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An experimental investigation on sisal fibre reinforced concrete with different mix proportions

A.Hari kishore[1]and Dr.E.Arunakranthi[2]

[1]P.G. Student, Dept. of Civil Engineering, JNTUA College of Engineering , Anantapuramu, Andhra Pradesh, India

[2]Associate Professor, Dept. of Civil Engineering, JNTUA College of Engineering, Anantapuramu, Andhra Pradesh,India

***ABSTRACT**: Fibres are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact–, abrasion–, and shatter–resistance in concrete. Generally fibres do not increase the flexural strength of concrete, and so cannot replace moment–resisting or structural steel reinforcement. Indeed, some fibres actually reduce the strength of concrete.*

***In present work the amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (V_f). V_f typically ranges from 0 to 2.5% total 6 mixes are casted (Ie. 0, 0.5, 1, 1.5, 2 and 2.5 %). The aspect ratio (l/d) is calculated by dividing fiber length (l) by its diameter (d). Fibers with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. Increasing the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. However, fibers that are too long tend to "ball" in the mix and create workability problems. For all the replacement proportions, Mechanical properties such as compressive strength, tensile strength and flexural strength for various replacement proportions of fine aggregates with sisal fibres were determined*.

***KEY WORDS**: sisal fibres, compressive strength, Split tensile strength and flexural strength.*

INTRODUCTION

Sisal, with the botanical name Agave sisalana, is a species of Agave native to southern Mexico but widely cultivated and naturalized in many other countries. It yields a stiff fibre used in making various products. The term sisal may refer either to the plant's common name or the fibre, depending on the context. It is sometimes incorrectly referred to as "sisal hemp", because for centuries hemp was a major source for fibre, and others were named after it. The sisal fibre is traditionally used for rope and twine, and has many other uses, including: paper, cloth, wall coverings, carpets, and dartboards.Sisal fibre is one of the most widely used natural fibres and is very easily cultivated. It has short renewal times and grows wild in the hedges of fields and railway tracks. Nearly 4.5 million tons of sisal fibre is produced every year throughout the world. Tanzania and Brazil are the two main producing countries.

Sisal fibre is a hard fibre extracted from the leaves of the sisal plant. Though native to tropical and sub-tropical North and South America, sisal plant is now widely grown in tropical countries of Africa, the West Indies and the Far East. A sketch of a sisal plant is shown in fig.1 and sisal fibres are extracted from the leaves. A sisal plant produces about 200-250 leaves and each leaf contains 1000-1200 fibre bundles which is composed of 4% fibre,0.75% cuticle,8% dry matter and 87.25% water. So normally a leaf weighing about 600g will yield about 3% by weight of fibre with each leaf containing about 1000 fibres. The sisal leaf contains three types of fibres: mechanical, ribbon and xylem. The mechanical fibres are mostly extracted from the periphery of the leaf. They have a roughly thickened-horseshoe shape and seldom divide during the extraction processes. They are the most commercially useful of the sisal fibre.

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EXPERIMENTAL PROGRAM

Material used and their properties

Cement: Ordinary Portland Cement (OPC) ACC 53 grade available in local market of standard brand was used in investigation. OPC 53 grade confirming with IS 12269 – 1987 is used. The specific gravity is found to be 3.15.

Coarse Aggregate: Machine Crushed angular granite metal of less than 20 mm size from a local source was used as coarse aggregate. It is necessary to know the density, specific gravity and water absorption of aggregates in order to determine the mix proportions of concrete to be produced. Tests have been carried out as per the procedure given in IS 2386 (Part 3) – 1963. The specific gravity of coarse aggregate is 2.72.

Fine Aggregate: The locally available river sand was used as fine aggregate in present investigation. Fine aggregate passing through 4.75 mm IS sieve was used. It confirms to grading zone II of IS 383 – 1970. The specific gravity is fine aggregate is 2.67.

Water: The quality of water is important because its contaminants can adversely affect the strength of concrete and cause corrosion of the steel reinforcement. Potable tap water confirming to I S 456 – 2000 was used in this study for mixing and curing.

Siasal fibre: sisal fibre is one of the natural fibre available in local fields. Addition of sisal fibre content in concrete with different mixes. The used sisal fibre as shown in figure 1. The properties are showed in table 1.

