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Analysis of Self Compacting Concrete Using Hybrid Fibres

Apoorva Chandak[1], Nitin Agrawal[2], Divyansh Thakur[3] and Abhyuday Titiksh[4]
[1,2,3]UG Scholar, [4]Assistant Professor,
[1,2,3,4]Civil Engineering Department, SSGI(FET), Chhattisgarh Swami Vivekanand Technical University, Bhilai, India

Abstract- The project shows the comparison between the conventional concrete and SCFRC using hybrid fibre (banana and sisal fibre). Concrete made with Portland cement has certain characteristics; concrete is relatively strong in compression but it is weak in tension. by the use of conventional rod reinforcement and to some extension by inclusion of a sufficient volume of certain fibre the weakness in tension can be overcome. Fibre Reinforced Concrete (FRC) is a composite material consisting of cement based matrix with an ordered distribution of fibre which can be steel, nylon, polyethylene etc. The self compacting property of the concrete helps in fresh state of concrete and properties in hardened state is enhanced by fibre. In the project hybrid banana and sisal fibre is used.

Keywords: *Concrete, Hybrid Fibres*

I. INTRODUCTION

Concrete is a composite material composed of aggregate bounded together with a fluid cement which hardens over time. The word concrete comes from the Latin word "*concretus*" (meaning compact or condensed), the perfect passive participle of "*concrescere*", from "*con-*" (together) and "*crescere*" (to grow). The conventional concrete is the normal concrete which is batched, mixed, placed into form and then compacted. It is essential to compact the concrete so that it should completely cover up the reinforcement and fill all the space in the form to meet strength and durability constraint. The air entrained in concrete during mixing has to be totally expelled out for getting uniform dense compacted mass. If compaction is not complete, it will lead to thrashing in strength and also affect characteristics of the concrete and hence affects its performance.

The basic ingredients of concrete are fine aggregate,coarse aggregate, cement,and water. Cement is the binder that binds the ingredients together, water gives viscosity to the concrete ,in order to be molded and react with the ingredients, and the aggregate are what adds bulk to the concrete, but are not involved in the chemical processes.

With the increase in water cement ratio , percentage of hydration increases. So only sufficient amount of water is necessary for hydration as well as to increase strength. water also impart workability to concrete , but excess of it causes porous concrete. Hence for a certain limit, strength increase with the increase of water cement ratio . but after that strength decreases with the increase of water cement ratio.

There are various types of special concrete used for construction, among them one is self compacting concrete (SCC).It is clear from its name only that there is no need of compaction by the vibrator . SSC flows due to its self weight without any vibration in each corner of the formwork without any kind of segregation or blockade and the another type is Fibre Reinforced Concrete. It is made with cement containing fine or fine and coarse aggregate and discontinuous discrete fibres. The fibre used for FRC can be natural material (eg: cellulose, asbestos, sisal,banana,etc) or are artificial fibre such as glass , steel, carbon, and polymer(eg polypropylene, kevlar).

Self-compacting concrete (SCC) offers several technical benefits as well as economical benefits; the use ofl fibers extends its possibilities. Self-compacting high performance fiber reinforced concrete is the hybrid of self-consolidating concrete (SCC) and high performance fiber reinforced concrete (FRC). It is a highly fluid , non-segregating concrete with a strain-hardening response under tension accompanied by multiple cracking.the workability of concrete is increased by using plasticizers or super plasticizer (sikacim , sika viscocrete,etc)

II. METHODOLOGY

A. Main Framework

In this project we will analyze the effect of hybrid fibres on Self Compacting Concrete. the two fibres used in the project are Banana & Sisal fibre.

The main focus has been given to following points:

- General overview on fibre
- Extraction of fibres (banana & sisal)
- Effects of fibre on
  - fresh concrete
  - Hardened concrete
- Different tests to determine workability, tensile , compressive , flexural strength of both the concrete.

