Experimental Investigation on Performance of Sisal Fiber Reinforced Concrete by Partially Replacing Cement by Micro-Silica

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***Abstract*—: In Civil Engineering, due to urbanization the demand for construction material increases, hence leading to prominent effect on economic system of nation. In construction field, concrete is most important ingredient. This increases quest for use of sustainable and eco-friendly materials in construction industry. In this project work we are using sisal fiber and micro silica. It is a natural fiber and micro silica similarly known as silica fume it is a byproduct of silicon and ferrosilicon alloy. To achieve decent compressive strength test, split tensile test and flexural test results. This project focuses on investigating the characteristics of M25 grade concrete. The paper highlights the study of compressive, Split tensile and Flexural test.**

Keywords— Sisal fiber, compressive strength, micro silica, Aggregates, split tensile, flexural strength.

I. INTRODUCTION

Civil engineering is a specialized branch of engineering. This includes contracts with the project, creation of the physical and natural environment, community works such as roads, bridges, airports, sewers, civil works and railways.

Concrete is a combined material of coarse fine and coarse aggregates combined with cement that hardens over time. Concrete is the most used material in the world after water and the most common building material.

Concrete is the supreme substitute in construction material. Strength, cost and durability of building is extremely in need of it. The foremost aim of the project is to decrease the amount of natural aggregate and mineral for concrete making.

Concrete is strong in compression and weak in tension. So we will afford the reinforcement to the concrete majorly steel is used for the reinforcement. In this task we would like to take the naturally accessible sisal fiber and Micro silica by partially substituting cement and to increase tensile, Flexural and compressive strength of concrete.

Sisal fiber is most broadly used natural fiber. It has tiny regeneration times and nurtures wild in borders of fields and railway tracks. Approximately 4.5million tons of sisal fibers are formed all year thought the world. Brazil is the most generating country in the world. Sisal fiber is the solid fiber take out from the grasses of the sisal plant (agave sisalana). Though intrinsic to tropical and sub-tropical northland South America. Sisal fibers are light building material, which is cool to handle, transport and collection. Therefore building material sisal fiber saves time. Relatively high tensile and flexural modulus.

Micro Silica is a pozzolanic material which is environmentally stable and proven itself as good to use all over the world since 1900. It is an industrial byproduct of high purity quartz industries and Ferro-alloy industries. Generally, size of micro silica varies from 10nm to 1000nm. First test of silica fume in concrete is done in 1952. The use of micro silica in concrete reduces bleeding, segregation and increases workability of the concrete.

Micro-silica is suitable with both pfa and GGBS. When using high levels of Pfa or GGBS substitute, micro-silica can be added to increase early strength as it sets faster in the first 3 days, or to improve fresh concrete consistency. High levels of GGBS substitute can cause tap water problems, not only on the concrete surface but also in the mix itself. The micro-silica will effectively eliminate this bleed-out effect, thus maintaining the concrete's reliability.

When microsilica is used to make triple-mix cement, advances are made in both fresh concrete stability and hardened concrete durability. The beneficial properties of combining both pozzolanic materials in the production of durable concrete. the world where concrete buildings are expected to last more than 100 years, like the Danish-built store, the Northumberland Bridge in Hong Kong and the Burj Khalifa at dubai.

II. OBJECTIVES

- To analyze the characteristics of micro-silica, and sisal fibers for M-25 grade of concrete.
- To determine the Compressive strength, Split tensile and Flexural Strength of concrete by partially replacing cement by micro-silica and sisal fiber.

III. METHODOLOGY AND MATERIALS

A) MATERIALS

[1] Cement: OPC of 43 grade "CORAMANDAL CEMENT" brand was used during the study.
[2] Fine Aggregate: The River sand is not retained from the 4.75mm IS sieve is used during the study.
[3] Course Aggregate: The considered coarse aggregate in the study is 20mm down size crushed granite stone which is obtained from the locally available quarry.
[4] Sisal Fiber: Naturally available sisal fiber is used.

