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INVESTIGATION OF CRACKING BEHAVIOUR OF FIBER REINFORCED SELF COMPACTING CONCRETE(SCC)

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ABSTRACT

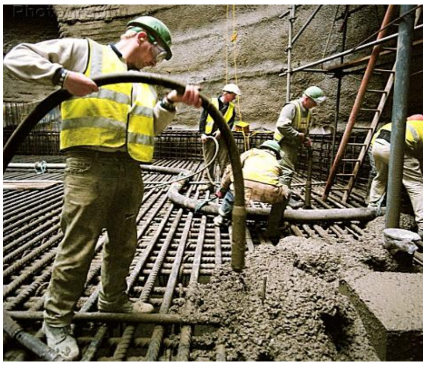
Concrete is been widely used construction material throughout the world were the properties and behavior of concrete changes with the materials used , add mixture water content and w/c ratio, workability of concrete is an a important criteria for placing concrete and for compacting of concrete special vibrating devices are been used, concrete also have the ability to get compacted by its own weight or mass by addition of add mixtures or fibers etc

This type of concrete is known as self compacting concrete(ssc). In the present study fiber reinforcements are introduced to observe the physical, chemical and mechanical properties of the self compacting concrete (scc)

Fibers are added to concrete to increase the flexural strength of concrete and to arrest the cracking pattern developed in the concrete. This fibers used in the study are 15mm long glass fiber and carbon fiber. The volume fraction of fibers taken are 0.1%, 0.15% ,0.2% grade of concrete considerd is m40 max

I. INTRODUCTION

- Concrete is a heterogeneous material prepared with fine aggregate, coarse aggregate, water and cement the properties of concrete will change with the mix proportions of materials, water content and temperature. Most concretes used are lime-based concretes such as Portland cement concrete.



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Introduction

Types of concrete

1. Normal concrete.
2. High Strength Concrete.
3. High Performance Concrete.
4. Air Entrained Concrete.
5. Light Weight Concrete.
6. Self Compacting Concrete.
7. Pervious Concrete.



II. SELF COMPACTING CONCRETE

• Self compacting concrete is a type of concrete which has the ability to flow and fill every part and space of the shuttering it doesn't require external vibrating techniques. Slump of the Self compacting concrete is maintained very high by adding admixtures in concrete this type of concretes are compacted by their self weight. Self compacting concrete is developed in Japan and European countries.


Advantages of Self compacting concrete:

1. Improved quality of concrete and reduction of onsite repairs.
2. Faster construction times.
3. Lower overall costs.
4. Facilitation of introduction of automation into concrete construction.
5. Better surface finishes.
6. Easier placing.

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Disadvantages of Self compacting concrete:

1. SCC requires high fluidity in tight joints formwork, which slowdowns the casting rate.
2. Due to its low water-cement ratio, plastic shrinkage cracks may occur
3. Highly skilled and experienced workers are required for the production of SCC.
4. It is more costly than any other conventional concrete.
5. Additional costs for admixtures.

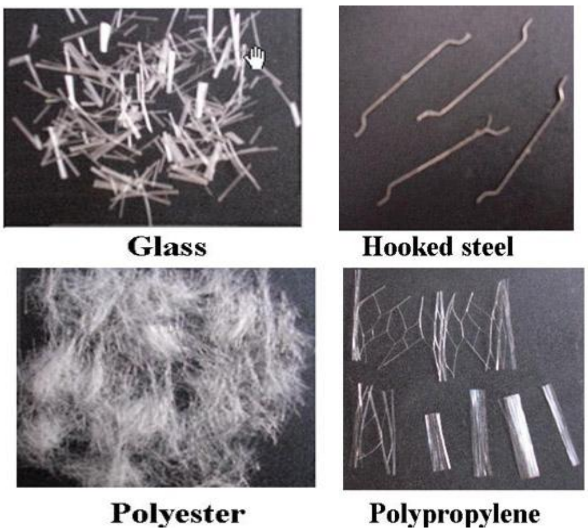
There is an innovative change in the Concrete technology in the recent past with the

III. FIBER REINFORCED CONCRETE

- accessibility of various grades of cements and mineral admixtures. The main purpose of the fiber is to control cracking and to increase the fracture toughness.