B. Fibre

The use of natural fibre like rice husk , coconut fibre etc or some artificial fibre like steel glass etc to reinforce concrete materials is a well–known concept. Since ancient times it is being practiced , with straw mixed into mud bricks and horsehair included in mortars. However, in our modern day construction practices we have forgotten the ancient practices to control cracks in concrete. Concrete cracking is normal. Plastic shrinkage occurs when the evaporation of water from the surface of concrete is greater than the rising bleed water. As concrete is weak in tension in its plastic stage, a volume change causes cracking in the surface. As it hardens, the water present in the pores of concrete begins to evaporate. This causes the concrete to shrink due to the volume change, which is restrained by the subgrade and reinforcement. This results in a tensile stress being developed in hardened concrete, again causing the concrete to crack.

Cracks lead to a bad perception of quality, durability and serviceability, however in most cases they become only aesthetic problems. Cracks also results in conflicts between the owner, design Engineer Architect, and contractor which results in job delays and cost of the construction increases due to work stoppages and evaluation, which is more severe than the actual consequences of cracking. One of the solutions to this problem is invention of ductility performance. To provide the advantages of using fiber reinforced concrete for different applications an attempt has been made in this article. The use of fibers help in enhancing the properties of concrete both in fresh and hardened stage and thus results into a more durable concrete. Incorporating fibers help to reduce thermal and shrinkage cracks. Addition of steel fibers enhances the, post-crack tensile strength, fatigue strength, ductility performance and impact strength of concrete structures.

The fibre used in the project are described.

C. Banana fibre

Banana plantation generates a huge volume of fibers as residues. The use of natural fibers as fillers in the rubber industry is a new trend. This is especially due to their availability, low cost and environmental friendliness. Of the commonly available natural fibers, banana fiber contains the highest cellulose content of 60-65%.However, in discriminate use of synthetic fibers causes severe impact on the environment as it pollutes the environment and is non-biodegradable. Thus it becomes necessary to explore natural fibers such as banana fibers.

D. Extraction of Banana Fibre

Certain care must be taken while the extraction of the natural fibre from the plant to avoid damge to it. In the present experiments done, initially the banana plant sections are cut from the main stem of the plant and then rolled lightly so that excess moisture can be drained out. Pigments, broken fibers, coating of cellulose which are the impurities in the rolled fibre. are removed manually by means of comb, and then the fibers are made to be cleaned and dried. This manual and mechanical extraction of banana fibers was , time consuming, tedious, and caused damage to the fiber. Hence, this type of Technique cannot be recommended for industrial application purpose.

Figure 1: Banana Fibre

E. Sisal Fibre:

Sisal plants such as *Agave sisalana*, consist of a sword-shaped leaves about 1.6–2 metres (4.9–6.6 ft) tall. Young leaves have a few minute teeth, but as they mature they lose them. They has a 7–10 year life-span and produces typically about 200–250 commercially usable leaves. Each leaf contains approximate 1000 fibres. Only about 4% of the plant by weight is taken as fibre weight. Sisal is said as a plant of the tropics and subtropics, since production increases from sunshine and temperatures above 25 degrees Celsius.

F. Extraction of Sisal fibre

Decortication is a process by which fibre is extracted in which leaves are beaten and crushed by a rotating wheel set with blunt knives, so that only fibres should remain. In East Africa production is typically on large scale,there the leaves are transported to a central decortication plant, and there water is used to wash away all the waste parts of the leaf.

The fibre is then left out to dry, brushed and baled for export. Proper drying must be done as fibre quality depends highly on moisture content of the fibre. Artificial drying gives much effective output and result with better grades of fibre than sun drying process, but is not always possible in the developing countries where sisal is being produced. In the drier climate sisal is mainly grown by smallholders of north-east Brazil and portable raspadors are used by the team to extract fibre which do not use water. Fibre is effectively cleaned by brushing. Dry fibres are combed by machine and sorted into various grades, largely on the basis of the previous in-field separation of leaves into size groups.

Figure 2: Extraction of sisal Fibre

III. MIX PROPORTION

A. *Mix Proportion of M-30 Conventional Concrete*

Table 1: Proposed Mix Design

Materials	Mix. 'A' (M30)
Water kg/m^3	160
Cement kg/m^3	380
Fine Agg. kg/m^3	711
Coarse Agg. kg/m^3	1283
Calculated Proportions	1 : 1.871 : 3.376
Suggested Proportions	1 : 2 : 3.5

B. *Mix proportion of SCFRC*

Self compacting concrete is prepared by increasing the coarse aggregate content to the mix.The self compacting property of this concrete is due to action of gravity The mix get compacted under its own self weight. No such proportion has been designed for SCC. the proportion used in the project is shown in the following table.

