

## Study of sisal fibre reinforced concrete in lintels. Estudio de hormigón armado con fibra de sisal en dinteles.

Vinay Kumar S<sup>1</sup>, Yashasvi G V<sup>1</sup> Sudarshan S.K.<sup>3</sup>

Department of Civil Engineering, T. John Institute of Technology, India.

Corresponding author mail id: [vinni946@gmail.com](mailto:vinni946@gmail.com), [yashasvi17.gv@gmail.com](mailto:yashasvi17.gv@gmail.com),  
[sudarshansk@tjohngroup.com](mailto:sudarshansk@tjohngroup.com).

### ABSTRACT

Concrete made with Portland cement has certain characteristics: - it is relatively strong in compression but weak in tension and tends to fail quickly when subjected to Tension. The deficiency in tension can be mitigated with conventional reinforcement & to some extent by the inclusion of a sufficient volume of Fibers. Change in the behavior of the Fiber – matrix composite after it has cracked, is due to the addition of Fibers (Balasubramanyan et al. 2015) Sisal Fiber is a promising concrete composite on account of its low density, less cost, increased specific strength and modulus, zero health risk, and it is easily cultivated in few countries including India. There has been an increasing interest in finding new applications for sisal-fiber which is traditionally used for making ropes, mats, carpets, fancy articles and others. The purpose of this research is to investigate the use of sisal fibers in concrete to enhance the mechanical characteristics of concrete and compare the differences in properties of concrete containing no fibers with fibers. The correlation on the effects of different type and geometry of fibers to the concrete is also the aim of the research. The scrutiny was carried out using several tests, which contained workability test, compressive test, split tensile test & flexural test. A total of ten mix batches of concrete containing 0%, 0.6%, 0.7%, 0.8% dosage of Fiber were cast. M25 grade concrete is considered for research as this grade is seen maximum consumption in industry.

Keywords: concrete, sisal fibre, resistance.

### RESUMEN

El hormigón hecho con cemento Portland tiene ciertas características: - es relativamente fuerte en compresión pero débil en tensión y tiende a fallar rápidamente cuando se somete a tensión. La deficiencia de tensión se puede mitigar con refuerzo convencional y hasta cierto punto mediante la inclusión de un volumen suficiente de Fibras. El cambio en el comportamiento del compuesto Fibra-matriz después de que se ha agrietado, se debe a la adición de Fibras (Balasubramanyan et al.2015) La fibra de sisal es un compuesto de concreto prometedor debido a su baja densidad, menor costo,

mayor resistencia específica y módulo, cero riesgo para la salud, y se cultiva fácilmente en pocos países, incluida la India. Ha habido un interés creciente en encontrar nuevas aplicaciones para la fibra de sisal que se usa tradicionalmente para hacer cuerdas, esteras, alfombras, artículos de fantasía y otros. El propósito de esta investigación es investigar el uso de fibras de sisal en el hormigón para mejorar las características mecánicas del hormigón y comparar las diferencias en las propiedades del hormigón que no contiene fibras con las fibras. La correlación de los efectos de diferentes tipos y geometrías de fibras en el hormigón es también el objetivo de la investigación. El escrutinio se llevó a cabo utilizando varias pruebas, que incluían prueba de trabajabilidad, prueba de compresión, prueba de tracción dividida y prueba de flexión. Se fundió un total de diez lotes de mezcla de hormigón que contenían 0%, 0,6%, 0,7%, 0,8% de dosis de fibra. El hormigón de grado M25 se considera para investigación ya que este grado se considera el consumo máximo en la industria.

Palabras clave: hormigón, fibra de sisal, resistencia.

## INTRODUCTION

Concrete is a composite material consisting hydraulic cement, water, coarse aggregate and fine aggregate. The resulting material is a stone like structure which is formed by the chemical reaction of the cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. The weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks. Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete Fibers that are uniformly distributed and randomly oriented. Fibers include steel Fibers, glass Fibers, synthetic fibers and natural Fibers, each of which lends varying properties to the concrete. In addition, the character of Fiber reinforced concrete changes with varying concretes, Fiber materials, geometries, distribution, orientation and densities.

