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Comparative Study on Conventional Concrete and Sisal Fibre Reinforced Concrete with Varying Length

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ABSTRACT

Fibre is a piece of material which is used to make a fibre reinforced concrete. Fibres are generally classified as natural fibre and artificial fibre. Natural fibre such as jute, sisal, coir, bamboo, flax, kneaf, pine, sugarcane etc. The tensile as well as the flexure strength of concrete mix can be improved by the use of fibre. Plane concrete have a very low tensile strength, less ductility and little resistance to cracking. This research work is about to study the strength of concrete by using naturally occurring sisal fibre. Sisal fibre has less deterioration when it is used in the concrete mix. Sisal fibre restrained plastic shrinkage by controlling crack development at the early stage of concrete. By using different aspect ratios and the constant percentage of fibre i.e. 1%, effect on strength of concrete cube specimen are studied. The diameter of fibre is measured by using micrometer gauge and it was found to be an average 0.5mm. Fibre is used with aspect ratios of 60, 100 and 140 with constant percentage. The materials are hand mixed with 1% addition of sisal fibre in M30 grade of concrete. The obtained specimens were subjected to tests aimed to check the compressive strength. An increase in compressive strength by 66.47 % and was observed at 1% addition of fibre in M30 grade of concrete. The fibre used in this work is extracted manually by using natural methods.

Keywords – Fibre reinforced concrete (FRC), Natural fibre, Sisal fibre, Compressive strength.

INTRODUCTION

Concrete is a homogenous mixer of cement, aggregates and water. Concrete is a brittle material which has low tensile strength, less ductility and little resistance to crack. In the plain concrete internal micro cracks are present. Significant volumetric changes in the concrete which develop internal stresses within the concrete matrix due to which micro cracks are develop in the concrete. These micro cracks present in the concrete sometimes leads to the structural failure. A homogenous mixer of cement, aggregate, water and discontinuous discrete fibres is known as fibre reinforced concrete. The discontinuous discrete fibres present in the concrete mix resist to the propagation of cracks. When the fibres are added to the concrete it increases so many mechanical properties such as toughness, ductility, tensile as well as flexural strength etc. In the ancient time fibre reinforced composite are made with naturally occurring fibre such as straw and horse hair etc.

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Sisal is easy to cultivate and widely used natural fibre to make fibre reinforced concrete. Sisal is a renewable source of fibre. Sisal fibre is a natural fibre which is extracted from leaves of plant which is known as Agave sisalana. Sisal is a perennial shrub which is grown in the tropical and subtropical region. The soft tissue present on the leaves is scrapped from the fibre by hand or machine. Fibres are dried and brushed to remove dirt to obtained clean fibre. The fibres obtained from sisal are sturdy and strong. Sisal is a good reinforcing material because it is easily available, low cost, high specific strength. Sisal plant are easily and abundant available in India, especially in the southern region like Andra Pradesh, Karnataka, Tamilnadu and Kerala.

The aim of this study is to find out the effect of length of fibre on the strength of concrete. Most of the study is done with the different percentage of fibre.

Figure 1: Sisal plant

OBJECTIVE OF THE WORK

The following are the objective of project work

1) To find the significant of strength due to a variation of sisal fibre length.
2) To find out the value of compressive of the specimen with different length of sisal fibre.
3) To compare and choose the optimum length of sisal fibre contents in concrete structure respects to its compressive strength.

SCOPE OF THE WORK

The scope of our work is as follows:

In order to achieve the objective of this study, a compression test was implemented which was accordance to the universal testing machine (UTM) for cube with appropriate loading bearers. The concrete grade M30 was used during the preparation of the concrete mixture for the usage of normal concrete as well as FRC. In this study, the sisal fibre was used in incorporated with the normal concrete that contain normal composition and proportion of concrete materials which are cement, aggregates, and water.

Total 24 cubes of concrete were prepared for this study. The proposed size for the cube is 150mm x 150mm x 150mm. For the cube specimen, compression test for 7 days and 28 days is conducted.

MATERIALS USED

Cement

Ordinary Portland cement (OPC) of 53 grade confirming to IS: 12269-1987 is used to prepare concrete mix. Properties of cement are as follows;

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Table 1: Properties of cement

Sr. No.	Property	Value
1	Type of cement	OPC
2	Specific gravity	3.15
3	Initial setting time	30 min.
4	Final setting time	600 min.

Aggregate

The fine aggregate used was river sand without any impurities and confirming to IS: 383-1970. The course aggregate was obtained from local crushing plant. Physical properties of fine and coursed aggregate are given in the following table.

Table 2: Properties of course and fine aggregate

Sr. No	Property	Value
1	Type of sand	River sand
2	Specific gravity of sand	2.6
3	Specific gravity of CA	2.66
4	Grading	Zone III
5	Water absorption of FA	2.32%
6	Water absorption of CA	1.57%

Water

Potable water is used for the mixing and curing, which is free from impurities like oils, acids, alkalis, sugar, salts and organic materials or other substances that may be deleterious to concrete or steel and confirming to IS: 456-2000.

