

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 2, February 2019

Experimental Investigation of Sisal Fibre Concrete by Using Fly Ash

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ABSTRACT: Cement is commonly used binder material for concrete in construction industry and also day by day increase the concrete materials rate so in this project we are reduce the materials quantity. This experimental investigation is the fully replacement of fine aggregate by M sand, partial replacement cement by fly ash and addition of sisal fibre components in effective way. The sisal fibre is constant amount of 1% and the partially replacement of fly ash 5%, 10%, 15% and 20% respectively. The water reduces agent or super plasticizer used 1.5% (conplast). The specimens are tested after curing periods like 3days, 14days and 28days respectively finally the test results are compared to the conventional concrete. We are achieved optimum strength in 15% replacement of fly ash. The grade of concrete we are used M35.

KEY WORDS: Fly ash, Sisal fibre, M-sand, Super plasticizer.

I. INTRODUCTION

Natural fibre has special appeal in the field of civil Engineering. Natural fibres are a good reinforcing material. Sisal fibre is a promising reinforcement for use in composites on account of its low cost, easy availability, low density, no health hazards, renewability and high specific strength and modulus. The structure and properties of sisal fibre have been investigated by several researchers. Sisal fibre in reinforced concrete composite over other conventional material seems largely from their higher specific strength, stiffness and fatigue characteristics which enable structural design to be more versatile.

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.

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II. RELATED WORKS

K.V.Sabarish, K.Dhanasekar, R.Ancil (Sep 2017) “Strength and Durability evaluation of sisal fibre reinforced concrete” The addition of natural fibre composites improved the workability about 29% without polymer. Addition of fibres not only increases tensile strength but also increases bond strength, decreases permeability.

Aggregate Research Industries (ARI) (Feb 2016) “What’s the allowable fly ash limit” The International Building Code limit the maximum fly ash content to 25% if the concrete will be exposed to deicing chemicals. This restriction applies only to deicer exposure.

Vinod Goud, Niraj Soni, Goutam Varma, Kapil Kushwah, Sharad Chaurasia, Vishwajeet Sharma (Oct 2016) “Partial Replacement of Cement with Fly Ash In Concrete And Its Effect” The 10 and 20% replacement of cement with fly ash shows good compressive strength for 28 days and above 30% replacement ultimate compressive strength of concrete decreases.

Abdul Rahuman, Sasikumar yeshika (Mar 2015) “Study on Properties Of Sisal Fiber Reinforced Concrete With Different Mix Proportions And Different Percentage Of Fiber Addition” The increase in tensile strength for M25 mix design with 1% and 1.5% addition of fiber. It is concluded that 1.5% addition of fiber will give better strength.

Athiappan. K, Vijaychandrakanth. S (May 2014) “Experimental Study on Flexural Behaviour of Sisal Fibre in Reinforced Concrete Beam” The energy ductility is higher for 0.3% of sisal fibre in volume of cement specimen. Thus the 0.3% of sisal fibre specimen improves the ductility performance of the concrete beam.

III. MATERIALS USED

A) CEMENT

Cement is basically used as a binding material for concrete. Here ordinary Portland cement of grade 53 (chettinad brand) is used. The properties of cement are shown in Table No: 3.1.

Table 3.1 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: 3.2.

Table 3.2 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

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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 3.3.

Table 3.3 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 3.4.

Table 3.4 Properties of Coarse Aggregate

S.No	Test	Values
1	Specific gravity	2.65
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, 1% 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 3.5.

Table 3.5 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

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IV. EXPERIMENTAL WORKS

A) MIX DESIGN PROPORTION

Grade of concrete and Water cement ratio used here is M35 and 0.45 respectively. The mix ratio adopted for the study is given in Table 4.1.

Table 4.1 Material required for 1M³ of concrete

Water in litres	Cement in kg	Fine aggregate in kg	Coarse aggregate in kg
158	351	745	1162
Ratio	1	2.12	3.30

B) PREPARATION OF TEST SPECIMENS

According to specimens 3 different shape moulds with appropriate sizes are used. Cube (150 mm x 150 mm x 150 mm) for compressive test, Cylinder (150 mm x 300 mm) for split tensile test and prism (500 mm x 100 mm x 100 mm) for flexural test were casted for each mix. A set of 3 specimens as an average has been prepared for each mix and for each test. These casted specimens are then cured and then tested for after curing period 3,7 and 28 days.

