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STUDY OF HIGH STRENGTH CONCRETE USING COIR FIBER BLENDED WITH SILICA FUME

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ABSTRACT - *The most widely used material in building construction is Concrete. High Strength Concrete is widely used in the construction industry worldwide nowadays. We use Mineral Admixtures like Silica Fume, Fly Ash and workable agents like super plasticizers are also used to produce High Strength Concrete with normal ingredients. The use of supplementary cementitious materials like Silica Fume, Fly Ash is fundamental in developing low cost construction materials. By addition of these pozzolanic materials, various properties of concrete like workability, durability, strength resistance to cracks and permeability can be improved and thus emissions of CO2 can be decreased. Silica Fume is known to enhance both mechanical characteristics and durability of concrete; also acts as perfect filler due to its fineness. To delay and control the tensile cracking of composite material coir fiber is included in concrete. An attempt is made to reuse coir fiber materials as fiber composites in concrete which not only solve the ductility problem but also the problem of waste disposal to some extent. Thermally, coir fiber decreases room temperature than atmospheric temperature.*

In the present project, an attempt has been made to study the properties of High strength concrete using coconut fiber and suitability of Silica Fume as a Mineral Admixture and its effects on High Strength Concrete. Concrete mixes are planned to made using Ordinary Portland Cement alone as control and also replacing percentage of cement by 5%, 10%, 15% and 20% of Silica Fume. 2% of Coir Fiber is added in all the concrete mixes. For all the mixes beams were casted and tested at 3 days, 7 days and 28 days for compressive strength, Split Tensile Strength and Flexural Strength respectively. Workability is decreased due to the presence of Coir Fiber. Hence, in this study, the optimum content of Silica Fume in concrete in order to increase its Flexural Strength was 10% and 2% fiber.

Keywords: *High Strength Concrete, Cementitious material, coir, Silica Fume, Waste disposal.*

1. INTRODUCTION

During past few years, requirement of high strength concrete has been increased than the conventional concrete. Now a Days usage of high strength concrete enhanced to have more durable and high stiffness buildings. So, many researchers are inventing distinct new types of concrete composites in the laboratories by utilizing the waste industrial byproducts, domestic wastages and agricultural wastes etc., for the partial replacement of conventional construction materials, to make the concrete composite eco friendly, durable, high strength and cost effective. In High Strength Concrete mixes, water- cement ratio is very low and high cement content. This increase in cement content leads to the high emissions of CO_2 and less strength than the target strength. To overcome this, some waste industrial byproducts known as pozzolans are used in concrete composites for partial replacement of cement content. Among pozzolans Silica Fume is highly reactive due to high content of amorphous Silica and large surface area and it acts as perfect filler due to its fineness.

As the concrete is weak in tensile and flexure, reinforcement will be provided. To overcome high potential tensile stresses and shear stresses at weaker zones in concrete member, steel reinforcement is adopted usually. The development of micro cracks should be controlled to produce concrete with homogeneous tensile properties, even though addition of steel reinforcement significantly enhances the strength of concrete. A new form of binder, that could combine Portland cement in bonding with cement matrices, fiber, is brought in as solution to develop concrete with increased flexure and tensile strength. Among several kinds of fibers such as glass, carbon, steel, poly propylene, nylon, jute and sisal etc., incorporation of natural fibers, is recommended to make concrete cost effective eco friendly, earthquake resistant concrete composite, which have light weight, high strength to weight ratio, corrosion resistance, non- abrasiveness, thermal insulation and less wear and tear (Masjid Ali et al., 2012).

The scope of the study is to experimentally study the increased properties of concrete in which Silica Fume is used as pozzolanic material and coconut fibers are introduced.