[5] Micro-silica: Micro-silica is moreover known as silica fume, is a mineral compound derived from very fine, solid, glass-like spheres of silicon dioxide.

IV. METHODOLOGY

- Mixing: Dry combination the sand and cement ingredients and add coarse aggregate to it and blend it exhaustively to attain cement particles on each and every coarse aggregate and Enhance the calculated quantity of water, sisal fiber and micro- silica to the dry blend and blend thoroughly to get identical blend.

Fig.1.Mixing of Concrete

- Casting: Place the molds on the table and pour the wet concrete into the molds in III layers, turn on the vibrating table button and sideways this tamping must be done with a standard tamping rod. Demould the samples after 24 hours.

Fig.2.Casting of Specimens

- Curing: After casting of specimens, they were kept for moist curing for the standard period of 7 and 28 Days

Fig.3.Curing of Specimens

C) MIX PROPOTION

- **M25:1: 1: 2**
- **WATER CEMENT RATIO : 0.45**

Cubes: Total of 30 cubes casted.

Table.1.Quantity of materials used for Cubes

Materials	0% grams	5% grams	10% grams	15% grams	20% grams
Cement	2198	2087	1976	1868	1758
Fine aggregate	2220	2220	2220	2220	2220
Course aggregate	4450	4450	4450	4450	4450
Sisal fiber(1% constant)	22	22	22	22	22
Micro- silica	0	111	222	333	444

Cylinders : Total 30 cylinders casted.

Table.2.Quantity of materials used for Cylinders

Materials	0% grams	5% grams	10% grams	15% grams	20% grams
Cement	3465	3290	3115	2940	2765
Fine aggregate	3500	3500	3500	3500	3500
Course aggregate	7000	7000	7000	7000	7000
Sisal fiber(1%constant)	35	35	35	35	35
Micro silica	0	175	350	525	700

Beams : Total 30 Beams casted.

Table.3.Quantity of materials used for Beams

Materials	0% grams	5% grams	10% grams	15% grams	20% grams
Cement	3267	3102	2937	2772	2607
Fine aggregate	3300	3300	3300	3300	3300
Course aggregate	6600	6600	6600	6600	6600
Sisal fiber(1%constant)	33	33	33	33	33
Micro silica	0	165	330	495	660

V.

VI. EXPERIMENTAL INVESTIGATION

A) **Sisal fiber test:** We made the compressive and split Tensile Strength test on Sisal fiber as taking the M25 grade ratio for replacing the cement by sisal fiber in 0%, 0.5%,1%,1.5%,2% and taken the results as follows:

Table.4. Test Results for Sisal fiber

Sl.No.	Percentage of Fiber added	Compressive strength test results(28days)	Split tensile strength test(28 days)
1	0	33.03	2.58
2	0.5	39.24	3.14
3	1	43.97	4.22
4	1.5	40.28	4.50
5	2	35.46	5.15

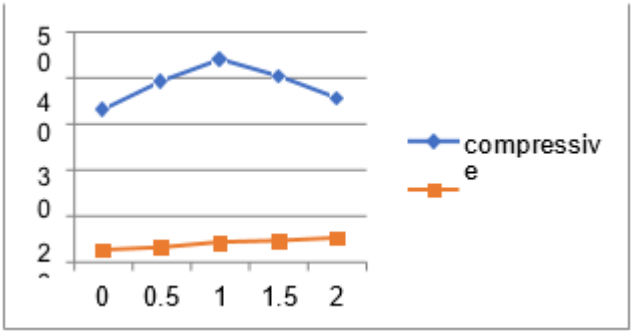

Fig.4.Compressive and Split Tensile Strength for Sisal Fibers

Comparing both the test that is compression strength test and split tensile test the optimum value. We are going to consider 1% Sisal Fibers common for our project and varying the micro silica as 0%, 5%, 10% etc.

B) Compressive Strength Test

Compressive strength test is showed on the cubes of size 150x150x150mm of total 30 moulds of diverse mixes at seven days and twenty eight days.