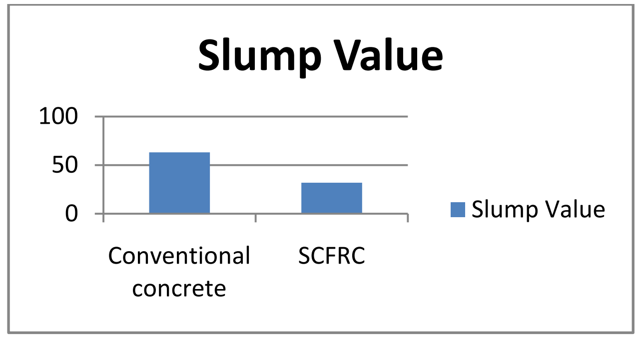
	MATERIAL	QUANTITY
1	Cement	1.41 Kg
2	Sand(< 4.75mm)	2.88 Kg
3	10mm aggregaate	1.14 Kg
4	20 mm aggregate	1.72 Kg
5	Fibre	.5% of Cement
6	Water	.45 w/c
7	Admixture (Sikacim)	1%

IV. OBSERVATIONS

A. *Slump Test*

SLUMP TEST REPORT

Designation	Sample Description	Mix Proportions	Slump (mm)
M1	M30 - Conventional	1 : 2 : 3.5	63
M2	M30 - Hybrid Fiber Reinforced		32

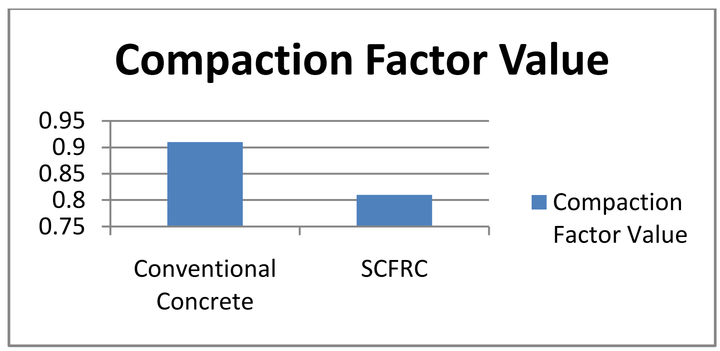


The experiment performed shows that the slump value of concrete is more than the SCFRC.

B. *Compaction Factor Test*

COMPACTION FACTOR TEST REPORT

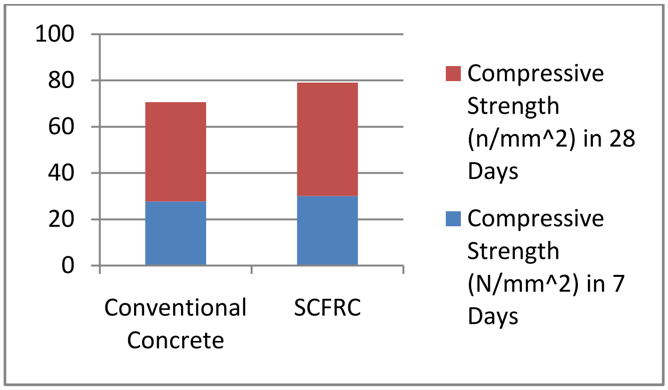
Designation	Sample Description	Mix Proportions	Compaction Factor
M1	M30 - Conventional	1 : 2 : 3.5	0.91
M2	M30 - Hybrid Fiber Reinforced		0.81



C. *Compressive Strength Test*

STRENGTH TEST REPORT

Batch No.	Sample Description	Compressive Strength Test (N/mm^2)		
		Size of Cube (mm x mm x mm)	7 days Strength	28 days Strength
M1	M30 – Conventional Concrete	150 x 150 x 150	27.72	42.90
M2	M30 - Hybrid Fiber Reinforced	150 x 150 x 150	30.10	49.00

