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Research Paper

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Experimental Investigation of Sisal Fiber Reinforced Self Compacting Concrete

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***Abstract*—** Concrete is a poured mixture of cement, water, fine aggregate, and coarse aggregate that hardens into a strong building material**.** Concrete is an important construction material that is utilized all over the world. Self-compacting concrete flows and distributes into the form without the requirement for mechanical vibration compacting. It can be utilized in situations where compaction for new concrete is inconvenient. The objective of this investigation of is to utilize regular fiber to work on the exhibition of self-compacting concrete (sisal fiber). Superplasticizer are used to promote the workability of viscosity modifying agents and fibers while decreasing bleeding and segregation. sisal fibers are extracted from the leaves of the plants aqua sisalana. The fibers are obtained by the spinning process and decorations made by machines. The characteristics of new and solidified concrete with built up sisal fiber were explored in this paper. Fiber Self-compacting concrete is completed with a water-concrete proportion of 0.34 for different levels of fiber addition.0.5%, 1.0%, 1.5% and 2.0% of the materials were blended. Sisal fiber is included. Plan and cast the 3D square, chamber, and pillar M50 blend. The examples were put through a progression of tests The test conducted for 7 and 28 days.

Keywords— Sisal fiber, cement, M-sand, Coarse-aggregate, Silicafume, Sikacimpink, Compressive strength, tensile strength, flexuralstrength

I. INTRODUCTION

Concrete is being utilized more than 150 years. It is blended, put into structure and afterward compacted. It is fundamental to reduce the substantial with the goal that it ought to totally cover the support and occupy all the space in the structure for meeting strength and sturdiness necessity. The air entrained in concrete during blending must be totally removed out for getting uniform thick mass. On the off chance that compaction is unfinished, it will prompt misfortune in strength and furthermore influence execution of the design. The compaction becomes troublesome when level of support is high which doesn't permit inclusion of vibrator at certain spots. Additionally, the vibration increments commotion level in and around building site. Self-compacting concrete was along these lines created to beat the issues referenced previously. Substantial position has been altered by Self-Compacting concrete, which streams under its own weight and doesn't need outside vibration for compaction. A profoundly useful cement can stream under its own load over bound regions without isolation or dying. It was first presented by Japanese scientists in the last part of the 1980s. Specialists have laid out a few standards for Self-Compacting substantial combination proportioning, which incorporate diminishing the volume proportion of total to cementitious material(1), expanding the glue volume and water-concrete ratio(2), decreasing the volume proportion of total to cementitious material(3), keeping the greatest coarse aggregate molecule size and all out volume under severe control(4), consolidating different thickness expanding admixtures.

Superplasticisers diminish water request and simultaneously increment smoothness. Be that as it may, there is chance of draining and blend may become tacky. To defeat this issue viscosity-modifying specialist (VMA) is expected to be added. VMA is a pseudo plastic specialist, which thickens the water and holds the blend under suspension, giving isolation opposition. The rule of sedimentation speed is contrarily corresponding to the consistency of the drifting medium is applied in the framework. The VMA offers high shear protection from the fixings very still what's more, less shear obstruction at development and this property holds the coarser particles under suspension in self-compacting concrete. The SCC as some other sort of cement has a fundamentally lower pliable and shear strength in correlation with the pressure strength and consequently, it should be built up. Fiber built up concrete is an option in contrast to conventional stirrups support prompting brought down work costs. To be ready to get to mechanical properties of the fiber supported concrete, information on definite spread and headings of strands is important. Quite possibly of the main leap forward in the development area as of late has been its improvement. Functionality execution for filling formwork with a fluid arrangement is proposed to be depicted as

follows: ability to(i)filling, (ii)passing skill, (iii)Segregation opposition.

Non-woven matting, brushing, and meandering additionally made with the fiber. After that the fiber is washed and dried, either precisely or normally. Sisal is a coarse and solid fiber. Its solidarity, versatility, capacity to extend, partiality for explicit dyestuffs, and protection from decay in saltwater lake it ideal for cordage.