Even though the market for Fiber reinforced concrete is still small compared to the overall production of concrete, the worldwide yearly consumption of fibers used in concrete is 300,0000 tones. Concrete containing hydraulic cement, water, aggregate and discontinuous discrete fibers is called Fiber reinforced concrete. But in our project, we have to use banana Fiber and sisal Fiber. The fibers are used to reduce shrinkage cracking. Main role of fibers is to bridge the cracks that develop in concrete and increase the ductility of the concrete elements, improvement on post cracking behavior of concrete. (Karunya et al. 2019) It increases more resistance to impact loads, controls plastic shrinkage cracking and dry shrinkage cracking and lowers the permeability of concrete matrix and thus reduce the bleed.

The Portland cement concrete is a brittle material. It possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are present in concrete and its poor tensile strength is due to propagation of such micro cracks leading to brittle fraction of concrete. In plain concrete and similar brittle materials, structural cracks Develop even before loading due to drying shrinkage and other causes. When load is applied the internal cracks propagate and open up due to stress and additional cracks are formed. The development of these cracks is the cause of inelastic deformation in concrete. The addition of small closely spaced and uniformly dispersed fibers to concrete can act as a crack arrester and improves its static and dynamic properties. This is known as Fiber reinforced concrete, which can also be defined as the concrete containing fibrous materials which increases its structural performance. It contains short discrete particles fibers that are uniformly distributed and randomly oriented. The fibers are of same order of magnitude as aggregate inclusions. Addition of fibers can increase strength (Balasubramanyan et al. 2015) and also reduce plastic shrinkage and drying shrinkage by arresting the propagation of crack. The development of steel reinforcement has overcome the problem of poor tensile strength (Sathish et al. 2014). But it doesn't completely solve the problem of micro cracks due to drying and plastic shrinkage owing to weathering conditions. This led to study on research of various methods to adopt fibers as of usage of various organic and inorganic fibers which are eco-friendly and economic. According to study of natural Fibers, compared to natural inorganic Fibers, vegetable fibers (natural organic) are very much renewable, eco-friendly, economical and production cost is also very low. (Aruna et al. 2014) Hence study on vegetable fibers with respect to natural inorganic Fiber is been carried out in this project The mixes for addition of different proportions of Fiber-cement ratio of natural organic (vegetable) fibers are being compared with one of the natural inorganic fibers in concrete with respect to plain concrete for their properties.

A paper titled Compressive Strength tensile strength and flexural strength on hardened concrete of sisal Fiber and GGBS (Sathish et al. 2014) studies reinforced composite using opc cement of grade 53. The Super plasticizer was added at 0.2% by weight of the cement, Super plasticizers are added to reduce the water requirement by 15 to 20%. The Super plasticizer was added at 0.2% by weight of the cement, Super plasticizers are added to reduce the water requirement by 15 to 20%. The cement in concrete is replaced accordingly with the percentage of 10 %, 20% and 30% by weight of cement and 1% of sisal Fibers added by weight of cement The compressive strength, tensile strength and flexural strength of concrete decreased at the dosage of 30% replacement of cement by sisal and GGBS. The compressive strength, tensile strength and flexural strength of concrete increased at above or below 20% and 30% for the mix design of M30.

A paper titled Mechanical Behavior of Sisal Fiber Reinforced Cement Composites (Aruna et al. 2014) discussed mechanical response measured under tension. The high energy absorption capacity of the developed composite system was reflected in high toughness values under tension respectively. Reinforced composite using OPC cement of grade 53. Addition of sisal fibers to cement mortar matrices reduced the compressive strength by 21.36 from 23.71%. The production of sisal fibers as compared with synthetic fibers or even with mineral asbestos fibers needs much less energy in addition to the ecological, social and economic benefits.