2. EXPERIMENTAL INVESTIGATION

Materials used:

Cement: Ordinary Portland cement of grade 53 ACC cement was used in this study. The properties of cement are tabulated as follows:

Table 1: Properties of Cement

Sl. No	Property	Results
1	Specific Gravity	3.15
2	Normal Consistency	26.50
3	Fineness of Cement	289
4	Fineness	3%
5	Initial Setting Time	39 mins
6	Final Setting Time	185 mins
7	Soundness	1 mm

Fine Aggregate: Locally available river sand is used as Fine Aggregate which passed through 4.75mm IS Sieve. The properties of Fine Aggregate are tabulated in Table 2.

Table 2: Properties of Fine Aggregate

Sl. No	Property	Results
1	Specific Gravity	2.45
2	Fineness Modulus	3.015
3	Bulk Density	16.70 KN/m^3
4	Bulking of Sand	27.53%
5	Grading of Sand	Zone II

Coarse Aggregate: Locally available natural granite aggregate is used in this study. All size Coarse Aggregate which passes through 20mm IS Sieve and retained on 16mm and 10mm Sieve has been used for work. The aggregates were tested as per Indian Standards Specification IS: 383- 1970. The properties of Coarse Aggregate are tabulated in Table 3.

Table 3: Properties of Coarse Aggregate

Sl. No	Property	Results
1	Specific Gravity 16mm and 10mm	2.658
2	Fineness Modulus	2.08
3	Flakiness Index	18.96%
4	Elongation Index	24.64%
5	Crushing Value	20%
6	Impact Value	20.36%
7	Water Absorption	0.50%

Silica Fume: Silica Fume is a byproduct resulting from the reduction of high purity quartz with coal or coke and wood chips in an electric arc furnace during the production of silicon metal or silicon alloys. This Silica Fume is known to improve both the mechanical characteristics and durability of concrete. The chemical and physical properties of Silica Fume are tabulated in Table 4.

Table 4: Properties of Silica Fume

Sl. No	Property	Results
1	Silica (SiO_2)	99.886%
2	Alumina (Al_2O_3)	0.043%
3	Ferric Oxide (Fe_2O_3)	0.040%
4	Titanium Oxide (TiO2)	0.001%
5	Calcium Oxide (CaO)	0.001%
6	Magnesium Oxide (MgO)	0.000%
7	Potassium Oxide (K_2O)	0.001%
8	Sodium Oxide (Na_2O)	0.003%
9	Loss on Ignition	0.015%
10	Lead (Pb)	0.000%
11	Arsenic (As)	0.000%
12	Physical State	Micronized powder
13	Specific Gravity	2.63
14	Moisture	0.58%
15	Pack Density	0.76 gm/cc
16	P^H of 5% Solution	6.90

Coir Fiber: Coconut Fiber is extracted from the outer shell of a coconut. The common, scientific name and plant family of Coconut Fiber is Coir, Cocos nucifera and Arecaceae (Palm) respectively. Cocos nucifera and Arecaceae (Palm) respectively. The properties of Coir Fiber are tabulated in Table 5.

Table 5: Properties of Coir Fiber

Sl. No	Property	Results
1	Specific Gravity	1.12
2	Thickness of Fiber	0.05 mm
3	Chopped length of Fiber	50 mm
4	Water Absorption	98%

Water: Locally available portable fresh water was used for mixing and curing of the specimens. For mixing mortar concrete and curing of concrete, clean portable water was used i.e., the water must be free from injurious amounts of oils, acids, alkalis, sugar, salts, organic materials or other substances that may be deleterious to concrete or steel. For mixing the concrete, Portable water is generally considered satisfactory.

Super Plasticizer: SP430 is a super plasticizing Admixture which is Chloride free based on selected Sulphonated Naphthalene Polymers and is supplied as a brown solution which instantly disperses in water. It has been specially formulated to give high water reduction up to 25% without loss of workability or to produce high quality concrete of reduced permeability.