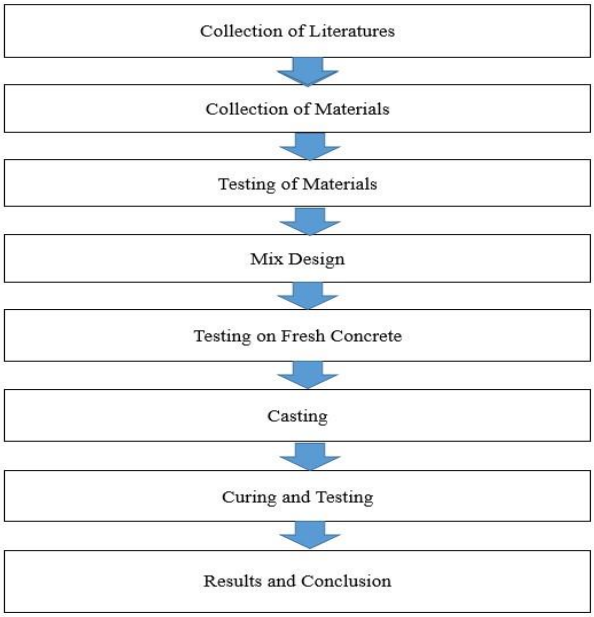
Figure 1: Self compacting concrete

II. OBJECTIVES

The fundamental goal of the undertaking is (I) to sort out the which level of sisal fiber should be utilized in the substantial, (ii) to decide the strength characteristics of cement containing sisal fiber (compressive strength, rigidity, flexural strength, (iii) to decide the stream qualities of Self-compacting concrete with different sisal fiber rates.

III. METHODOLOGY

The methodology of the project is given as flowchart:



IV. RELATED WORKS

K. Pavithra et al (2021) have reasoned that as far as flexural strength, a critical increment of up to 200 percent is accomplished, while compressive strength increments by 40-50 percent. The filaments are for the most part observed to be appropriate for working on the elasticity of cement and can be utilized wherever strain individuals are available. Synthetic strands give transient strength yet are not harmless to the ecosystem, subsequently involving normal filaments in concrete is exceptionally proposed to advance long haul substantial sturdiness.[1]

Abdalla M. Saba et al (2021) have reasoned that the outcomes show that at 0.5 percent steel fiber fixation, concrete compressive strength worked on by 12.5 percent, and at 1% steel fiber content, concrete rigidity and flexural strength expanded by 48 to 51 percent when contrasted with control blend following 28 days. The consideration of 20% silica rage with concrete substitution minorly affects the primary attributes and compressive strength of fundamentally solid and harmless to the ecosystem concrete. The discoveries of this study show that utilizing silica smolder rather than concrete and utilizing steel fiber brought about a more savvy and enduring self-compacting concrete [2]

S. Hima Venkata Mahalakshmi, Veerendrakumar C. Khed (2020) have presumed that when contrasted with an ordinary blend of self - compacting concrete, adding silica-smolder further develops isolation opposition and ability to fill. Involving M-sand in self-compacting concrete limits the requirement for normal cement while likewise giving sati silica-seethe strength. Silica rage works on self - compacting substantial's usefulness. In contrast with different combinations, SCC with 5% Silica seethe delivers great outcomes.[3]

V. Gokulnath et al (2019) have inferred that when M-sand is contrasted with waterway sand, its properties improve somewhat. Following 28 days, the greatest strength of 1.2 percent steel fiber in assembling sand was accomplished. The M-sand has a higher parted elasticity of 11% because of the presence of 1.2 steel strands in the M-sand. While looking at M-sand and waterway sand, the assembling sand has a high flexural strength with rigidity.[4]

V. MATERIALS

A. CEMENT

Portland concrete cement is the most broadly involved development material in structural designing activities around the world. The examination was directed utilizing customary Portland concrete of 53 grade, which is generally accessible in the nearby market. Actual models for not entirely set in stone as per IS 169-1989, and substance still up in the air as per IS 4032-1988. The properties of cement are as follow: Specific gravity of 3.12, initial setting time of 28 minutes, Final setting time 532 minutes, Consistency of 33% and fineness modulus of 2.5

B. FINE AGGREGATE

M-sand is a development aggregate made by smashing hard stones into little sand measured rakish molded particles, then, at that point, washing and definitively reviewing them. It is a superior option in contrast to river sand for development. The properties of Fine aggregate are as follow: Grading of sand as Zone II, Specific gravity of 2.62, fineness modulus of 2.46 and water absorption of 1.5%

