Improvement in Flexural Strength and Stiffness of Sisal Fibre Reinforced beam Specimen

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Abstract- *Flexural strength is an important property which is to be considered for the members like beams, slabs and other members. As the concrete is weak in bending tension, and cannot sustain the Tension due to bending. Cracks are developed in the concrete from the tension face , travelling towards the centre of the beam. These cracks need to be controlled by placing reinforcement, also beam at supports, lead to crack, in diagonal direction which are generally controlled by placing shear reinforcements in the form of stirrups. The enhancement in the flexural strength of the concrete leads to lesser bending thereby increasing the stiffness of beam. In the present work, the flexural strength of the beams of size 150mm x 150mm x 700mm reinforced with small sisal fibres of various lengths and different percentage volume were casted and tested for the flexural strength.. Results shows that, the fibre reinforced beams have shown the very high flexural strength and stiffness.*

I. INTRODUCTION

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.

Fibreshavebeenusedtotoughenbricks etc. since many centuries. but only since last three to four decades, the principles of fibre reinforcement of brittle materialsstarted in practice. The need for economical, sustainable, safe, and secureshelteris aninherentglobalproblemandnumerous challenges remain in order to produce environmentally friendlyconstruction productswhicharestructurally safeand durable. In recent years, a great deal of interest has been created worldwide on the potential applications of natural fibrereinforced,cementbasedcomposites. Natural fibres have always been considered promising as reinforcement of cement based matrices because of their availability, low cost and low consumption of energy.Fibers such as sisal, jute and coconut have been used as reinforcement of cementitious matrices in the form of short filament fibers. Fibers may be used as primary or secondary reinforcement in the composites like concrete.

II. SISAL PLANT AND FIBRE

Sisal is a strong leaf fibre obtained from the leaves of plant Agave sisalana. The plant is a perennial shrub that grows in the tropical and subtropical regions of the world.

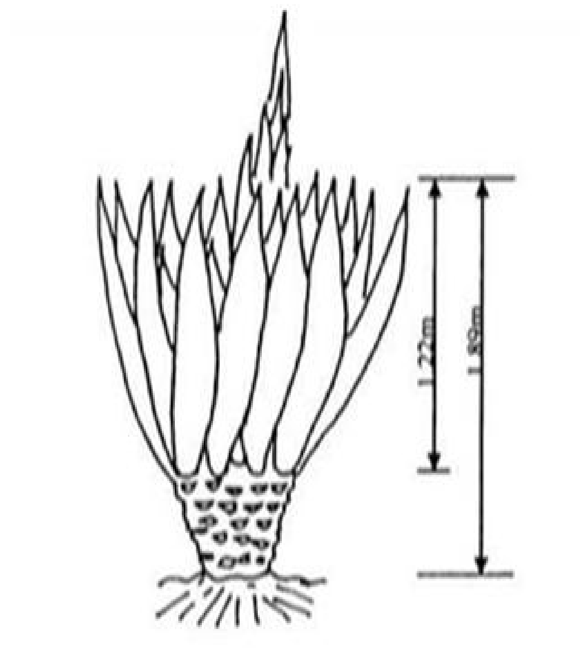

Fig.1:- Sisal Plant.

It is one of the most extensively cultivated hard fibre in the world due to the ease of cultivation of sisal plants and is quite easy to grow in all kinds of environment. The major producers of sisal fibres are: Mexico, Brazil, Tanzania, Kenya, Madagascar and china. In India, it is mainly cultivated and grown in semi arid regions of Andhra Pradesh, Bihar, Orissa, Karnataka, Maharashtra and West Bengal.

The sisal plant looks like an over grown pineapple plant with a pineapple like bowl (a short, stocky trunk). From which the leaves extend. For a matured plant, the bowl is about 50 cm in height and about 20 cm in diameter. The leaves can attain a length of up to 2 meter. The leaves which may be as broad as 12 cm are tipped with sharp, highly lignified spines of about 1 to 1.5 cm long.

The outside of the sisal leaf consists of a well developed epidermis with a wax surface. This epidermis contains cutin, waxes, and carbohydrates. Initially, all the leaves grow vertically on the plant but with age, they fan out gradually. The mature leaves are those closest to the ground containing the longest fibres.

Sisal is a natural fibre which is having enhanced mechanical properties as well as physical properties. As reinforcement in the cement based matrix has shown to be a promising opportunity. The cement matrices can consist of paste, mortar or concrete.[11]

III. FLEXURAL STRENGTH OF SISAL FIBRE REINFORCED CONCRETE

To find the strength of sisal fibre reinforced concrete,different combinations of percentage of sisal and Aspect ratio are used. Sisal percentage in M20 mix 0.5%, 1%, 1.5% and 2% are selected. Here above percentages for different Aspect ratio or length fibres were used. While casting the PCC, the fibres are randomly spread in the plastic concrete mix. Generally the average diameter of sisal fibre is about0.3 to 0.4 mm therefore the Aspect ratio used was 50, 75 and 100.With these combinations, Concrete specimensare casted, cured and tested for flexure.