Types of Fibers used for concrete

- Glass fibers
- Carbon fibers
- Basalt fibers
- Plastic fibers
- Polypropylene fibers
- Organic Fibers
- Asbestos Fibers



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Fibers used in this study

• The fibers used in this study are 15 mm long glass fiber and carbon fiber. The volume fractions of fibers taken are 0.1%, 0.15%, 0.2%. Grade of concrete considered is M40 mix.

Fig : glass fiber and carbon fiber used for fiber reinforced concrete

IV. LITERATURE SURVEY

• **GaoPeiwei., et al. (2000)** the authors has studiedspecial type of concrete, in which same ingredients are used like conventional concrete. Keeping in mind to produce high performance concrete, mineral and chemical admixtures with Viscosity Modifying Agents (VMA), are necessary. The objective is to decrease the amount of cement in HPC. Preserving valuable natural resources is the primary key, then decrease the cost and energy and the final goal is long-term strength &durability.

• **Raghu Prasad P.S. et al. (2004)** the authors has studied that the use of admixtures both initial and final setting times of cement are getting late. This is due to the delayed pozzolanic reaction affected by the addition of particular admixtures. This type of delayed setting property is occasionally helpful during the concreting in summer season. There will also significant strength gain for mixed cements and concretes after 28 days. Due to this reason concrete corrosion will be less.

• **Okamura et al. (1995)** author established a special type of concrete that flows and gets compacted at every place of the formwork by its own weight. This research work was started combined by prof. Kokubu of Kobe University, Japan andProf. Hajime Okamura. Previously it was used as anti washout concrete. They initiate that for attainment of the self-compact ability, usage of Super Plasticizer was necessary.The water/cement ratio should be in between 0.4 to 0.6. The self-compactability of the concrete is mainly affected by the material characteristics and mix proportions. Author restricted the coarse aggregate content to 60% of the solid volume and the fine aggregate content to 40% to attain self-compact ability.

• **Kung-Chung Hsu, et al. (2001)** Authors projected a new mix design technique for SCC and their main emphasis was with binder paste to fill voids of loosely filled aggregate. They familiarized a factor called Packing Factor (PF) for aggregate. It is the ratio of mass of aggregates in firmly packed state to the one in loosely packed state. The method completely influenced bythe Packing Factor (PF). The amount of binders used

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in the proposed method can be less than that required by other mix design methods due to the increased sand content. Packing factor influence the aggregate content and that affects the fresh properties of concrete.

- **R.SriRavindrarajah, et al. (2003)**the author obtained an experimental investigation between the properties of flowing concrete and self-compacting concrete mix having different percentage of high-water reducing super-plasticizer. The properties investigated were workability, bleeding capacity, segregation potential, compressive and tensile strengths, and drying shrinkage. Drying shrinkage was influenced by the mix compositions and super-plasticizer dosage.
- **Frances Yang,et al. (2004)** this paper investigates the technique to develop SCC as well as its components and mix proportioning methods. It highlights several benefits of using SCC and mentions to several tools used to measure its properties. Again, it reports the protective measures that should be taken for preparing and developing the mix and some model applications of SCC was proposed by the author, for example, Toronto International Airport. A high strength SCC was used for constructing compactly reinforced elements poured in beneath freezing weather for the 68 Story Trump Tower in New York cityof USA.

Table : proportion of M40 concrete mixes

Grade	Designation	Description	Designation	Fiber content (%)
M40	PSCC	Plain self compacting concrete	PSCC	0.0%
M40	GFSCC-0.1	0.1% Glass fiber reinforced SCC	GFSCC-0.1	0.1%
M40	GFSCC-0.15	0.15% Glass fiber reinforced SCC	GFSCC-0.15	0.15%
M40	GFSCC-0.20	0.20% Glass fiber reinforced SCC	GFSCC-0.20	0.20%
M40	CFSCC-0.1	0.1% carbon fiber reinforced SCC	CFSCC-0.1	0.1%
M40	CFSCC-0.15	0.15% carbon fiber reinforced SCC	CFSCC-0.15	0.15%
M40	CFSCC-0.2	0.2% carbon fiber reinforced SCC	CFSCC-0.2	0.2%

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Table : Mechanical Properties of Fibers

Type of fiber	length	Density(g/cm^3)	Elastic modulus (MPa)	Tensile strength(MPa)
Glass	15mm	2.53	43-50	1950-2050
carbon	15mm	1.80	243	4600

Fig : glass fiber and carbon fiber used for fiber reinforced concrete

- slump flow testSlump flow test is used widely to determine the free flow of the self compacted concrete (SCC) with any restrictions or obstructions to the flow of the concrete..