C. COARSE AGGREGATE

The most extreme aggregate size is normally 10mm and is restricted to 20mm. Using a very much reviewed cubical or adjusted aggregate is better. Aggregate should be of reliable quality with regards to shape and evaluating. The properties of coarse aggregate are as follow: Specific gravity of 2.70, water absorption of 2% and fineness modulus of 6.2

D. WATER

Construction necessitates the use of water. The Ph of water should be at least 6. Throughout the experiment, portable water was utilized in accordance with IS 456-2000 criteria.

E. ADMIXTURES

An admixture is a fixing that is added to the bunch previously or during blending, yet isn't water, aggregate or concrete. concrete admixtures are utilized to improve or give it novel characteristics. The utilization of admixtures ought to give an advantage not reachable by changing concrete and aggregate extents alone, and it ought to adversely affect the concretes characteristics

F. CHEMICAL ADMIXTURE

SIKACIM PINK

Cement, mortar, and mortar waterproofing compound in a fluid structure. Considering sika's innovation of extraordinary particular polymers, surface dynamic specialists, and added substances, a uniquely planned unmistakable pink hued fluid coordinated water sealing compound for cement, mortar, and mortar has been created. The Sikacimpink appeared as Pink colour hazy liquid, having density of 1.21 at 25º and pH of ≥ 6

Figure 2: Sikacim pink

G. MINERAL ADMIXTURES

SILICA FUMES

The development of silicon metal or ferrosilicon combinations produces silica exhaust as a by - item. Concrete is one of the most useful applications for silica rage. It is an exceptionally responsive pozzolan due it its synthetic and actual qualities. Silica seethe cement can profoundly vigorous and durable. Silica rage is accessible from substantial added substance makes and in the event that predefined, is basically added during the substantial assembling process. The setting, cleaning, and relieving of silica rage concrete require specific consideration from the substantial project worker. The particular gravity of silica vapor is 2.2.

Figure 3: Silica fumes

H. SISAL FIBER

The leaves of the plants are utilized to make sisal fiber. Agave Sisalana is the natural name for this plant. It is fundamentally made in Mexico. Machine embellishments, in which the leaf is squashed among rollers and afterward precisely rejected, is the most widely recognized techniques for acquiring fiber. Sisal fiber is quite possibly of the most broadly utilized regular fiber, and it is the additionally one of the least demanding to develop. Sisal is sustainable power source that is completely biodegradable.

In the delivery business, (i) sisal is broadly utilized for mooring little ships, lashing and freight taking care of, (ii) its additionally frightening to discover that it utilized as the fiber center of lift steel wire links for oil and adaptability. Rural twine or baler twine has generally been made of sisal, (iii) it is utilized in composite materials in the vehicle business with fiberglass, (iv) Spa things, feline scratching posts, floor coverings, shoes, fabrics and plate cushions are a portion of different things produced using sisal fiber, (v) for a milder hand, sisal is utilized alone in the rugs or in mixes with fleece and acrylic.

Figure 4: Drying stage of Sisal fiber

VI. FRESH CONCRETE PROPERTIES

Self-Compacting concrete has the accompanying properties (i) filling skill, (ii) ability to passing, (iii) high isolation obstruction

A. filling skill

Under its own weight, it can possibly stream into any region inside the formwork. Droop stream, V-channel, and different tests are utilized to gauge the filling capacities of new concrete

B. passing skill

It alludes to its ability to course through little holes, for example, between steel building up bars, under its own weight. The U-box, L-box and J-ring test strategies can be utilized to decide passing capacity.

C. High isolation obstruction

All through the transportation situation method, it should meet the filling skill and ability to pass with uniform organization.

VII. TEST METHODS

A. Slump cone test

The Slump cone test is utilized to decide how well substantial streams on a level plane without even a trace of obstacles. It's the most considered normal used test, and it gives a strong sign of filling capacity. It tends to be used on the spot and it additionally uncovers isolation opposition. Begin the stopwatch when the downturn cone is raised and perceive what amount of time it requires for the substantial to reach 500mm. T50 time is the name given to this period. This is a proportion of how rapidly substantial spreads.

