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Effect of Agave Fiber on the Strength Properties of Concrete with Fly Ash

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***Abstract*- Concrete is the most widely used construction material in the world. It is used in all types of infrastructure applications because it offers considerable strength. Concrete is strong in compression, weak in tension and has some brittle characteristics. In order to overcome the weakness, regular concrete is therefore normally reinforced with steel bars. Researchers have attempted to enhance the tensile property by addition synthetic fibers, but as they are expensive, we are attempting to use the natural fibers to incorporate tensile strength in conventional concrete. Agave (sisal) was examined for its suitability for incorporation in cement concrete. The physical property of this fiber has shown no deterioration in the concrete medium. Fibers were brushed and lined up and cut to obtain 4cm length for required aspect ratio. Attempt was made to analyze the suitability of partial replacement of cement with fly ash infused with natural fibers thereby utilizing the industrial waste in concrete. Materials were mixed with agave fibers of 2%, 4%, 6% and 8% of volume of concrete for M20 mix grade and casted in cubes, cylinders and beams. The strength parameters like compressive strength, Split Tensile Strength and Flexural Strengths were analyzed.**

Keyword:- Agave Fibers, Industrial waste, Split Tensile Strength, Flexural Strength

1. INTRODUCTION

1.1 General

Concrete is one of the most versatile building material. It can be cast to fit any structural shape from a cylindrical water storage tank to a rectangular beam or column in a high-rise building.

The science of incorporating one or more materials in concrete to improve strength and satisfy design requirements is not new. Mostly concrete is reinforced with steel bars. Over the years scientists have been doing research on reinforcing concrete with fibers. The approach of replacing steel by

incorporating the natural fibers in concrete is termed as Natural Fiber Reinforced Concrete (NFRC). Flexural tests show that agave fiber composites have a higher flexural strength and modulus, due to improved fiber interaction. It was demonstrated that the standard deviation has decreased with an increase diameter of fibers. Addition of fiber reinforcement in discrete form improves many engineering properties of concrete. The use of fibers in reinforced concrete flexure members increases ductility, tensile strength, moment carrying capacity and stiffness. The fibers improve post cracking behavior.

1.2 Fiber

Fibers are a class of hair-like materials that are continuous filaments or are in discrete elongated pieces, similar to pieces of thread. They can be used as a component of composite materials. They can also be matted into sheets to make products such as paper or felt. Fibers are produced from different materials in various shapes and sizes right from steel fibers, glass fibers, natural organic fibers (jute, hemp, bamboo, acacia etc.,

1.2.1 Agave fiber

There are plenty of renewable resources obtainable from the plant kingdom and a vast resource for different natural fibers ex: Jute, Banana, Coir, etc.

which are abundantly available in many parts of the world.. Agave fibers are cellulosic in nature. Agave fiber reinforced concrete is the concrete with randomly distributed fibers. The failure strength and modulus of elasticity depends on the amount of cellulose and the orientation of the micro-fibers. The main disadvantage is that it is of high price. Addition of fiber reduces workability. Agave fiber reinforced concrete should be hand mixed.

Fig1: Agave fibre plant and fibres

2. OBJECTIVE

The main Objectivce is to study the effect of fly ash on sisal fiber reinforced concrete and investigate the optimum percentage of fiber mix. Fibers Are mixed in different proportions by cutting it into small pieces of sizes 3 to 5cm.To study the mechanical and transport properties of concrete for

- Compressive test on concrete cubes (150*150*15mm)
- Split tensile strength test on cylinders (diameter 100mm and 200mm long
- Flexural strength test on beam (10*10*50mm)

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3. LITERATURE REVIEW

Abdul Rahuman and Saikumar Yeshika conducted a research work to check the workability and strength properties of sisal fiber reinforced concrete with different mix proportions and different percentage of fiber addition. Fibers were brushed, lined up and cut to obtain 4cm length. Degree of workability of concrete mix with 0.2% super plasticizer and water cement ratio 0.45 had good workability with slump value 53mm and compaction factor 0.88, which is effective, was obtained. Materials were hand mixed with 0.5%, 1%, 1.5% addition of fiber in M20 and M25 mix design and casted in cubes and cylinders. The obtained specimens were subjected to tests aimed to check the compressive, tensile and flexural strength. An increase in compressive strength by 50.53% and tensile strength by 3.416% was observed for 1.5% addition of fiber in M20 mix design respectively. An increase in compressive strength by 52.51% and tensile strength by 3.904% was observed for 1.5% addition of fiber in M25 mix design respectively.

Sathish and v. Murugesh focused on studying the compressive strength, split tensile strength, flexural strength performance of the blended concrete containing sisal fiber and different percentage of slag as a partial replacement of OPC. The cement in Concrete was replaced accordingly with the percentage of 10%, 20% and 30% by weight of slag and 1% of sisal fiber was added by weight of cement. Concrete cubes were tested at the ages of 7, 14 and 28 days of curing. Finally, the strength performance of slag blended fiber reinforced concrete is compared with GGBS mixed concrete.

4. MATERIALS AND PROPERTIES

4.1 Cement

Cement is a well-known building material that has occupied an indispensable place in the construction There is a variety of cement available in the market and each type is used under certain condition due to its special properties. The properties of 53 grade cement was analysed.The specific gavity was found to be 3.01.The fineness modulus was calculated as 92%.

