STUDIES ON BOND AND FLEXURAL STRENGTH OF SISAL FIBRE ROPE REINFORCED CONCRETE

[1]S.Yazhini [2]Dr.G.Ramakrishna,
[1]PG Student, [2]Professor,
[1,2]Department of Civil Engineering,
Pondicherry Engineering College, Puducherry, India.

Abstract:The present study was designed to check the mechanical properties of conventional concrete and compare with 0.5% sisal fibre reinforced concrete. To determine the bond strength between sisal fibre rope and sisal fibre reinforced concrete. To determine the flexural strength of sisal fibre reinforced concrete beam with sisal fibre rope.In this research, sisal is being used in concrete. Short discrete vegetable fibres (sisal) was examined for its suitability for incorporation in cement concrete. Fibres were brushed, lined up and cut to obtain 1.5 cm length.The fibre diameter was observed to be average 0.1mm. Degree of workability of concrete mix with water cement ratio 0.45 had good workability with slump value 50mm, which is effective, was obtained. Materials were hand mixed with 0.5% addition of fibre in M30 mix design and casted in cubes and cylinders and small beams. The obtained specimens were subjected to tests aimed to check the compressive, tensile and flexural strength.The purpose of this research is based on the investigation of the use of sisal fibres in structural concrete to enhance the mechanical characteristics of concrete.

Keywords -- sisal fibres, reinforced concrete, compression strength, split tensile strength, flexural strength.

INTRODUCTION

Natural fibres as reinforcement in composites (such as cement paste, cement sand mortar and/or concrete) have been studied by many researchers, but only for non-structural members. These composites have been tested for plastering and as roofing materials, corrugated slabs and boards in different parts of the world. Significant improvement in the properties of these composites has been obtained by the insertion of fibres. Their potential as an earthquake- resistant structural material needs to be considered. Concrete is strong in compression, and its other properties like tensile strength, toughness, and damping can be improved significantly by incorporating sisal fibres.
Sisal fibre reinforced concrete was investigated in detail for its possible use in civil engineering applications. The work presented in this study investigates the bond strength between sisal fibre and concrete, primarily because the bond between the reinforcing material and matrix contributes to the better behaviour of the ensuing composite. The outcome of this work can help in selecting the optimum fibre properties ultimately resulting in increased strength of the composite. The aim of this study is to develop a new construction technology using sisal fibre reinforced concrete (SFRC) and sisal rope reinforcement. Therefore, the effects of rope embedment length, rope diameter with fibre contents on the bond strength between rope and SFRC are investigated in this study.

I.FIBRE REINFORCED CONCRETE (FRC)

Fibre-reinforced concrete (FRC) is concrete containing fibrous material which increase its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these different fibres that character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and densities of fibre reinforced concrete.

ADVANTAGES OF FIBRE REINFORCED CONCRETE

- Fibre reinforced concrete has started to find its place in many areas of civil infrastructure applications, where the need for repairing, increased durability arises also avoid the corrosion at the maximum.
- The advantages of natural fibre materials are strength, durability, reduce cost of environmental compatibility and bio degradability. It is a hard and tough fibre. In components such as slabs and pavements, fibre is added to control cracking induced by temperature variation.
- Fibre reinforced concrete is better suited to minimize cavitation erosion damage in structures such as sluice-ways, navigational locks and bridge piers where high velocity flows are encountered also avoid catastrophic failures in bridges.
- Also in the quake prone areas the use of fibre reinforced concrete would certainly minimize the human casualties.

II. NATURAL FIBRE REINFORCED CONCRETE

Fibres can be added to cement based matrices as primary or secondary reinforcement. Fibres work as primary reinforcement in thin products in which conventional reinforcing bars cannot be used. In these applications, the fibres act to increase both the strength and the toughness of

the composite. In components such as slabs and pavements, fibres are added to control cracking induced by humidity or temperature variations and in these applications they work as secondary reinforcement.
The use of fibres in concrete provides an exciting challenge to the construction industry for housing, for providing roofing sheets and to contribute to the rapid development of a
country's infrastructure. Natural fibre has special appeal in the field of civil engineering.

NATURAL FIBRES AS REINFORCEMENT

The reason for putting fibres into cement-based materials are generally agreed to be as follows:

- Improvement of flexure (bending strength).
- Improvement of impact toughness.
- Control of cracking and change in failure behaviour to give post-crack load-bearing capacity change in the flow characteristics of the fresh material. (Advanced High Strength Natural Fibre Composites in Construction).

III. OBJECTIVES OF THE STUDY

The main objective of this study are,

- To study the mechanical properties of conventional concrete and compare with 0.5% sisal fibre reinforced concrete. To determine the bond strength between sisal fibre rope and sisal fibre reinforced concrete.
- To determine the flexural strength of sisal fibre reinforced concrete beam with sisal fibre rope.

IV. SCOPE

The scope of this study is,

- To determine the mechanical properties of sisal reinforced concrete such as compressive strength, splitting tensile strength, modulus of elasticity and modulus of rupture at 0.5% fibre content and compare with the mechanical properties of plain concrete.
- To determine the tensile strength of sisal fibre ropes of various diameters.
- To determine the bond strength between sisal fibre rope of diameter (18, 27 and 36mm) and rope embedment length of (100, 150 and 200 mm) by Rope pull out test.
- The flexural behaviour of 0.5 % sisal fibre reinforced concrete beams with sisal fibre rope.