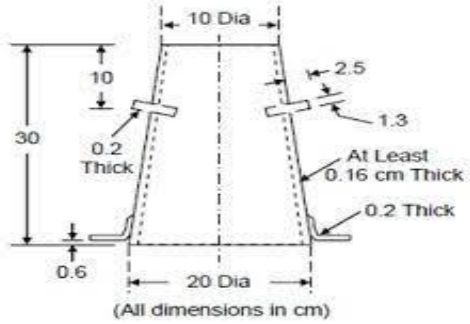


Figure 5: Slump cone test

B. L-box test

The test assesses the progression of concrete as well as the sum to which the substantial is exposed to supporting blockage. It is most normally utilized while submerged cementing is being finished.

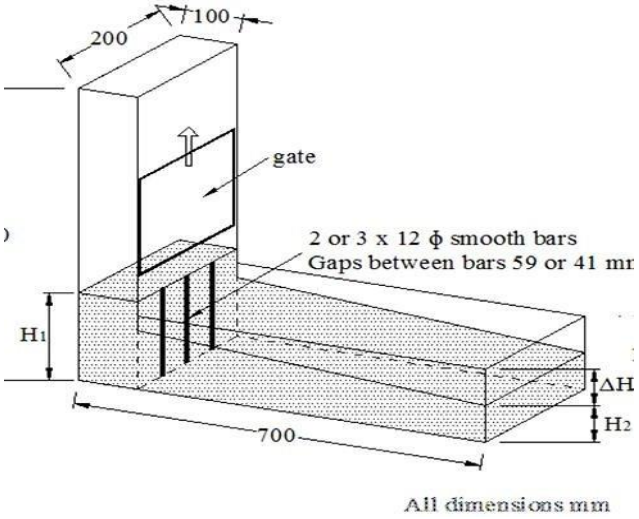


Figure 6: L-box test apparatus

C. J-ring test

This test decides the substantial's ability to pass. It's likewise a famous test method at work. To reproduce the blockage of support at the site, the bars and areas in this test can be put at fluctuated removes separated. These segments are typically multiple times the totals greatest size. The ring made by vertical parts has a width 300mm and a level of 100mm.

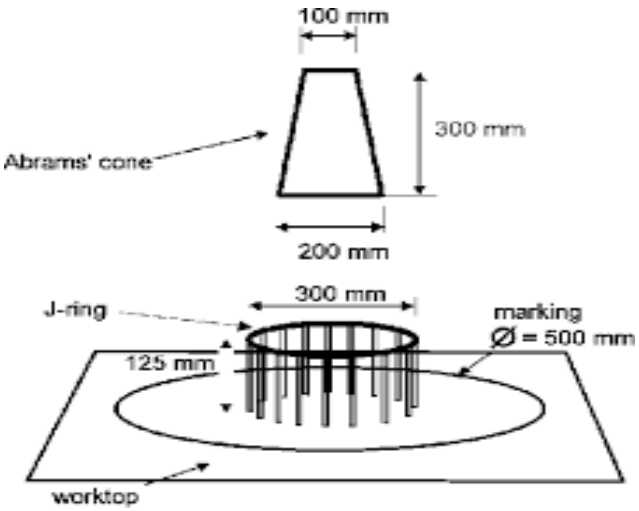


Figure 7: J-ring test apparatus

VIII. MIX DESIGN

Stage 1: Stipulations for proportioning

Grade designation- M50
Types of cement- OPC 53 grade
Nominal maximum size of aggregate-20mm
Exposure condition-Severe (for reinforced concrete)

Maximum cement content-450 Kg/m^3
Chemical admixture-PCE type
Mineral admixture-Silica fume

Stage 2: Test information for materials

Cement-OPC 53 grade
Specific gravity of cement-3.12
Specific gravity of Fine aggregate-2.62
Specific gravity of Coarse aggregate-2.70
Specific gravity of Super plastcizer-1.11

Stage 3: Target strength for blend proportioning

$F_{ck}' = f_{ck} + 1.65s$
Where, s= standard deviation
$= 50+(1.65*5) = 58.25$ N/mm^2

Stage 4: Approximate air content

Measure of air captured in concrete is 1% for 20mm greatest size of totals (from IS 10262:2019, table3)

Stage 5: Selection of water concrete proportion

For the OPC 53 bend, the free water-concrete proportion important for the objective strength of 58.25 N/mm2 is 0.34 as indicated by the IS 10262:2019. 0.34>0.45. thus OK.