1. Concrete is placed inside the inverted slump cone without any vibration or tamping, the concrete is allowed to compact or settle by its own weight.
2. Slowly the inverted cone is lifted up and the concrete is allowed to flow freely.
3. The cone was vertically lifted and allows the concrete to flow out freely. Immediately the stop watch was started, and reading was recorded for T_{50} test when concrete reached 500mm marked circle.

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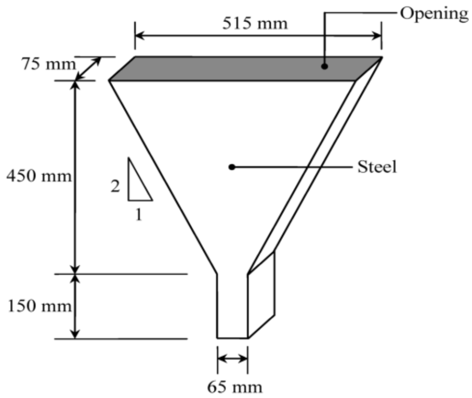
V.FUNNEL TEST

- This test is performed to determine the flow-ability of self-compacting concrete. And also to determine the viscosity of concrete due to internal friction effect.
- Concrete with higher degree of slump is prepared.
- Concrete is placed and leveled at the top in the V shaped funnel.
- The trap door is opened at the bottom of the V shaped funnel and the time to flow out completely is measured by a stop watch
- The funnel is again filled up with the concrete and the flow-ability of self-compacting concrete is measured again



L box test

- The test is for measuring the flow of the SCC and the blocking resistance. The blocking resistance is found by placing 3 reinforcement bars or fixed rods as shown in figure below and the flow length is measured.
- L box test Apparatus is placed on a level surface and the side faces of the apparatus are oiled.
- The vertical part of the box was filled in concrete, which is left for 10secs.
- The height of the concrete is measured in vertical box is H_1.
- Three reinforcement bars are placed as a obstruction.
- The length of the concrete flow is measured in horizontal box is H_2.
- The criteria to satisfy self compacting concrete(SCC) is $H_2/H_1 > 0.8$

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Casting & curing of specimens

• Cubesof size (150×150×150) mm, cylinders(150×300)mm, prisms(100×100×500)mm were casted and investigations were conducted to study the mechanical behavior, fracture behavior, microstructure of plain SCC for glass fiber reinforced SCC(GFSCC), carbon fiber reinforced SCC(CFSCC).

• After casting was done the cubes were kept in room temperature for 24 hours then the moulds were removed and taken to the curing tank containing fresh potable water to cure the specimen for 7 days and 28days, there after the casted concrete samples were tested in the laboratory to find the results.

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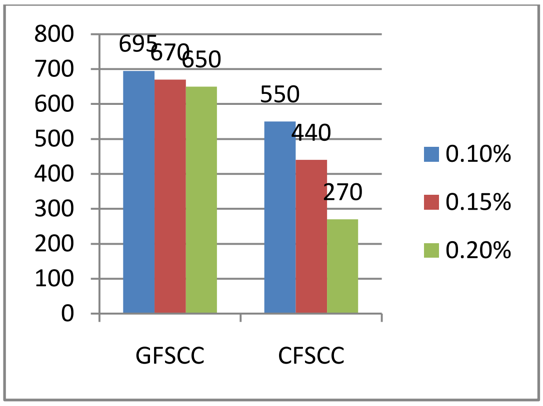
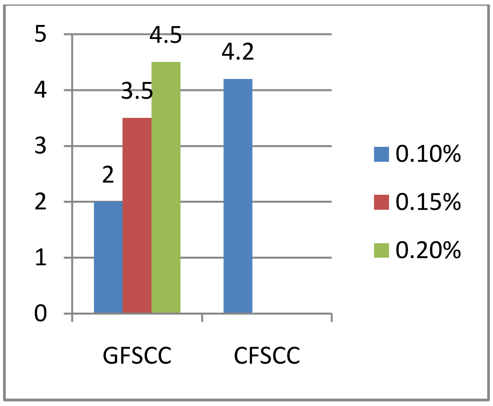
Test results from SCC