Sisal fibre

Sisal is a long, soft, shiny fibre obtained from leaves of sisal plant. The fibre used in this work is naturally occurring fibre without any prior treatment. Leaves of sisal plant are cure for 10 days and then the fibres are obtained by removing the soft tissue from the fibre. Then the fibres are dried for one day and brushed to remove dirt, to get clean fibre. For the comparative study three different lengths of fibre are used i.e. 3cm, 5cm and 7cm. To obtain the require length fibres are cut using scissor and then these fibres are mixed with other material to produce fibre reinforced concrete.

Figure 2: Sisal fibre

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Table 2: Properties of sisal fibres (Mukherjee & Satyanarayana, 1984)

Diameter (µm)	Density (g c^{-2})	Cellulose (%)	Lignin (%)	1/d ratio*	Cell wall thickness(μm)	Microfibrillar Angle (deg)
100-300	1.450	70	12	100	12.5	20-25

MIX PROPORTION

Mix design is the process of selecting the ingredients of concrete and determining their relative proportions to produce a homogenous mixer of concrete. The object of mix design is to achieve stipulated minimum strength and durability.

Table 3: Mix proportion of M30 grade of concrete

Sr. No.	Cement (Kg)	FA (Kg)	CA (Kg)	Water (Kg)	Fibre (Kg)
1	36.48	49.44	91.92	14.6	0.273

CASTING AND TESTING OF SPECIMEN

Based on the design four batches were prepare by using M30 grade of concrete; One for normal mix and three for different length of fibres i.e. for 3mm, 5mm and 7mm. For the four mixes cube (150mm x 150mm x 150) are casted. To take an average three were casted for each mix and for each test. The test was conducted on 7 days and 28 days after casting and curing of specimen.

RESULT AND DISSCUSSION

Workability of concrete

Workability is the ease with which concrete can be handled and placed. It is the behaviour of concrete from mixing to till finishing. To check the workability of concrete slump cone test was conducted. Figure shows the shape of slump and it is true slump which indicates the concrete having good workability. The 1% addition of fibres does not affect the workability of concrete. Also visual observation was made to assess appearance, segregation and uniformity of concrete mix. Form the observation, mix was uniform and has no bleeding or segregation. It was also observe that sisal fibre thoroughly and uniformly distributed in the mix.

Figure 3: Slump cone test

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Compressive test on concrete

There are total 24 cubes are tested by using Universal Testing Machine (UTM). The compressive strength is obtained for 7 days and 28 days. Following table shows the results of the compression test.

Figure 4: Compression test

Table 3: Compressive strength results

Specimen	Normal concrete		FRC with 3cm fibre		FRC with 5cm fibre		FRC with 7cm fibre	
	7 days	28 days	7 days	28 days	7 days	28 days	7 days	28 days
Cube no. 1	23.58	30.25	34.91	45.75	32.90	43.18	30.24	39.77
Cube no. 2	23.15	29.92	34.48	45.20	33.13	42.86	30.92	40.20
Cube no. 3	23.81	30.94	35.03	46.12	32.84	42.04	30.61	39.98
Average	23.51	30.37	34.81	45.69	32.96	42.69	30.59	39.98

From the results it was observed that increase in the compressive strength by the addition of 1% sisal fibre. It was also observe that slightly decrease in strength of 7cm fibre. Plain cement concrete is brittle material and it does not resist the formation of crack. When the fibre is added to the concrete it increases the toughness and other mechanical properties. Fibre has tendency to reduce crack formation and it act as a barrier when stresses are produced in the hardened concrete.

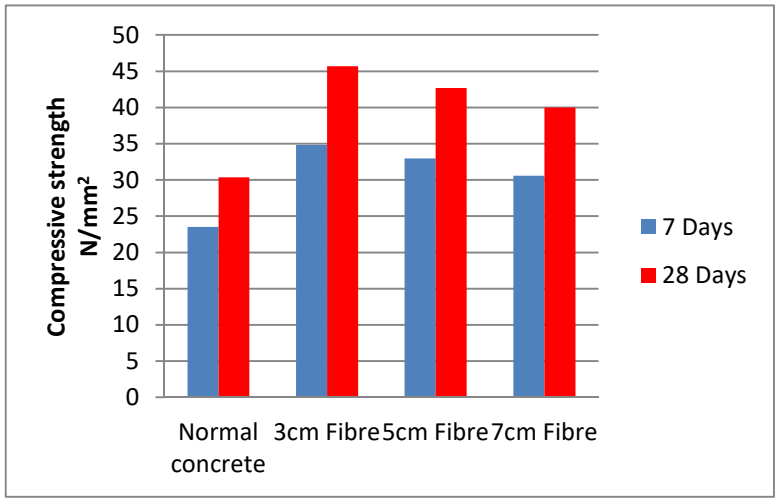

Chart 1: Graphical representation compressive strength

CONCLUSIONS

From the summery of this experimental work it is clear that addition of sisal fibre improve the strength of concrete. The addition of 1% fibre does not affect workability of concrete. Also it was observed that minimum fibre length gives higher strength and it decreases as the length of fibre increases. For aspect ratio 50-100 gives maximum strength and if the aspect ratio increases above 100 then strength of concrete decreases. Maximum strength observed at 1% with aspect ratio 60 which is 66.47 % more than the average compressive strength of normal concrete.

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