Stage 6: Proportioning of beginning blend

A. Selection of water content and cement/ silica fume content

This water content of 150 Kg/m^3 will relate to a concrete substance of 442 Kg/m^3 for water concrete proportion of 0.34. The concrete substance of 442 Kg/m^3 can be additionally isolated into OPC and silica seethe. Silica exhaust of 5% is embraced. The OPC content is for 419.9 Kg/m^3 and silica exhaust will be 22.1 Kg/m^3

B. Selection of admixture content

Taking an admixture portion of 2.5% by mass of cementitious materials
Mass of admixture = (2.5/100) * 442 = 11.1 Kg/m^3

C. Selection of powder content and fine aggregate content

The powder content required is for the most part in the scope of 400 to 600 Kg/m^3
Powder content of 520 Kg/m^3 is chosen.
Fines expected to be contributed by fine aggregate = (complete powder content) - (silica fume content + concrete substance)
= 520 - (22.1+419.9) = 78 Kg/m^3
The fine aggregate has 8% materials.
Fine aggregate amount = 78/0.8 = 975 Kg/m^3

D. Selection of Coarse aggregate

Let v_{ca} be volume of coarse aggregate
Accepting 1m3 of cement
V_{ca} = (1 - air content) - [volume of (water + silica fume+ admixture + fine aggregate)]
$= 0.32$ m^3
Mass of Coarse aggregate = v_{ca} * specific gravity of coarse aggregate * 1000 = 0.32 * 2.70 * 1000 = 870 Kg/m^3

E. Calculation of volume of powder content

Volume of powder content = volume of (OPC + silica fume + part of fine aggregate) = 0.17 m^3
Proportion of water to powder by volume = 0.15/0.17 = 0.88

Mix proportions for concrete per m3

Cement = 419.9 Kg = 1
Water = 150 Kg = 0.34
Fine aggregate = 975 Kg = 2.32
Coarse aggregate = 870 Kg = 2.07

IX. EXPERIMENT PROCEDURE

The materials were gauged by the extents of the blend. The water concrete proportion was determined to be 0.34. To make a fine glue, the fitting measure of not set in stone and appropriately blended in. slump cone test, L-box test, J-ring test for self - compacting concrete are being completed. The concrete blend was placed in the essential molds for the strength evaluation after the stream attributes preliminaries were finished. The examples were demolded and shipped to the relieving tank following 24 hours subsequent to projecting. The examples were inspected for their individual strength following 7 and 28 days of relieving.

X. TEST RESULTS

Fresh concrete properties

The fresh concrete properties are tried to check whether the extent expansion of filaments used is right. For new concrete, the accompanying test are done. (i)Slump cone and T50, (ii) L-box test, (iii) J-ring test.

Table 1: Fresh concrete properties

Test conducted	% of sisal fiber				
	0.0	0.5	1.0	1.5	2.0
Slump flow	630	670	710	750	780
T50 slump flow	2.4	2.7	3.2	3.6	3.9
L-box	0.99	0.93	0.91	0.88	0.87
J-ring test	6.5	7.8	8.2	9.0	9.4