V. NEED FOR STUDY

Natural fibres as reinforcement in composites have been studied by many researchers only for non-structural members.Natural fibres are good alternative at lower cost and promote sustainable development. Earthquakes have caused mass destruction of buildings because of non-engineered constructions. These observations emphasize the need for new techniques for economical and safe housing in earthquake prone rural areas. Natural fibre reinforced concrete structures can be one solution. Sisal is a complete biodegradable and highly renewable resource of energy. Sisal fibre is exceptionally durable and require low maintenance with minimum wear and tear. Sisal is one of the promising natural fibre. An effort to diversify and encourage the use of natural fibres for construction is to be made in this study. Natural fibres (e.g. coconut/coir, sisal, bamboo,flax and hemp) are cheaper than conventional steel fibres and are locally available in many countries. Hence sisal fibre reinforced concrete (SFRC) and sisal fibre rope is investigated for their potential in low-cost housing in under-developed and developing countries.

VI. MATERIALS USED

A.Cement

Ordinary Portland cement of grade 43 has been used in the study. Table 1 shows the physical characteristics of cement used, tested in accordance with IS: 4031-1988.

Table 1: Physical properties of cement

SI.NO	Specifications	Results
1	Specific gravity	3.15
2	Standard consistency	30%
3	Initial setting time	36 minutes
4	Final setting time	208 minutes

B. Fine Aggregate

The fine aggregate used was locally available river sand conforming to IS: 383-1970.the fine aggregate was tested for its physical requirements as shown in table II.

Table 2: Physical properties of fine aggregate

SI.NO	Specifications	Results
1	Specific gravity	2.6
2	Fineness modulus	2.8
3	Bulk density	1530 Kg/m³
4	zone	II

C. Coarse Aggregate

The physical properties of coarse aggregates are,

Table 3: Physical properties of coarse aggregate

SI.NO	Specifications	Results
1	Specific gravity	2.67
2	Bulk density	1403 Kg/m³

D. Water

Water used for mixing and curing was potable water.

SISAL FIBRE

Sisal fibre is one of the most widely used natural fibres and is easily cultivated .Sisal is a hard fibre extracted from the leaves of the sisal plant (Agave sisalana). Sisal is fully biodegradable and highly renewable resource of energy. The material is chosen to improve the various strength properties of the structure to obtain sustainability and better quality structure. There are three types of fibres in sisal, arch fibres, conducting fibres and structural fibres. Out of which structural fibres are mostly adopted because of its durability as they do not split during extraction process. Out of which structural fibres are mostly adopted because of its durability as they do not split during extraction process. These fibres have a good tension resistance or tensile. They are very well resistant against heat. In developing countries, sisal fibres are used as reinforcement in houses.

The following are the properties of sisal fibre,

- Fibre diameter-0.1 mm
- Tensile strength – 31-221 N/mm²
- Specific gravity-1.4.

SISAL PLANT

SISAL FIBRE

SISAL ROPE

Fig 1: Sisal Products

PROPERTIES OF SISAL FIBRE:

- Sisal Fibre is exceptionally durable with a low maintenance with minimal wear and tear.
- It is Recyclable.
- Sisal fibres are Anti-static, does not attracts or traps dust particles and do not absorb moisture or water easily.
- It exhibits good sound and impact absorbing properties.
- Its leaves can be treated with natural borax for fire resistance properties.

APPLICATIONS OF SISAL FIBRE:

- It is also used as cement reinforcement.
- In developing countries, sisal fibres are used as reinforcement in houses.
- Sisal is also used in housing schemes. Sisal house is panelised system for building emergency shelters. It uses pre-made panels that are connected toform a shed like structure. These are used as emergency shelters and later can be disassembled and reused or converted into permanent houses.
- Sisal-based bricks, roofing tiles, insulation material and fibreboard.

Table 4: Chemical Composition of Sisal Fibre

Chemicals	Percentage
Cellulose	65%
Hemicelluloses	12%
Lignin	9.9%
Waxes	2%
Total	100%

VII. MIX PROPORTION

- In this project the mix design ratio used for M30 grade of concrete is,

Table 5: Mix Design Ratio

Cement	FA	CA	Water
1	1.33	2.83	0.45

VIII. RESULTS AND DISCUSSION

Compressive Strength:

The compressive strength result obtained for both 7-days and 28-days it was observed that the compressive strength of 0.5% sisal fibre added specimens increased with respect to conventional concrete.

