Study on Strength of Sisal Fiber Reinforced Concrete with Addition of Fly Ash

V.Praveen kumar[1], M.Yeswanth[2]
[1]Dept of Civil Engineering
[2]Assisstant professor, Dept of Civil Engineering
[1, 2] Nandha Engineering college, Perundurai.

Abstract- *In this current era, there are some concerns of using synthetic fibres in regards to their impact on the environment since they are non-recyclable and non-degradable. There are many attempts by various groups of engineers and researchers to use natural fibres in engineering applications, in the hopes of replacing synthetic fibres with natural fibres. Natural fibres are used since many centuries for different purposes since the beginning of civilization. They have been used for ropes, toughening of pots etc since many centuries. Natural fibers are of two types. Natural inorganic fibers such as Basalt, Asbestos etc and the other are the natural organic fibers such as coconut, palm, kenaf, jute, sisal, banana, pine, sugarcane, bamboo etc. The natural fibers are investigated by different researchers as construction materials that can be used in cement paste/mortar/concrete. The present work is carried out to evaluate the compressive, Tensile as well as Flexural strength of concrete using sisal fibres as reinforcement. By using fibre percentage, effect on strength of concrete specimen for various combinations is studied. The fibre diameter was first observed through micrometer gauge and was seen to be average 0.3mm. Fibres used with percentage of 0.05%, 0.1%, 0.15% and 0.2% were used for the work. Normal M25 mix was used for the study. The experimental work was carried out for three different combinations. The obtained specimens were subjected to tests ai med to check the compression, split tension and flexural strength.*

I. INTRODUCTION

In recent years, there is an increase in interest in the development of natural fibres for industrial applications by engineers and researchers. Many efforts are focused on the possibility of replacing natural fibres with the more conventional synthetic fibres, such as glass, carbon and aramid. Sisal fibres possess good properties, suitable to be used as engineering materials. These properties include high strength, low weight, corrosion resistance, low cost, less health hazards, and obtained from renewable resources. A particular interest for the use of natural fibres is in the form of reinforcing fibres in composite materials.

Concrete is a brittle material. It possesses a low tensile strength, ductility and very 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.

Fly Ash in concrete as a partial replacement is gaining huge importance these days. Fly ash can be a cost effective substitute for Portland cement in many markets. Fly Ash is similar to cement in which both are having same cementitious behaviour and properties. The pozzolanic nature in fly ash makes to act like cement. Fly ash is a group of materials that can vary significantly in composition. Fly ash is a by-product of burning pulverized coal in an electrical generating station. Fly ash requires less water than Portland cement and is easier to use in cold weather. The physical, mineralogical and chemical properties of fly ash are involved in concrete strength. Fly ash is also recognized as an environmentally friendly material because it is a by-product.

Sisal fibre and Fly Ash are better in environmental compatibility and bio degradability over other conventional materials. M-Sand is a replacement material for fine aggregate. It is a substitute of river sand for concrete construction. M-Sand is produced from hard granite stone by crushing, now a days they are used widely. Due to high cost of natural sand and also there are some specific features in addition to it. By using these natural, waste and low-cost components this study is conducted and find out the strength, workability and also about the drawbacks of this combinations.

II. MATERIALS USED

A) CEMENT

Cement is basically used as a binding material for concrete. Here ordinary Portland cement of grade 45 (chettinad brand) is used. The properties of cement are shown in Table No: 2.1.

Table 2.1 Properties of cement

S. No	Test	Values
1	Specific gravity	3.12
2	Consistency of cement	34%
3	Initial setting time	36 min
4	Final setting time	575 min

B) FLY ASH

Fly ash is a pozzolona which is a fine material which in itself is not cementitious but reacts with lime in the presence of water, under ambient condition and forms hydrated mineralogy akin to that OPC. In this study, low calcium class F fly ash obtained from Tuticorin Thermal Power Plant, Tamil Nadu was used. The properties of Fly Ash are presented in Table No: 2.2.

Table 2.2 Properties of Fly ash

S.No	Test	Values
1	Specific gravity	2.80
2	Fineness modulus	3.25%

C) MANUFACTURING SAND (M SAND)

M Sand is used as a fine aggregate in this study. The sand used for experimental program was locally procured. M sand is known as manufactured sand. It is crushed aggregate produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillarity etc. Usage of M-Sand can drastically reduce the cost since like, river sand; it does not contain impurities and wastage. In international construction scenario, no river sand is used at all, only sand is manufactured and used, which gives superior strength and its cubical shape ensures significant reduction in the cement used in the concrete. In the present study, the different properties of M sand are depicted in the Table 2.3.