Fig: 1 sample of sisal fibre

Table: 1 Physical properties of sisal fibre

Sl. No	Property	Units	Value
1	Tensile strength	Kg/cm^2	800
2	Ultimate elongation	%	3.0
3	Specific gravity	_	1.50

Compressive strength

Compressive strength results are presented below table 2 and 3 from this it can be observed that as increase sisal fibre content in concrete compressive strengths were increased up to 1.5% . for 0.5%, 1.0% and 1.5% sisal fibre reinforced concrete there is increase in compressive strength about 4.53%, 0.83% and 1.08% and for 2.0% and 2.5% sisal fibre content there is decrease in compressive strength about 4.30% and 4.25% respectively over reference concrete. The variation as shown in below fig2.

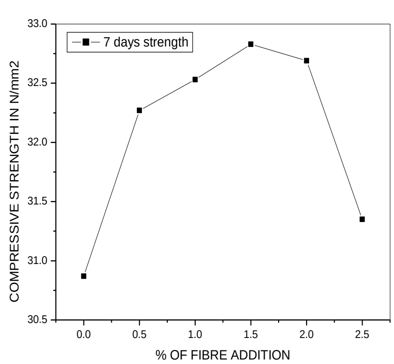


Fig: 2(a) 7 days compressive strength

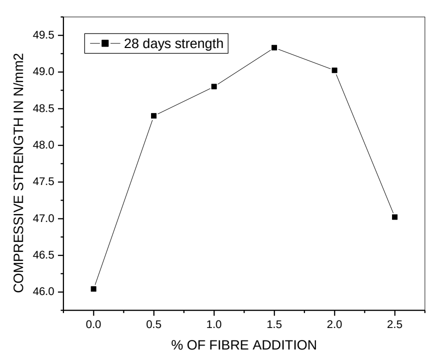


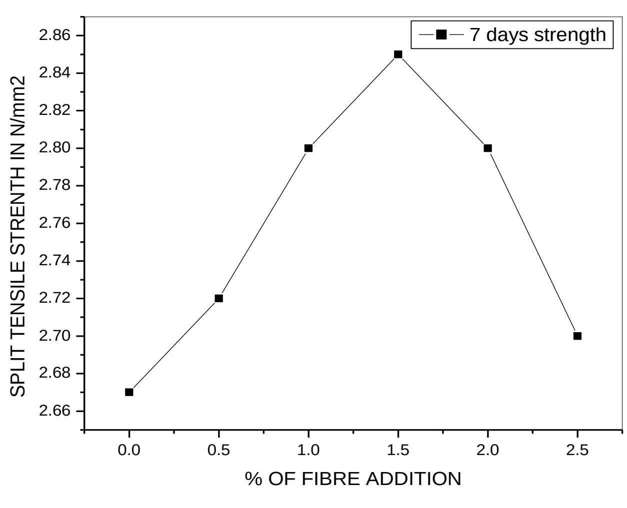
Fig : 2(b) 28 days compressive strength

Table: 2 compressive strength for 7 days and 28 days

Sl.No	% Addition of fibre	7 days average compressive Stress (N/mm^2)	% Increase / decrease compressive strength	28 days average compressive Stress(N/mm^2)	%Increase/ decrease compressive strength
1	0	30.87	_	46.30	_
2	0.5	32.27	4.53	48.40	4.53
3	1	32.53	0.80	48.80	0.83
4	1.5	32.89	1.10	49.33	1.08
5	2	32.68	- 0.64	49.02	-4.30
6	2.5	31.35	-4.24	47.02	-4.25

Split tensile strength

In split tensile strength also follows same trend, split tensile strength results are presented below table 4 and 5 from this it can be observed that as increase sisal fibre content in concrete split tensile strengths were increased up to 1.5%. for 0.5%, 1.0% and 1.5% sisal fibre reinforced concrete there is increase in compressive about 1.99%, 2.93% and 1.66% and for 2.0% and 2.5% sisal fibre content there is decrease in split tensile strength about 2.93% and 3.69% respectively over reference concrete. The variation as shown in below fig3.