Table 5: Compressive Strength Test Results

Description	Compressive Strength (MPa)	
Cube(150x150x150) mm	7-days	28-days
Plain concrete	29.6	39.6
0.5% sisal fibre reinforced concrete Slump value=50 mm	30.1	40.3

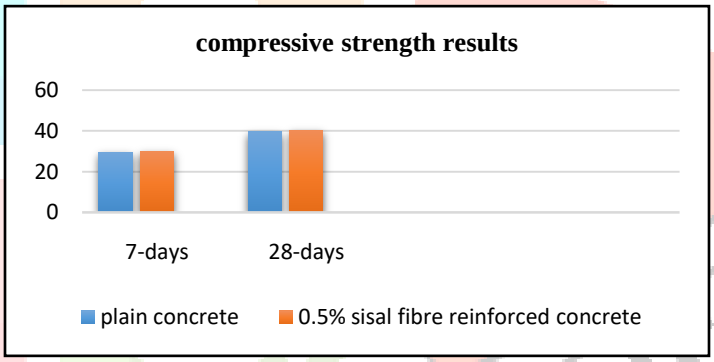

Fig 2: Compressive Strength Test Results

Fig 3: Compression Testing of Cube

Tensile Strength:

The tensile strength also can be increased by addition of sisal fibre to the concrete.

Table 6: Split Tensile Strength Test Results

Description	Split tensile strength (MPa)	
Cylinder (200x100) mm	7-days	28-days
Plain concrete	2.5	3.4
0.5% sisal fibre reinforced concrete Slump value=50 mm	2.7	3.6

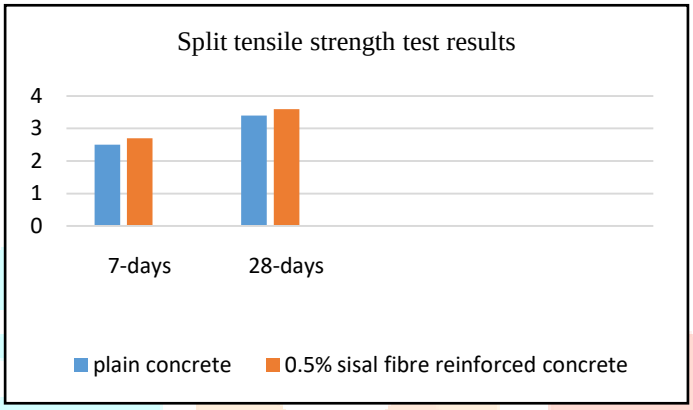

Fig 4: Split Tensile Strength Test Results

Fig 5: Split Tensile Testing Of Cylinder

Flexural Strength Test:

Table 7: Flexural Strength Test Results

Description	Compressive Strength (MPa)	
Prism(500x100x100) mm	7-days	28-days
Plain concrete	3.9	4.7
0.5% sisal fibre reinforced concrete Slump value=50 mm	4.0	5.8

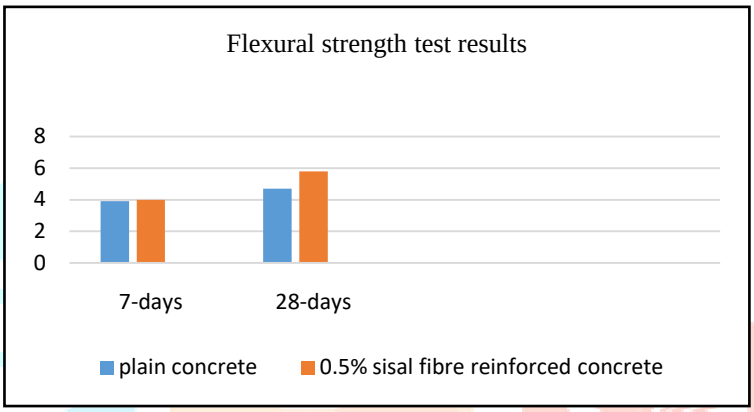

Fig 6: Flexural Strength Test Results

Fig 7: Flexure Strength Testing Of Small Beams

IX. CONCLUSION

- The study has been concluded that the compressive strength, split tensile strength and flexural strength test results shows that the strength of 0.5% sisal fibre reinforced concrete has increased gradually with respect to conventional concrete.
- Hence it is recommended that sisal fibre reinforced concrete gives better result compared to conventional concrete.
- The bond strength between sisal fibre rope of diameter (18, 27 and 36mm) and rope embedment length of (100, 150 and 200 mm) by Rope pull out test work is under progress.
- The flexural behaviour of 0.5 % sisal fibre reinforced concrete beams with sisal fibre rope work is under process.

X. REFERENCES

[1] Majid Ali, NawawiChouw . Experimental investigations on coconut- fibre rope tensile strength and pullout from coconut fibre reinforced concrete.Construction and building materials 41 (2013) 681-690.
[2]Abdul Rahuman,SaikumarYeshika**.** Study on properties of sisal fibre reinforced concrete with different mix proportions and different percentage of fibre addition.IJRET 2015.
[3]Athiappan k ,Vijaychandrakanth S.Experimental study on flexural behaviour of sisal fibre in reinforced concrete beam.(IJERT) 2014.
[4] Sathish .P, Murugesh .v.Experimental study on sisal fibre reinforced concrete with partial replacement of cement by GGBFS. International journal of science and research.(IJSR) 2015.
[5] JitendraD.Dalvi, UttamB.Kalwane, PallaviPasnur**.** Effect of fibre length and percentage of sisal on strength of concrete. MJRET (2016).