Fig.5.Compressive testing machine

Table.5.Specimens tested for 7 and 28 days

MIX	7 days (N/mm²)	28days (N/mm²)
0%	10.19	22.4
5%	15.25	29.31
10%	27.92	38.42
15%	27.09	37.34
20%	18.64	21.45

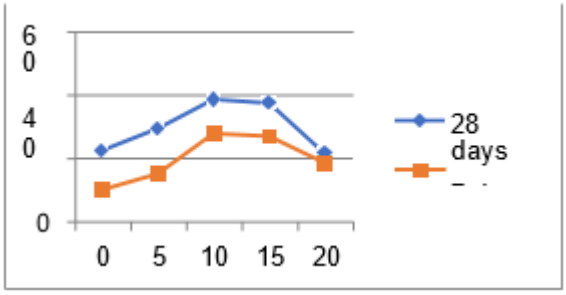

Fig.6.Compressive strength on 7 and 28 days

C) Split tensile strength test

Split tensile strength test is showed on the cylinders of size 150mm dia and 300mm long of total 30 moulds of diverse mixes at seven days and twenty eight days.

Fig.7.Split Tensile Testing Machine

Table.6.Specimens tested for 7 and 28 days

MIX	7 days (N/mm²)	28days (N/mm²)
0%	2.130	4.31
5%	2.18	4.45
10%	0.186	4.68
15%	0.180	3.44
20%	0.124	3.40

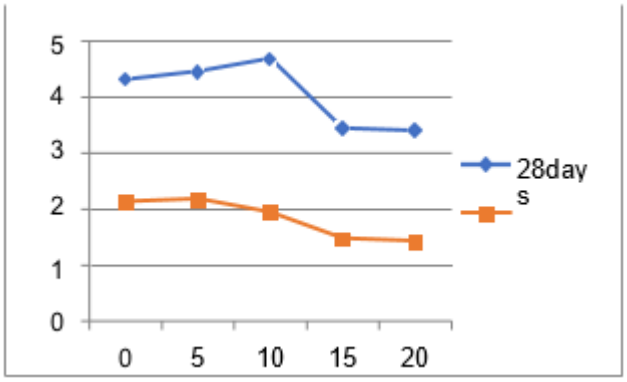

Fig.8.Split tensile strength on 7 and 28 days

D) Flexural strength test

Flexural strength test is conducted on the Beams of size of 100X100X500mm of total 30 moulds of different mixes at seven days and twenty eight days.

Fig.9.Flexural Testing Machine

Table.7.Specimens tested for 7 and 28 days

MIX	7 days (N/mm²)	28days (N/mm²)
0%	1.195	3.20
5%	1.225	3.45
10%	1.305	4.03
15%	1.03	3.01
20%	0.165	2.45

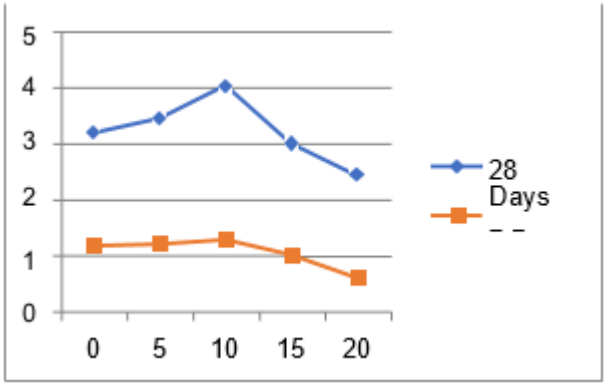

Fig.10. Flexural strength on 7 and 28 days

VII.CONCLUSIONS

The Paper mainly examines the properties of Sisal fiber and Micro-silica .Based on the limited study done on the project following conclusions is drawn:

- By incorporating Sisal Fibers into the concrete, we conclude that the compressive strength ,Cracking strength and Bending strength are increased.
- Sisal fiber mixed with the concrete reduced Shrinkage and Cracking witin the concrete element.
- Compressive Strength, Tensile Strength and Flexural Strength increase with increasing proptional of Sisal Fiber and Micro-silica upto an optimity.

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