V. RESULTS

A) COMPRESSIVE STRENGTH

The cube is tested to find out the compressive strength of concrete. The result of compressive strength values for the tested specimen is listed in Tables 4.2 for specimen having different percentage of fly ash.

Table 4.2 Compressive Strength of concrete with different percentage of Fly ash

S.No	Percentage of fly ash in %	Compressive strength in N/mm ²		
		3 days	7 days	28 days
1	0	14.66	26.88	36.63
2	5	16.36	29.23	38.92
3	10	17.98	32.10	42.63
4	15	19.52	36.63	46.31
5	20	15.68	31.25	41.45

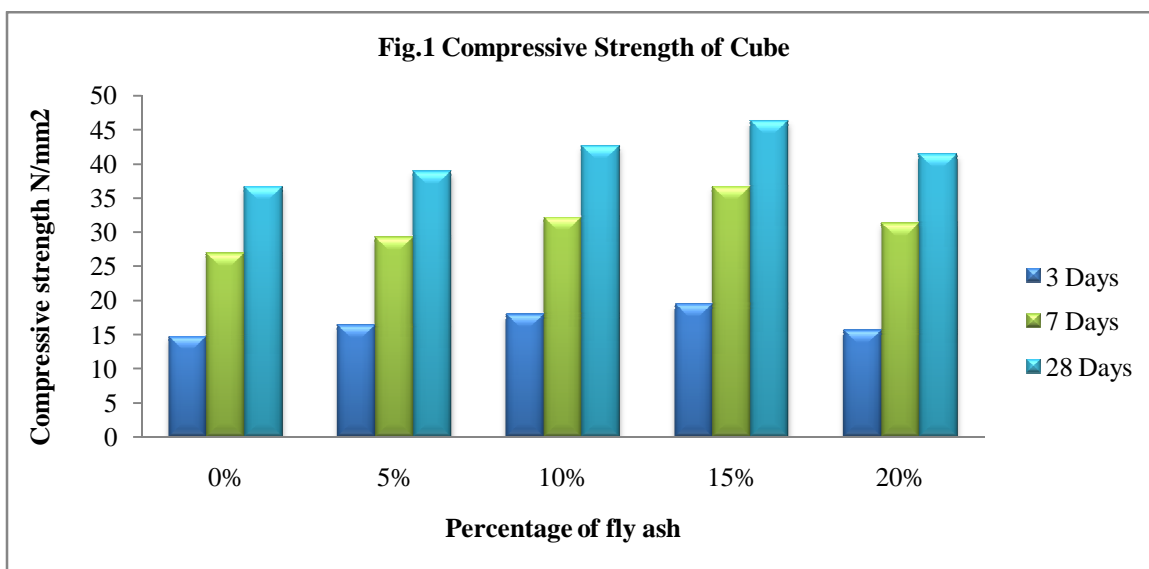
The result of the compressive strength was obtained for 3 days, 7 days and 28 days. It was observed that the compressive strength increased by adding 5% of fly ash up to 15% and there was a gradual decrease was noticed in strength in further addition of percentage of fly ash in concrete. The illustrated result of Compressive Strength was shown in Fig.1.

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B) SPLIT TENSILE STRENGTH

For split tensile test cylindrical specimen is used which got placed horizontally. This test also conducted in Compression Testing Machine and test results are tabulated in table 4.3.

Table 4.3 Split Tensile Strength of concrete with different percentage of Fly ash

S.No	Percentage of fly ash in %	Split tensile strength in N/mm ²		
		3 days	7 days	28 days
1	0	1.37	2.23	3.43
2	5	1.40	2.82	3.56
3	10	1.56	3.33	3.92
4	15	1.70	3.52	4.25
5	20	1.51	3.02	3.78