Fig2: Cement

3.2 Fine aggregate

IS: 383-1970 defines the fine aggregates as particles, which will pass through 4.75mm IS sieve. It is also called as sand. Generally natural sand is used for construction work, due to its scarcity we have used manufactured sand (M-sand). Manufactured sand is a substitute of river for construction purposes sand produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material.

Fig3: Fine aggregate

4.3 Coarse aggregate

The coarse aggregate is defined as an aggregate most of which is retained on 4.75mm IS sieve. The aggregates are formed due to natural disintegration of rocks or by artificial crushing of the rock or gravels. Some other properties of the aggregate, which is not possessed by the parent rocks, are particle shape and size, texture and absorption. The size of the aggregates generally used was 20mm down. Crushed granite jelly obtained from machine crusher is used as coarse aggregates. The aggregate may be classified as rounded, partly rounded, flaky, angular, elongated based on its shape and surface texture.. The properties of the coarse aggregate are tested as per IS 2386-part III.The flakiness and elongation i9ndex was calculated as 24.33% and 21.44%.

Fig4: coarse aggregate

4.4 Agave fiber:

Agave fibers are cellulosic in nature. Agave fiber reinforced concrete is the concrete with randomly distributed fibers. The failure strength and modulus of elasticity depends on the amount of cellulose and the orientation of the micro-fibers.

	Particulars	Result
1	Diameter	0.2mm
2	Elongation	4%
3	water absorption	3%
4	Cellulose	70%
5	Tensile Strength	300 Mpa
6		Density

5. EXPERIMENTAL METHODOLOGY AND RSULTS

5.1. Concrete mix design

Based on trial mixes for different proportions of ingredients, the final design mix was prepared for

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M20 grade of concrete as per IS 10262:2009. The concrete mix proportion and w/c ratio was considered as 0.5 and with varying percent of fibers and design was done.. The different specimens as per the requirement of test were casted. The specimens were tested after 28 days of curing. In each category there should be three specimens to be tested and average value is reported in the form of graphs

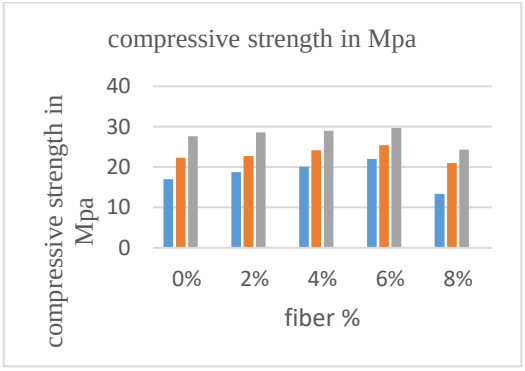
Fig5: concrete mould

5.2 Compression Test

The compressive strength of concrete i.e., ultimate strength of concrete is defined as the load which causes failure of the specimen divided by the area of the cross section in the uni-axial compression, under a given rate of loading. To avoid large variation in the result of compression test, great care is taken during the casting of the specimens and loading as well. The test results conducted for 3 ,7 days are tabulated below.

Table1: Compressive Strength Test Results

Percentage of addition of agave fiber	% of FlyAsh	Compressive Strength (MPa)	
		7 days	28 days
0%	-	22.3	27.66
2%	30%	22.7	28.55
4%	30%	24.11	29
6%	30%	25.4	29.7
8%	30%	21	24.33



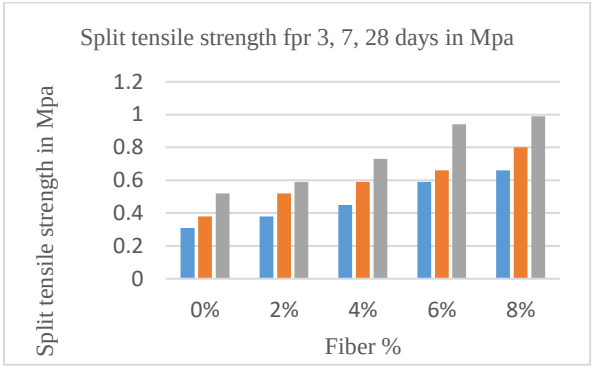
Graph1: Compressive strength v/s % addition of agave fibre

5.3 Split Tensile Strength of Concrete

Tensile strength is an important property of concrete because concrete structures are highly vulnerable to tensile cracking due to various kinds of effects and applied loading itself. However, tensile strength of concrete is very low when compared to its compressive strength. It is the standard test, to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS: 5816-1970.A standard test cylinder of concrete specimen (300mm height, 150mm diameter) is placed horizontally between the loading surfaces of compression testing machine. The compression load is applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. The test results conducted for 3 ,7 days are tabulated below.

Table2: Split Tensile Strength Test Results

Percentage of addition of agave fiber	% of FlyAsh	Split Tensile Strength (MPa)	
		7 days	28days
0%	-	0.30	0.52
2%	30%	0.45	0.59
4%	30%	0.50	0.73
6%	30%	0.57	0.94
8%	30%	0.53	0.99



Graph2: Split tensile strength v/s %addition of agave fibre

6. CONCLUSIONS

- Compressive strength was higher than conventional concrete for 2%, 4% and 6% addition of agave fiber at 3, 7 and 28 days of curing ages. Addition of agave fiber greater than 8% had lower strength than conventional concrete.
- Split tensile strength of agave fiber reinforced concrete was comparable with conventional concrete up to 8% addition. All the 4 percentages of addition of agave fiber had greater split tensile strength than conventional concrete.
- The results demonstrated that, irrespective of agave fiber percentage addition there was good relationship between compressive strength and split tensile strength.

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