Figure 8: Slump cone test

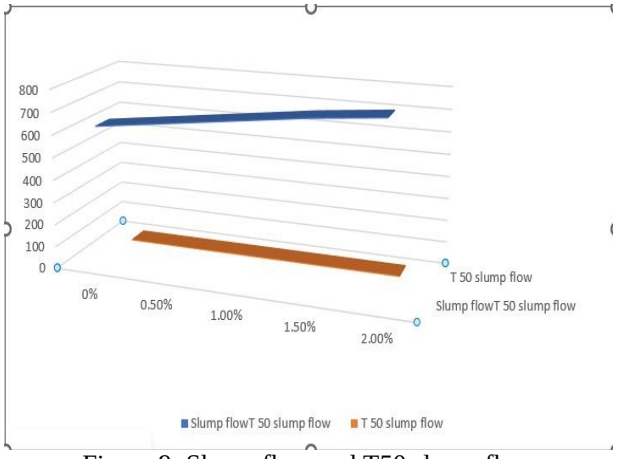


Figure 9: Slump flow and T50 slump flow

Figure 10: L-box test

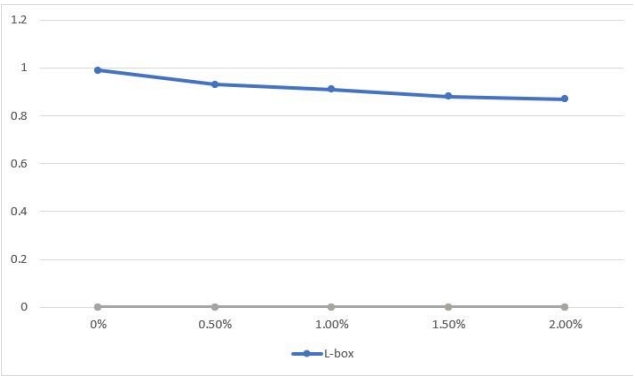


Figure 11: L-box test

Figure 12: J-ring test

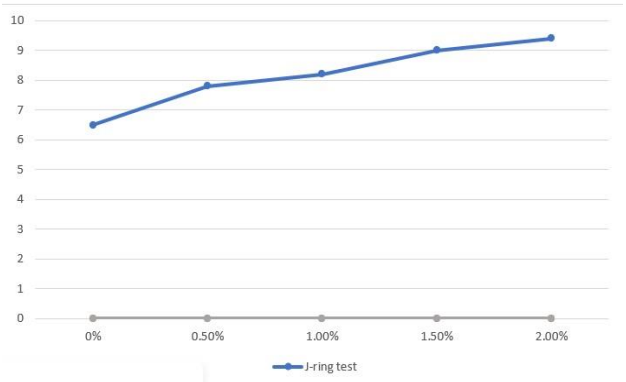


Figure 13: J-ring test

Hardened concrete properties

The hardened concrete properties including compressive strength, tensile strength and flexural strength were analyzed.

Compressive strength

Concrete upon the size of the aggregate, either 15cm X 15cm X 15cm or 10cm X 10cm X 10cm 3D shapes. Cubical molds estimating 15cm X 15cm X 15cm are much of the time utilized for most of the works. This substantial is filled the shape and tempered appropriately to dispense with any voids. Molds are taken out following 24 hours,

and test examples are drenched in water to fix. This example top surface ought to be level and smooth. This is achieved by applying concrete glue to the entire surface of the examples and streamlining it equally. Following seven days or 28 days of restoring, these examples are assessed on a pressure testing hardware.

Figure 14: Compression test

Table 2: Average compressive strength

% of sisal fiber	Compressive strength (N/mm^2)	
	7 days	28 days
0	34.67	51.33
0.5	36.80	51.64
1.0	37.90	52.71
1.5	39.10	54.71
2.0	38.30	52.40

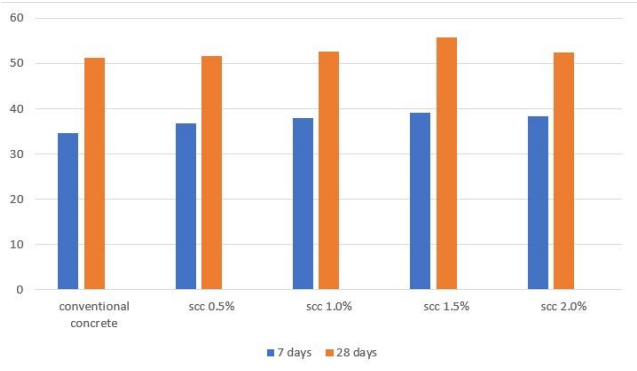


Figure 15: compressive strength 7 and 28 days

Tensile strength

The tensile strength is determined in a roundabout way. A 15cm breadth and 30cm length test example is utilized and is placed over a pressure testing gear. The heap is conveyed entirely and similarly over the examples along the chamber length until the chamber falls flat. The chamber will bomb along its measurement in an upward bearing. Compressed wood strips are embedded between the examples and the stacking plates to keep direct pressure from the immediate site of use. The tractable pressure that structures as the heap increment parts the chamber into two sections.