Table 01: Flexural Strength at 7 days curing

Details of sisal Insertion		7 Days Strength (N/mm2)	% increase than normal concrete
%	A R		
0	0	2.95	-
0.50%	50	3.07	**4.07**
	75	3.25	**10.17**
	100	3.08	**4.41**
1%	50	4.25	**44.07**
	75	3.47	**17.63**
	100	2.94	**-0.34**
1.50%	50	4.26	**44.41**
	75	3.52	**19.32**
	100	3.61	**22.37**
2%	50	2.8	**-5.08**
	75	3.3	**11.86**
	100	3.6	**22.03**

The results for 7 and 28 days strength are tabulated in Table 6.9 below, The final Flexural strength results of beams of size 150 x 150 x 700 mm, tested in UTM with very low rate of loading are combined and analyzed. Here load rate is maintained as the cross head displacement 1mm/min.

Table 02: Flexural Strength at 28 days curing

Details of sisal Insertion		28 Days Strength (N/mm2)	% increase than normal concrete
%	Aspect ratio		
0	0	3.95	-
0.50%	50	3.82	**-3.29**
	75	5.54	**40.25**
	100	7.23	**83.04**
1%	50	5.87	**48.61**
	75	6.64	**68.10**
	100	7.13	**80.51**
1.50%	50	5.92	**49.87**
	75	6.75	**70.89**
	100	7.41	**87.59**
2%	50	6.89	**74.43**
	75	6.48	**64.05**
	100	7.03	**77.97**

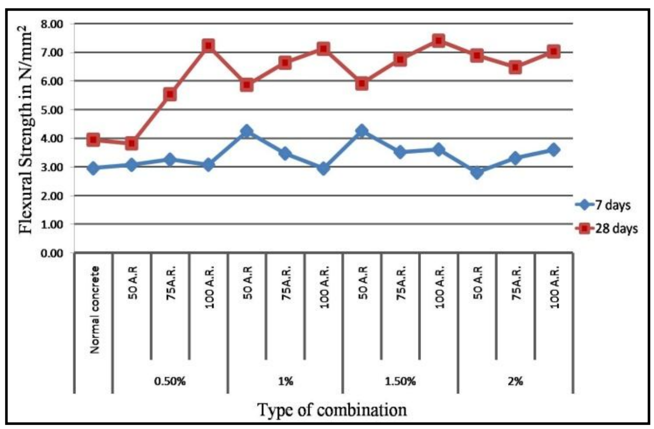

Fig. 2:- Flexure test results for variation of aspect ratios

Generally the beams at 28 days strength fail at an average deflection of about 1.5 to 1.7mm, but the loads at failure varies according to sisal percentage and aspect ratio. The stiffness of the member is calculated as load per unit deflection as shown in Table no.03.

Table 03: Stiffness at various combination

Details of sisal Insertion		28 Days Strength (N/mm2)	Deflection at failure	Stiffness (KN/mm)
%	A R			
0	0	3.95	1.6	2.47
0.50%	50	3.82	1.7	2.25
	75	5.54	1.6	3.46
	100	7.23	1.5	4.82
1%	50	5.87	1.6	3.67
	75	6.64	1.6	4.15
	100	7.13	1.6	4.46
1.50%	50	5.92	1.7	3.48
	75	6.75	1.7	3.97
	100	7.41	1.6	4.63
2%	50	6.89	1.6	4.31
	75	6.48	1.6	4.05
	100	7.03	1.6	4.39

Here the results show that, the flexural strength as well as stiffness of the beam specimens increased withthe insertion of the sisal fibres in the concrete. Here it is seen and to be noted that, the strength in each percentage group is maximum for the maximum length of fibre. For A.R. 100 in all group of percentage, the strength crosses 7 n/mm^2, also corresponding stiffness goes on increasing with the increase in the fibre length. The maximum strength is seen at 1.5% fibres with A.R. 100, however the maximum stiffness is seen at lower volume percent of fibre with the 100 A. R.

IV. CONCLUSION

- The Flexural strength results are shown to be very promising and the stiffness as well as strength of the member is increased, the stiffness increased with the 28 days results is very high, results showed that, with a very little deflection of 1.6mm the beam strength has reached up to highest crossing 7 N/mm^2
- Maximum Stiffness is seen to be as high as 4.82 KN/mm which is almost double as compared to normal concrete.

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