Table 2.3 Properties of Fine Aggregate

S.No	Test	Values
1	Specific gravity	2.55
2	Fineness modules	2.65%
3	Water absorption	1.50%

D) COARSE AGGREGATE

Coarse aggregate for the works should be crushed stone or rock. Locally available coarse aggregates were used in this work. Their size vary is from 4.75 mm to 20 mm these tend to improve quality and bond characteristics generally results in higher flexural strength of the concrete. The specific gravity, fineness modules and water absorption of coarse aggregate are tested and values are represented in Table 2.4.

Table 2.4 Properties of Coarse Aggregate

S.No	Test	Values
1	Specific gravity	25.6
2	Fineness modules	7.25%
3	Water absorption	0.58%

E) SISAL FIBRE

Sisal is a species of Agava. The material is chosen to improve the various strength properties of the structure to obtain sustainability and better-quality structure. Short discrete vegetable fibre (sisal) was examined for its suitability for incorporation in cement concrete. Fibre was brushed lined up and cut to obtain 4cm length and get mixed with concrete mixture. Vegetable fibre requires only a low degree of industrialization for their processing and in comparison, with an equivalent weight of the most common synthetic reinforcing fibres. In the present study 2%, 4% and 6% of sisal fibre is constantly used in all mix. Properties such as specific gravity, tensile strength and density of Sisal Fibre were tested and resulted in Table 2.5.

Table 2.5 Properties of Sisal Fibre

S.No	Test	Values
1	Specific gravity	1.35
2	Tensile strength	348 to 375 N/mm^2
3	Density	1.25 g/cm^3

III. EXPERIMENTAL WORKS

A) CONCRETE MIX PROPORTIONS

The mixes were designed in accordance with IS 10262-2009 mix design method. Based on the result, the mix proportions M40 is designed. Concrete mix with the W/C ratio of 0.40 is prepared. The details of mix proportion and materials required for $1m^3$ of concrete.

Table 3.1 Material required for 1M3 of concrete

Water (Litres)	Cement in (kg/m³)	Fine aggregate in (kg/m³)	Coarse aggregate in (kg/m³)
180	450	625	1085
Ratio	1	1.38	2.41

3.1 WORKABILITY OF FRESH CONCRETE

3.1.1 GENERAL

This chapter describes the workability characteristics of fresh concrete and static experimental results of beams. The behavior throughout the static test to failure is described using recorded data on deflection behavior and the ultimate load carrying capacity. The crack patterns and the modes of failure of each beam, ductility, stiffness, percentage of reduction in stiffness, energy Absorption and energy ductility were discussed.

Table 3.1: Relation between Workability and Slump

Workability	Compaction Factor	Slump (mm)
Very Low	0.78	0 - 25
Low	0.85	25 - 50
Medium	0.92	50 - 100
High	0.95	100 - 175

3.2 BATCHING

This process was done by prepare the mixture compounds through taking the specific weights depend on size of the mix, a sample of Batching process.

3.4 CURING OF SPECIMEN

After 24 hours of casting, the specimens were de-moulded and placed in water tank and allowed for curing. Curing is an important process to prevent the concrete specimens from losing of moisture while it is gaining strength. After 7 days and 28 days of curing, the specimens were taken out from water and allowed it for drying and hardened properties test of M40 conventional concrete were carried out.

IV. RESULTS AND DISCUSSION

4.1 TESTS ON HARDENED CONCRETE

One of the purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength. Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works were conducted the compressive strengthen test on cubes for 7 days and 28 days compressive strength, modulus of rupture test conducted on the prism and split tensile strength were conducted on the cylinder, and flexural strength test conducted on the reinforced concrete beam.

4.1.1 COMPRESSIVE STRENGTH

From the compressive strength results obtained for both 7 days and 28 days it was observed that the compressive strength increased by adding 0.15% of sisal fibre and there was a decrease in strength upon further addition in percentage of sisal fibre in concrete. Hence 0.05%, 0.1%, 0.15% and 0.2% addition of sisal fibre in volume of cement in concrete was considered as optimum. The 7th day, 14th and 28th compressive strength of concrete for addition of sisal fibre in volume of cement by various percentage is shown in Table 4.1.