Figure 16: Tensile strength test

Table 3: Average split tensile strength

% of sisal fiber	Split tensile strength (N/mm^2)	
	7 days	28 days
0	3.28	5.50
0.5	3.38	5.86
1.0	3.57	6.00
1.5	3.66	6.39
2.0	3.50	6.10

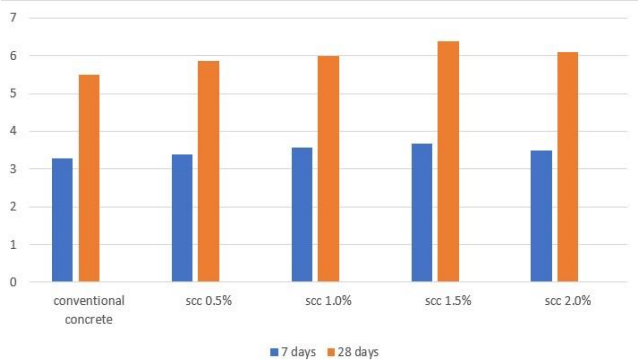


Figure 17: tensile strength 7 and 28 days

Flexural strength

It determines if an unreinforced concrete beam or slab can sustain bending failure. The results of a concrete flexural test are expressed as a modulus of rupture (MR) in MPa or psi. A three-point load test (ASTM C78) or a center-point load rest can be used to perform a flexural test on concrete (ASTM C293).

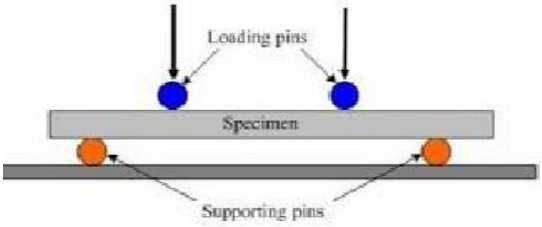


Figure 18: Flexural images

Table 4: Average flexural strength

% of sisal fiber	Flexural strength (N/mm^2)	
	7 days	28 days
0	4.37	6.20
1.5	4.95	7.82

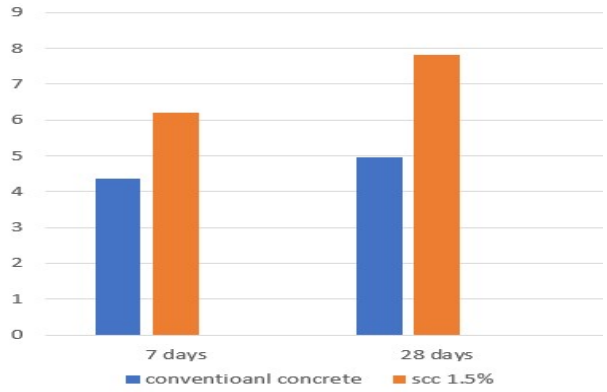


Figure 19: Flexural strength at 7 and 28 days

XI. CONCLUSION

The functionality of self - compacting concrete is unaffected by the expansion of sisal fiber. At 1.5 percent sisal fiber added, the example's compressive and parted elasticity were at their most extreme. At 28 days, substantial strength was at its pinnacle when the extent of fiber utilized was 1.5 percent, after which it started to disintegrate as additional strands were added. Self-compacting concrete with 1.5 percent sisal fiber had a higher most extreme compressive strength at 28 days (55.71N/mm2) than the customary cement. Self-compacting concrete with 1.5 percent sisal fiber had a greatest elasticity at 28 days (6.59N/mm2) than the customary cement. Self-compacting concrete with 1.5 percent sisal fiber had a higher greatest flexural strength at 28 days (7.82N/mm2) than the customary cement. The expansion of sisal strands no affected the completion capacity of Self-compacting concrete subsequent to projecting; the external surface was all around as smooth as plain Self compacting concrete. Expansion of sisal fiber at specific volume portion is viewed as not to influence the functionality of SCC. The SCC is effortlessly blended in with sisal filaments, in spite of the fact that while projecting some of the examples, functionality of Reinforced SCC blend can be improved by utilizing lower level of strands.

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