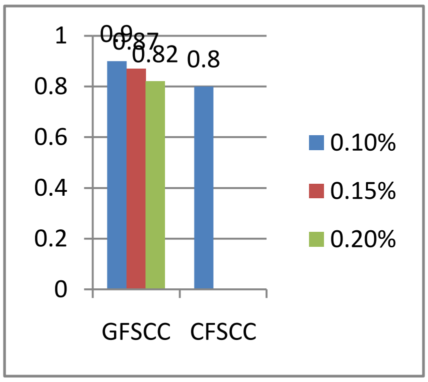
Sample	Slump flow 500-750mm	T50 flow 2-5 sec	L-box(H_2/H_1) 0.8-1.0	V-funnel 6-12 sec	T5 flow +3sec	remarks
PSCC	700	1.8	0.9	5	8	Low viscosity
GFSCC-0.1	695	2.0	0.9	6	9	Result satisfied
GFSCC-0.15	670	3.5	0.87	6.7	10	Result satisfied
GFSCC-0.20	650	4.5	0.82	7.7	11	Result satisfied
CFSCC-0.1	550	4.2	0.8	9	13	Result satisfied
CFSCC-0.15	400	-	-	17	-	High viscosity
CFSCC-0.2	270	-	-	25	-	High viscosity



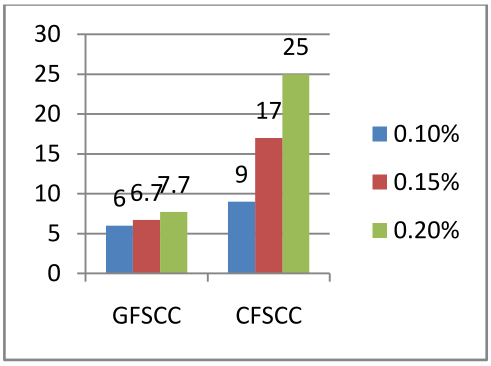
Graph : slump flow of fiber reinforced SCC



Graph : T_{50} of fiber reinforced SCC



Graph : L-box test of fiber reinforced SCC



Graph : V funnel test of fiber reinforced SCC

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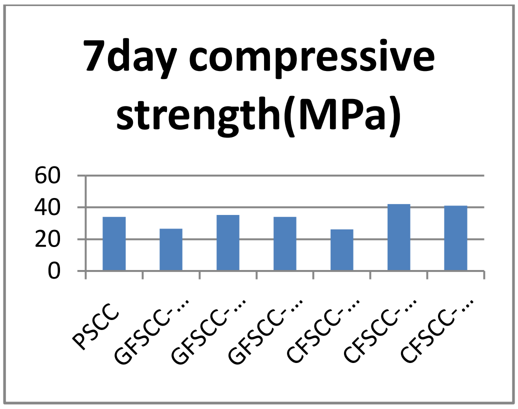
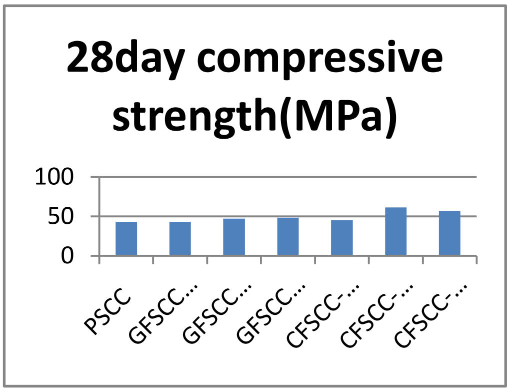
Table : strength of concrete from results