Table 4.1 Compression Strength

S.NO	Description	7 Days	28 Days
1	CSP=Conventional Specimen	30.48	41.25
2	SP1-0.05%	32.4	42.63
3	SP2-0.1%	33.64	43.46
4	SP3-0.15%	37.18	48.67
5	SP4-0.2%	35.85	46.49

4.1.2 SPLIT TENSILE STRENGTH OF CONCRETE

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. To determine the splitting tensile of concrete.

Table 4.2 Split Tensile Strength

S.NO	Description	7 Days	28 Days
1	CSP=Conventional Specimen	3.81	5.27
2	SP1-0.05%	3.94	5.48
3	SP2-0.1%	4.01	5.56
4	SP3-0.15%	4.15	5.69
5	SP4-0.2%	4.06	5.62

4.1.3 FLEXURAL STRENGTH

Prism is used to find out the flexural strength of concrete. Flexural strength is tested in Universal Testing Machine. As reported in Table 7.3, the flexural strength is increased with increase percentage of sisal fiber is 0.15% and decrease with consequent addition of Sisal fiber.

Concrete are strong in compression but weak in tension, so we are addition of sisal fibre it was given more tensile strength. The flexural strength was result obtained for 7 and 28 days. The illustrated result of flexural strength was shown in Table.4.3.

Table 4.3 Flexural Strength

S.NO	Description	7 Days	28 Days
1	CSP=Conventional Specimen	2.34	3.58
2	SP1-0.05%	2.57	3.75
3	SP2-0.1%	2.92	3.89
4	SP3-0.15%	3.26	4.02
5	SP4-0.2%	3.13	3.94

4.1.4 FLEXURAL STRENGTH OF RCC BEAMS

RCC beams were cast for controlled concrete and M40 grade concrete with 5% addition of fly ash and tested For M40 grade concrete RCC beam, the initial crack load was found as 95 kN, the ultimate load was found as 140 KN. The maximum deflection at L/2 was found as 13.81 mm and for 0.15% of sisal fibre RCC beam, the initial crack load was found as 120 KN, the ultimate load was found as 180 KN, and the maximum deflection at L/2 was found as 14.93 mm. The results are shown in Table 4.5

4.1.4.1 Modes of Failure

- All reinforced concrete beams failed in flexural zone.
- After the first crack load, the reinforcement started yielding and more number of cracks have formed in the flexural zone and extended towards the point loads with the increment in loads.
- At the ultimate load, the failure of all reinforced concrete beam occurred with crushing of concrete in compression zone.
- In control specimens are more number of cracks formed in flexural zone
- In SP3(0.15% sisal fibre) specimen are less number of cracks formed in flexural zone. It indicates the sisal fibre is contributing to the strength and stiffness of beam.

4.1.4.2 Flexural Behaviour of RCC Beams

The flexural behaviour of RCC beams for M40 grade concrete and M40 Concrete with 0.15% addition of sisal fibre in volume of cement were detailed in Table 4.1.4 Siffness at yield load and ultimate load, and deflection ductility were calculated and compared.

Table 4.1.4 Flexural Behavior of RCC Beams

S. No	Parameter	M40 RCC Reference concrete	M40 concrete adding 0.15% of sisal fibre in volume of cement
1.	Initial crack load (kN)	95	120
2.	Ultimate load (kN)	140	180
3.	Ultimate deflection (mm)	13.81	14.93

V. CONCLUSION

From the summary of this experimental work, the following conclusion.

1. Workability decreases with increase in percentage of sisal fibre.
2. Modulus of rupture decreases with increase in percentage of sisal fibre.
3. The optimum percentage of sisal fibre for maximum strengths (Compressive, Split Tensile and Flexural) was found to be 0.15% for M40 grade of concrete.
4. The reinforced concrete beams externally reinforced with sisal fibre fabric is to be mainly improve

strength when compared with the conventional concrete.

REFERENCES

[1] F. Silva and Dr. R. D. T. Filho (2004) “Sisal fibre reinforcement of durable thin walled structures”.
[2] R. S. P. coutts& P. G. Warden (1992) “Sisal Pulp reinforced cement mortor”.
[3] H. S. Ramaswamy, B. M. Ahuja and S.Krishnamoorthy (1983) “Behaviour of concrete reinforced with sisal, jute, coir and bamboo fibres”.
[4] P. Loganathan, Dr. G. S. Thirugnanam (2015) “Experimental study assessing the strength and crack resistant characteristics of sisal fibre reinforced concrete”.