Specific Gravity of Super plasticizer : 1.145

3. EXPERIMENTAL PROCEDURE

The Specimens of standard cube of size 150 mm x 150 mm x 150 mm and standard cylinders of size 150mm dia and 300 mm height and beams of size 150 mm x 150 mm x 600 mm were used to determine the Compressive Strength, Split Tensile Strength and Flexural Strength respectively. Totally 45 cubes, 45 cylinders and 45 beams were casted and tested for 3 days, 7 days and 28 days respectively with different proportions of Silica Fume (5%, 10%, 15%, 20%) and 2% of Coir Fiber for the strength parameters. Workability tests such as Slump Test, Compaction Factor Test and Vee- Bee time tests are also conducted on the fresh concrete before casting the concrete into the moulds. The following tests were conducted in the present project.

Tests Conducted:

Workability: The Workability can be defined as the ease with which concrete can be handled, placed, transported and finished without affecting of its strength. During Fresh concrete stage, all the mixes were evaluated for workability tests by conducting Slump Test, Compaction Factor Test and Vee- Bee Test. The results of the workability tests were tabulated in the Table 6.

Flexural Strength: The beam specimens of size 150 x 150 x 600mm were used in this study. The concrete beams were prepared as per the design mix and are placed for curing for 3 days, 7 days and 28 days. These beams are taken out from curing and rested in shade and are carried to the flexural Testing Machine. The Flexural Test is conducted on a loading frame. The beam specimen is simply supported on two rollers. The beam should be checked for its horizontal alignment and is adjusted if necessary. Care has to be taken to ensure that the loading points were at the same level and then the load is applied on the beam specimen through hydraulic jacks and was measured using 25 tons pre- calibrated proving ring. The load is transmitted to the beam specimen through I- section. Using dial gauges, the deflections at the center of span was recorded for each increment of loading. Continuous observations were made and the cracks were recognized. The deflect meters were removed and the loading is continued until the failure of beam takes place. The loading noted at failure is noted as the ultimate load. The results of Flexural Strength were tabulated in Table 7. Below figure shows the test carried out by beams for Flexural Strength.

Figure 2: Flexural Testing Machine

4. RESULTS AND DISCUSSIONS

Workability: Workability of Coir Fiber is decreased than the normal Mix, due to the presence of Coir Fiber. The following Table 6 shows the results of workability.

Table 6: Results of Workability of Mixes

Sl. No.	Mix No.	Slump Value (mm)	Vee- Bee Time (Sec)	Compaction Factor
1	Mix 1	0	14	0.82
2	Mix 2	0	19	0.70
3	Mix 3	0	15	0.73
4	Mix 4	0	14	0.741
5	Mix 5	0	13	0.749

Flexural Strength: The test was carried out confirming to obtain Flexural Strength of concrete at the age of 3 days, 7 days and 28 days. The beams were tested using Flexural Testing Machine. The following table 7 shows the results of Flexural Strength. Figure 2 shows Flexural Strength variation for various proportions of Silica Fume and 2% Coir Fiber at 3, 7 and 28 days.

Table 7: Flexural Strength values obtained for HSC Mix M60

Replacement of Silica Fume (%)	% of Coir Fiber	Flexural Strength in N/mm^2		
		3 days	7 days	28 days
0	2	3	4.35	6.238
5	2	3.14	4.77	6.32
10	2	3.46	4.87	6.46
15	2	3.16	4.77	6.18
20	2	2.76	4.67	5.98