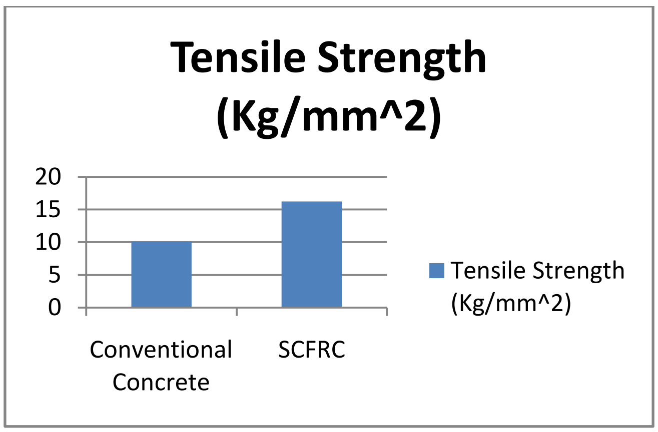


Fibre used in the SCFRC influences the compressive strength of the concrete. SCFRC shows better compressive strength than conventional concrete.

D. Tensile strength Test

TENSILE STRENGTH TEST REPORT

Designation	Sample Description	Mix Proportions	Tensile strength in 7 days (Kg/mm^2)
M1	M30 - Conventional	1 : 2 : 3.5	10.12
M2	M30 - Hybrid Fiber Reinforced		16.24

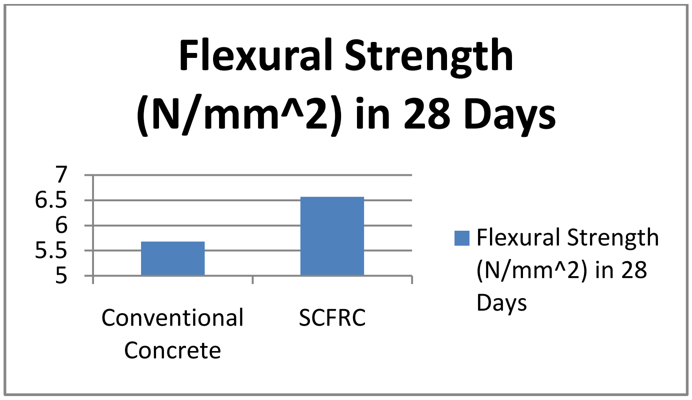


As we know that concrete withstand compressive load but fails at tensile load, addition of fibres increases the tensile strength of concrete.

E. Flexural Strength Test

FLEXURAL STRENGTH TEST REPORT

Batch No.	Sample Description	Flexural Strength Test (N/mm^2)	
		Size of Beam (mm x mm x mm)	28 days Strength
M1	M30 – Conventional Concrete	150 x 150 x 700	5.68
M4	M30 - Hybrid Fiber Reinforced	150 x 150 x 700	6.57



V. INTERPRETATION OF RESULT

A. Fresh Concrete

a. Scfrc gives Lower slump that means low workability,which creates problem during placing of concrete.
b. To increase workability more plasticizer can be used but it increases cost.
c. Proper dispersion of fibre should be done, after its addition its mixing becomes difficult , therefore it requires high degree of supervision

B. Hardened Concrete

a. Addition of fibres imparts Higher comp n flexural strength , which is more suitable for RCC frame members such as columns (comp members) n beams (flexural members)
b. The dispersed fibre imparts High tensile strength i.e, greater crack arresting property which can counteract the brittle failure property of concrete as it will resist for load and hence will be safer in areas of seismic activity
c. Addition of fibre should be specified range ,High fiber content damages the properties . The fibre content should be between 0.3-0.5%.
d. The addition of admixtures like super plasticizer although increases the cost of construction but it results in greater Compressive ,Tensile and flexural strength.

VI. STUDY OUTCOME

1. The study gives a comparison between the Conventional Concrete and self Compacting Fibre Reinforced Concrete on different properties of concrete like workability, durability and other properties of fresh concrete.
2. Self compacting fibre reinforced concrete give better compressive, tensile, and flexural strength.
3. Manufacturing of SCFRC requires skilled supervision. Its handling is little difficult than conventional concrete.
4. In Conventional concrete issue of degrading quality of concrete arises due to lack of compaction . This can be overcome by employing self compacting concrete.
5. SCFRC gives more crack resistant than conventional one and gives stability upto certain limit after crack on the structure.
6. It is a highly fluid, non-segregating concrete with a strain-hardening response under tension accompanied by multiple cracking.

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