cut to obtain 4cm length. Then casting and testing of concrete specimens using different ratio of sisal fiber that is 1% and 2%.

A. Materials Used

- Cement Used-OPC
- Cement Specific Gravity-3.15
- Coarse Aggregate Specific Gravity-2.66
- Fine Aggregate Specific Gravity-2.60
- Super Plasticizer-0.2% to the weight of cement.
- Water cement ratio-0.45
- Sisal fiber addition- 1%, and 2% to the weight of cement

B. Workability

To find workability, considerable trial and error method was done using slump cone test to find slump in concrete and compaction factor test to find consistency. Water cement ratio of 0.45 was used.

C. Mix Design

For M-30 Grade of Concrete

Characteristic Compressive Strength (f_{ck})	MPa
Maximum Size of coarse aggregate	mm
Degree of Workability(CF)	High
Degree of Quality Control	Good
Type of exposure condition	Moderate
Mix Proportion	1: 2.44: 3.13

Table 1:

III. RESULTS & DISCUSSION

The various mixes given in previous chapters are then used to prepare concrete for various tests. Following are the tests used for testing the suitability of concrete for use in construction.

1) Workability test
2) Compressive strength test
3) Flexural strength test

A. Slump Test

The slump test was performed on concrete to give measure of workability. The slump value for various mixes is shown in below table and figure.

Series	%weight of sisal fibre	Slump (mm)
C	0	108.18
S1	1	106.50
S2	2	104.65

Table 2:

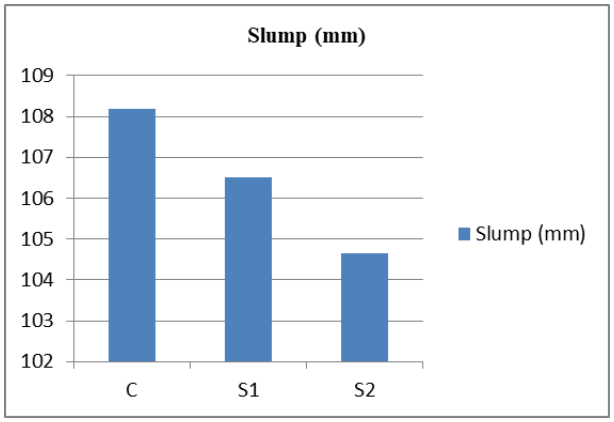

Fig. 3.1: Slump Test Results

From figure, it can be seen that there is marked decrease in slump value as amount of sisal fibre is increased. This is expected result as sisal fibre tends to reduce workability on account of absorption of water thereby reducing amount of water required for hardening.

The reduction in slump value is perhaps due to absorption of free water by fibres particles. The reduction is 10-20%.

B. Compressive Strength Test

The compressive strength test, as is generally known, is single most important property of concrete of any type. The characteristics of concrete are defined by compressive strength. The table and graph below shows variation in compressive strength of different mixes.

The result show slight increase from control sample in compressive strength which signifies that fibres used in study does not negatively affect the strength performance.

The S-mixes containing sisal fibre show increase in strength. The strength of S2 mix is found to be more than S1 and conventional mixes. The strength increase is up to 6%.

Series	%weight of sisal fibre	7 days compressive strength	28 days compressive strength	Average compressive strength
C	0	20.92	32.61	26.91
S1	1	22.59	33.41	28
S2	2	23.07	33.76	28.41

Table 3:

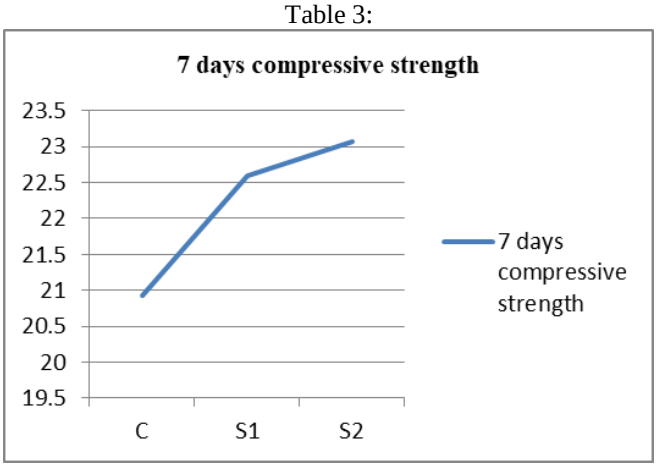

Fig. 3.2: Compressive Strength at 7 Days

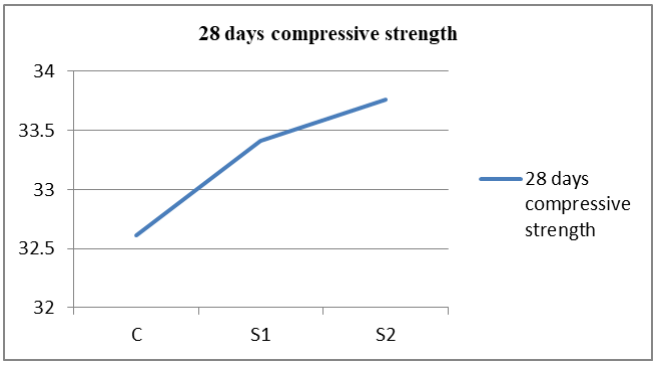

Fig. 3.3: Compressive Strength at 28 Days

C. Flexural Strength Test Results

The concrete is a brittle material due to which it is weak in tension. In case of flexural loading, the portion which is in tension tends to fail first thereby making the concrete weak in flexure. Hence, flexural strength of concrete is much less than compressive strength and is comparable to tensile strength.
Due to inclusion of fibres in present study, there is somewhat enhancement in flexural strength. For S2 mix containing 2 percent of sisal fibre there is about 35% increase in strength.

Series	%volume of sisal fibre	7 days flexure strength
C	0	2.74
S1	1	3.37
S2	2	3.72

Table 4:

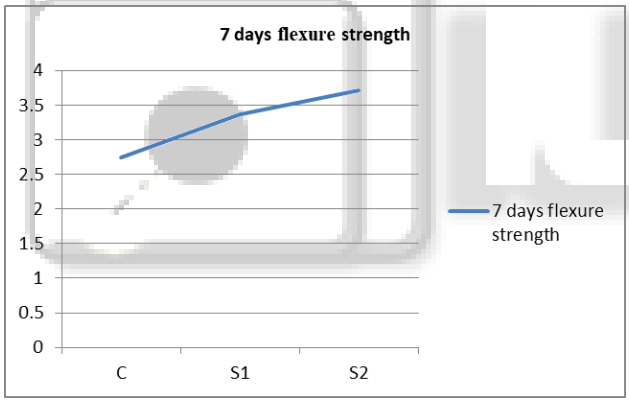

Fig. 3.4: Flexural Strength Test Graph Comparison

IV. CONCLUSION

The study aimed at experimental work involving preparation of concrete with inclusion of sisal fibres is used. The results obtained from experimental tests are then evaluated. The purpose behind inclusion of above fibres is to recycle these materials thereby contributing to environmental conservation.

The study consists of preparation of four different types of mixes. First type is control specimen of M30 grade concrete. Second of S1 type contain 1% sisal fibre and third is of S2 type containing 2% sisal fibre. The mix design is performed according to IS 10262:2009 – the Indian Standard code of practice for mix design.

The sisal fibre is varied from 1 to 2 percent weight of cement. The laboratory tests performed on concrete are workability (slump cone test), compressive strength and flexural strength.

Three standard cubes for each mix type is prepared for compressive strength and three standard beams for each mix type is prepared for flexural strength. The slump test results, as is expected from inclusion of fibre, there is marked decrease in slump value. The compressive strength test results showed slight increase in concrete with sisal fibre. There is about 6% increase. The flexural strength increase is very high comparative to control specimen but overall the magnitude of flexural strength is very less. The increase is about 35%.

REFERENCES

[1] Yanki Wu, Yanbin Li & Bin Niu (2014) Assessment of the mechanical properties of sisal fibre-reinforced silty clay using traxial shear tests.
[2] Tara Sen, H. N. Jagannatha Reddy (2011) Application of sisal, bamboo, coir and jute natural composites in structural up grading.
[3] F. Silva and Dr. R. D. T. Filho (2004) Sisal fibre reinforcement of durable thin walled structures– A new perspective.
[4] Indian Standard, I. S. "383: 1970." Specifications for coarse and fine aggregates, Bureau of Indian Standards. Manak Bhavan 9 Bahadur Shah Zafar Marg, New Delhi-11000 (2000).
[5] Indian Standard, I. S. "456: 2000." Plain and Reinforced Concrete Code of Practice Bureau of Indian Standards. Manak Bhavan 9 Bahadur Shah Zafar Marg, New Delhi-11000 (2000).
[6] Indian Standard, I. S. "10262:2009." Concrete Mix proportioning Guidelines Bureau of Indian Standards. Manak Bhavan 9 Bahadur Shah Zafar Marg, New Delhi-11000 (2009)