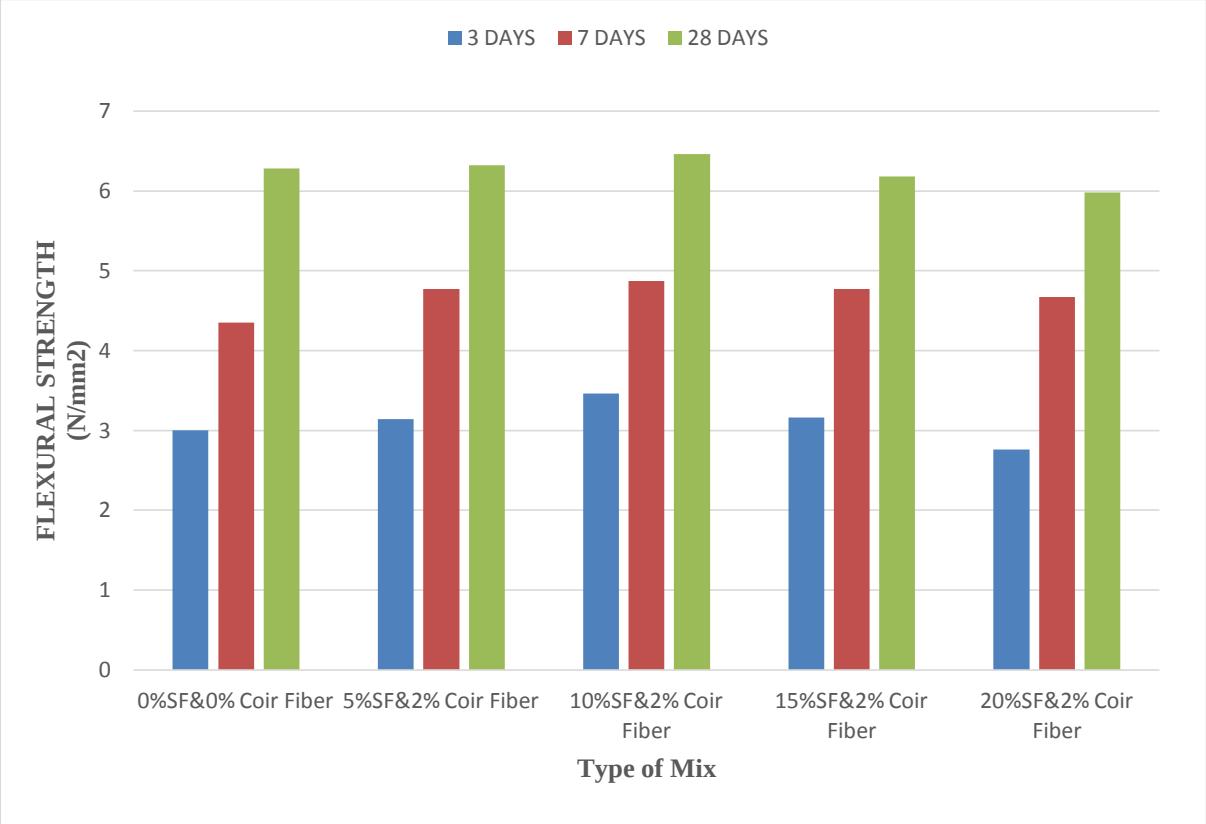

Figure 2: Flexural Strength variation for various proportions of Silica Fume and 2% Coir Fibers at 3, 7 and 28 days

5. CONCLUSIONS

Based on the experimental investigations carried out in this study, significant conclusions are summarized below:

- Compared to the normal concrete, workability of Fiber Reinforced Concrete Blended with Silica Fume is very low even, Silica Fume and Super plasticizer used in the mix, slump had not fall due to the Coir Fiber and low water content.
- Compaction Factor and Vee- Bee time tests also concluded that the workability of Coir Fiber Reinforced Concrete is very low.
- In this study, from the obtained results, it is clearly observed that the 28 days Flexural Strength has improved up to 10% replacement and gradually declined up to 20%.
- It has proved that the cracks at the time of failure are minimized by using these Coir fibers in the concrete mix. Due to the presence of Coir Fiber, they hold the specimen at cracking stage and prevented the breaking of specimen into two pieces.
- Finally, this can be concluded that the ductility of concrete increases by using Coir Fiber in the concrete. But, due to balling effects of fibers and presence of voids, the increment in strength is low than the strength of control mixing.

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