MIX	7day compressive strength(MPa)	28day compressive strength(MPa)	28day split tensile strength(MPa)	28day flexural strength(MPa)
PSCC	34	43.10	4.4	7.9
GFSCC-0.1	26.50	43.0	3.1	9.85
GFSCC-0.15	35.2	47.2	4.90	10.30
GFSCC-0.20	34.1	48.4	4.98	11.20
CFSCC-0.1	26.10	45.0	3.32	10.10
CFSCC-0.15	42.10	61.2	5.4	13.30
CFSCC-0.2	41.0	57.1	4.90	11.50 0

7day compressive strength(MPa) **28day compressive strength(MPa)**

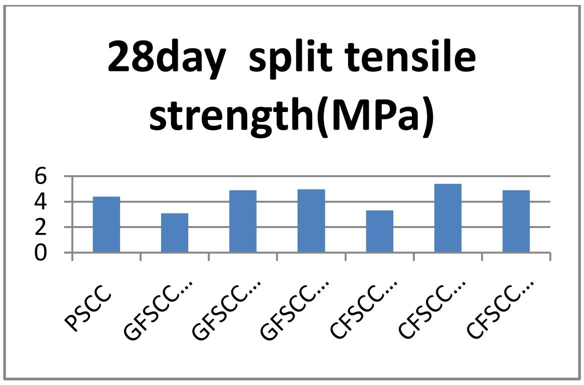


Graph : variation of 7days compressive strength

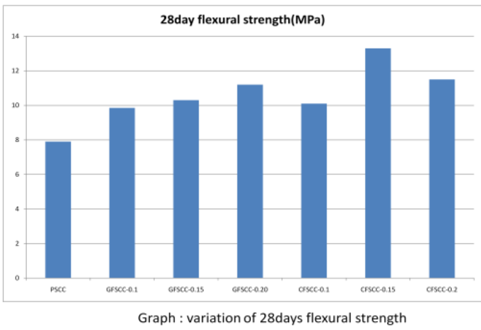


Graph : variation of 28days compressive strength

28day split tensile strength(MPa)



Graph : variation of 28days split tensile strength



Graph : variation of 28days flexural strength

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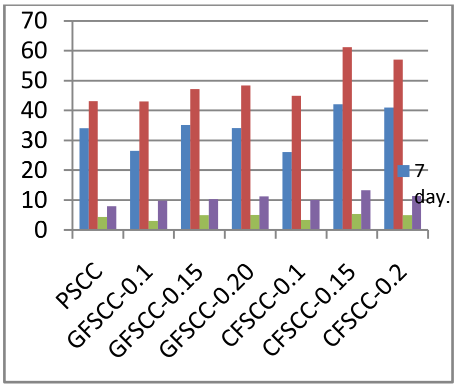

Graph : cumulative graph for compressive, tensile and flexural

VI. CONCLUSIONS

From the present study the following conclusions were drawn the fibers used in this study are 15 mm long glass fiber and carbon fiber. The volume fractions of fibers taken are 0.1%, 0.15%, 0.2%. Grade of concrete considered is M40 mix.

1. Addition of fibers to self-compacting concrete causes loss of basic characteristics of SCC measured in terms of slump flow, etc.
2. Reduction in slump flow was observed maximum with carbon fiber than glass fiber respectively. This is because carbon fibers absorbed more water than others and glass absorbed less.
3. Carbon fiber should not be more than 2% because the mix becomes harsh which did not satisfy the aspects like slump value, T_{50} test etc. required for self-compacting concrete.
4. Mix having 0.15% carbon fiber and glass fiber were observed to increase the mechanical properties to maximum.
5. 0.15% addition of glass fiber to SCC was observed to increase the 7-days compressive strength by 3.52% when compared with plain SCC.0.15% addition of carbon fiber to SCC was observed to increase the 7-days compressive strength by 23.82% when compared with plain SCC.
6. Compressive strength at 28days in concrete with 0.2% glass fibers is reduced when compared with 0.2% carbon fibers by 17.97%.
7. Split tensile strength is high for concrete with glass fibers when compared with carbon fibers.
8. Flexural strength of the concrete is increased with provision of fibers in concrete than the plain self compacting concrete.
9. Flexural strength for 0.15% fibers is increased by 29.12% for carbon fibers compared with the glass fibers.
10. The performance of carbon fiber reinforced SCC mixes was better than basalt glass FRSCC mixes.

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