A paper titled Use of sisal fibers in structural concrete to enhance the mechanical characteristics of concrete (Balasubramanian et al. 2015) studies a total of ten mix batches of concrete containing 0.5%, 1%, 2% dosage of Fibers. Reinforced composite using OPC cement of grade 53 is made by Adding this sisal Fiber, it has been found that there is an increase in properties of both fresh and hardened concrete. Addition of fibers of aspect ratio 300 by dosage of 0.5% shows an increase in split tensile strength as compared to conventional concrete. Addition of fibers of aspect ratio 300 by dosage of 1% shows an increase in flexural strength as compared to conventional concrete. Addition of fibers of aspect ratio 300 by dosage of 1.5% shows an increase in compressive strength as compared to conventional concrete. A paper titled Strength and Durability Evolution Sisal Fiber Reinforced (Sabari et al. 2017) uses ordinary Portland cement (OPC) of grade 53. The addition of natural sisal Fiber composites improved the workability about 29% without polymer. The increase of compressive strength, split tensile strength and flexural strength is about 13%, 15.5% and 12% for sisal Fiber concrete. The addition of the Fiber in small amounts will increase the tensile strength. Addition of fibers not only increases tensile strength but also increases bond strength, decreases permeability. Toughness of concrete also increases by the addition of the fiber. Investigation is made on a paper titled Effect on utilization of sisal finer in the concrete as the reinforcement (Karunya Latha et al. 2019) in which the fiber is mixed in different proportions by cutting it into small pieces of size 3 to 5 cm. The distinctive properties of natural Fiber reinforced concretes are improved tensile and bending strength, greater ductility and greater resistance to cracking and hence improved impact strength and toughness. Besides its ability to sustain loads. Freshly prepared Sisal Fiber contain some gelatinous chemical reagents which may affect the chemical properties of cement in concrete. When the percentage of Fiber is increased by more than 1% reduction in mechanical properties is observed. The addition of the Fiber in small amounts will increase the tensile strength. Addition of fibers not only increases tensile strength but also increases bond strength, decreases permeability. Toughness of concrete also increases by the addition of the fiber.

## MATERIAL AND METHODS

The main methodology of the study is literature review, Properties of all ingredients required for composite concrete, Mix design for M25 grade concrete for a slump of 100mm, Casting of cubes, cylinders and beams with varying percentage of sisal fibers 0 to 1% by weight of cement, Record slump value for every change of fiber % age, Curing for 28 days, Conduct compressive strength test, Carryout bending test, Carryout split tensile test, Record the values / outcome of test, Interpret the test results, Conclude the result based on the trend of result.

## RESULTS

Compressive strength is increased by 29% at 0.8% fiber mixture, however compressive strength had shown declining tendency beyond 0.8% fiber. Under two-point load test on beam specimen failure bending stress keeps on increasing with increase in % age of fibers. At 1% sisal fiber, failure bending stress is increased by 39%. Split tensile strength is found to be increased by 160% at .8% fiber addition. Further addition shows declining strength probably due to reduced workability.

Note: In beams casting fibers are placed in layer at bottom and all other tests pieces of fibers are mixed.

## REFERENCES

- Aruna M (2014). Mechanical Behavior of Sisal Fiber Reinforced Cement Composites Vol:8, No:4.
- Balasubramanian, Chandrashekar J, Senthil Selvan S (2015) Experimental Investigation of Natural Fiber Reinforced Concrete In Construction Industry. E-Issn: 2395-0056.
- Jeyanthi J, Manju S. Experimental Study on Sandwich Panel Using Sisal and Basalt Fibre" E-Issn: 2395-0056.
- Nirmal John Joy, Chippy Tresa Thomas. Effect of Sisal Fiber on Shear Strength Characteristics of Kuttanad Clay, E-Issn: 2395 -0056.
- Radha Sumithra K T, Abs Dadaphee. Experimental Investigation on the Properties of Sisal Fiber Reinforced Concrete, E-ISSN 2395-0056.
- Rajanayagam Alex, Karthikeyan L, Mukilan M, Veadhamoorthi K "A Detailed Study on Mechanical Properties of Natural Fibres" E-Issn: 2395-0056.
- Sabarish K V Strength And Durability Evaluation of Sisal Fiber Reinforced Concrete Issn : 0976-6316.
- Sathish P, Murugesh V (2014). Experimental Study on Sisal Fiber Reinforced Concrete with Partial Replacement of Cement by Ground Granulated Blast Furnace Slag, ISSN 2319-7064.

Sangeetha S P, Joanna P S. Flexural Behavior of Reinforced Concrete Beams with partial Replacement of GGBS, Volume-03, Issue-01, Pp-119-127.

Shankar Bose, Sindhu A.R. "Experimental Investigation and Model Study of Square Footing in Phosphogypsum Treated Clayey Soil Reinforced with Sisal Fibre, E-Issn: 2395 -0056.

Vikrant Dubey, Tegar J P, Impact of Sisal Fiber As A Reinforcement on The Behavior of Expansive Soil . E-Issn: 2395-0056.

Received: 15<sup>th</sup> February 2021; Accepted: 17<sup>th</sup> May 2021; First distributed: 17<sup>th</sup> May 2021