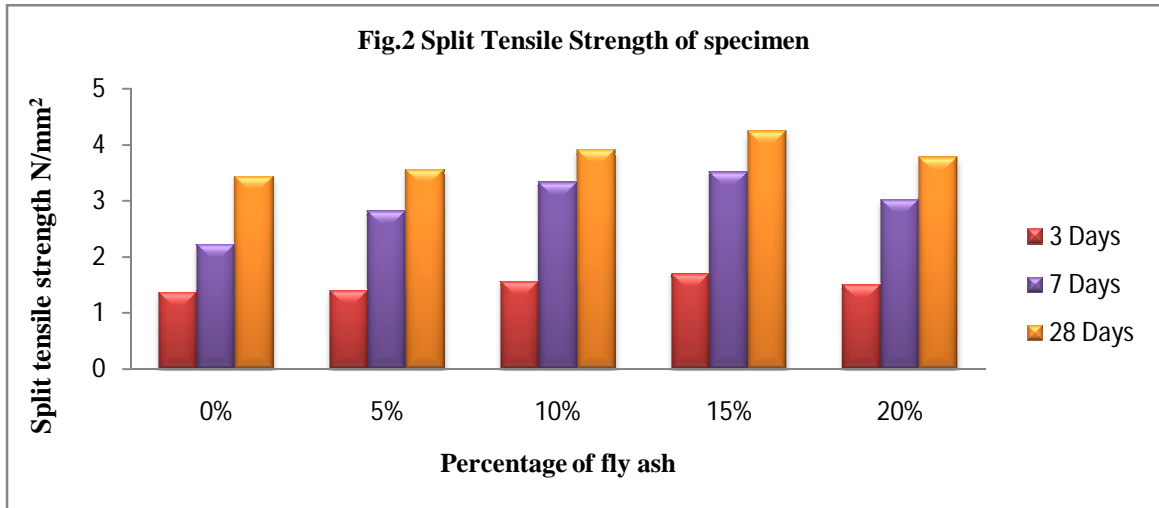
The result of the Split tensile strength was obtained for 3 days, 7 days and 28 days. It was noticed that the optimum strength was in 15% of fly ash. The results of Split tensile strength as illustrated in Figure 2.

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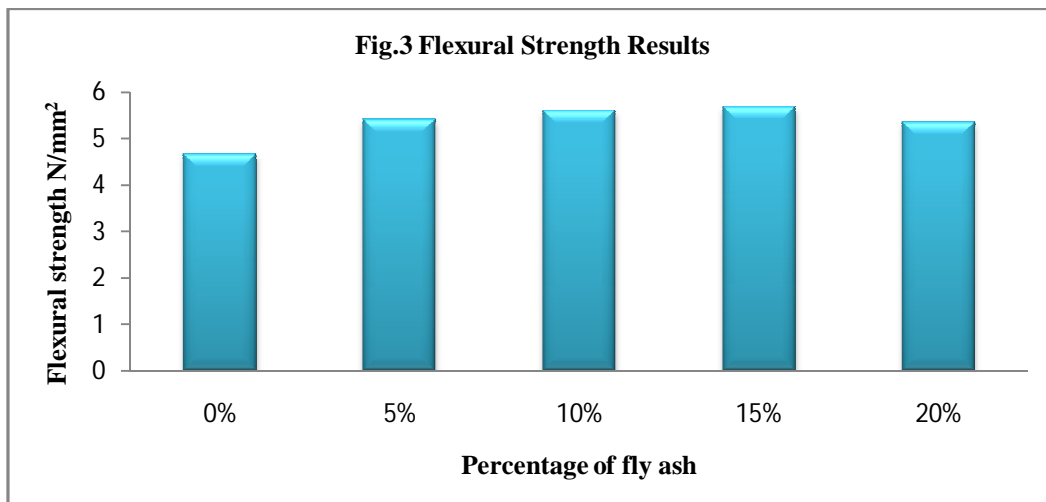
C) FLEXTURAL STRENGTH

Prism is used to find out the flexural strength of concrete. Flexural strength is tested in Universal Testing Machine. As reported in Table 4.4, the flexural strength is increased with increase percentage of Fly ash upto 15% and decrease with consequent addition of fly ash.

Table 4.4 Flexural Strength Result in N/mm² at 28 days

Control Sample	5% of Fly ash	10% of Fly ash	15% of Fly ash	20% of Fly ash
4.68	5.42	5.62	5.69	5.36

Concrete are strong in compression but weak in tension, so we are addition of sisal fibreit was given more tensile strength. The flexural strength was result obtained for 28 days. The illustrated result of flexural strength was shown in Figure.3.



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VI. CONCLUSION

This experimental investigation helps in the development of high strength concrete structures. The test results are discussed as following.

- ✚ Fly ash as a partial replacement of cement and it reduces the usage of cement amount in effectively manner.
- ✚ We are got the optimum strength in 15% of fly ash replacement.
- ✚ Sisal fibre 1% is increases the durability of high strength concrete and prevent creep and shrinkage cracks.
- ✚ M sand reduces the total cost of river sand and gives the same level of strength which is a more better replacement material for fine aggregate.
- ✚ Super plasticizer decreases the amount of water intake and supports the mixture well.
- ✚ Finally concluded that the M35 grade of concrete is gives high strength and it can be help to further investigation.

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