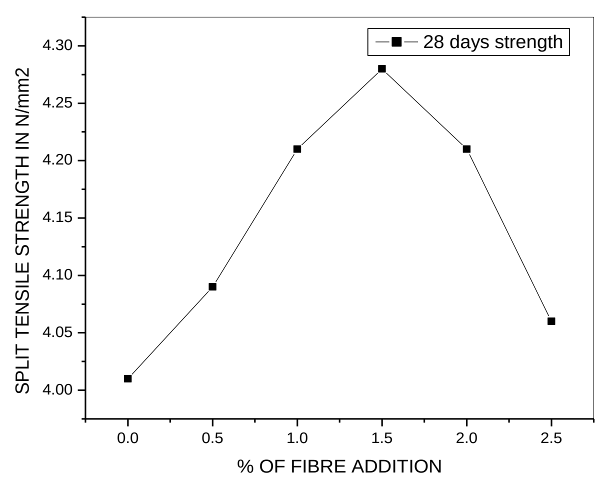


Fig :3(a) 7days split tensile strength

Fig :3(b) 28days split tensile strength

Table:4 split tensile for 7 days

Sl.No	% Addition of Fibre	7 days average tensile Stress (N/mm^2)	% Increase/ Decrease tensile strength	28 days average Stress(N/mm^2)	%Increase/ decrease tensile strength
1	0	2.67	_	4.01	_
2	0.5	2.72	1.87	4.09	1.99
3	1	2.80	2.94	4.21	2.93
4	1.5	2.85	1.78	4.28	1.66
5	2	2.80	-1.78	4.21	-2.93
6	2.5	2.70	-3.70	4.06	-3.69

Flexural strength

The 28 days flexure strength results are presented in Table 5 From these it is observed that the flexure strength increases with the increase in the percentage of sisal fibre up to 1.50% and for later replacements (2.0% and 2.5%) the flexure strengths are decreased. For 0.5, 1.0 and 1.5% of sisal fibre there is increase in flexure strength by 3.57%,4.08%and 3.3% over the nominal concrete. For 2.0% and 2.5%, the flexure strength has decreased by 2.08% and 1.47% respectively over nominal concrete. The variation as shown in fig 4.

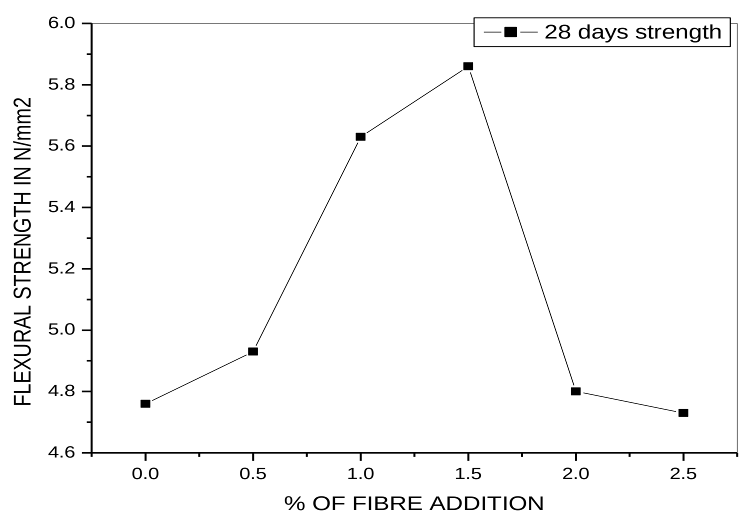


Fig:4 flexure strength for 28 days

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Table: 6 Flexural strength

S.No	% Addition of fibre	28 days average flexure Stress (N/mm^2)
1	0	4.76
2	0.5	4.93
3	1	5.63
4	1.5	5.86
5	2	4.8
6	2.5	4.73

CONCLUSION

Based on the above results of the investigation conducted on concrete with partial replacement of sisal fibre up to 2.5% by weight of cement, the followi1ng conclusions can be drawn:

1. Compressive strength of concrete is increased with the replacement of sisal fibre with cement up to 1.5% and the strengths decreased with the replacement of sisal fibre more than 25%. Hence 1.5% Cement replacement by sisal fibre is taken as optimum.
2. Split tensile strength of concrete is increased with the replacement of sisal fibre with cement up to 1.5% and the strengths decreased with the replacement of sisal fibre more than 25%. Hence 1.5% Cement replacement by sisal fibre is taken as optimum.
3. flexural strength of concrete is increased with the replacement of sisal fibre with cement up to 1.5% and the strengths decreased with the replacement of sisal fibre more than 25%. Hence 1.5% Cement replacement by sisal fibre is taken as optimum.
4. From above results it is noticed that though there is slight increase in Compressive strength, split tensile strength and flexural strength, the above replacements are acceptable and economical.

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