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Investigations on Flow and Strength of Glass Fiber Self Compacting Concrete

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Abstract - *Fibre-reinforced self-compacting concrete (FRSCC) is a new building material that combines positive characteristics of workability of self-compacting concrete (SCC) with enhanced characteristics of hardened concrete due to fibre addition. Fibers were combined randomly to create fibre reinforced concrete during the time, and fibres came in a variety of diameters. Generally, concrete has a higher compressive strength than it has tensile strength. However, random fibre insertion often boosts the tensile properties of the concrete without changing the compression properties. The purpose of this experimental work is to describe the mechanical strength behaviour of glass fibre reinforced Self Compacting Concrete (SCC) when it is exposed to compression, flexural, and split tensile strength tests for concrete grade M 70. Glass fibre contributed 0.5-2 percent of the binder. The mix design for M70 grade was determined in accordance with the codal clause of IS10262. The slump flow, L box, and V funnel tests are used to determine the different SCC fresh features such as flow ability, passage ability, and segregation resistance. Additionally, the compressive strength, flexural strength, and split tensile strength of firm concrete are determined.*

Key Words: Self Compacting Concrete, Fiber reinforced self-compacted concrete, Glass fiber, fiber reinforcement

1. INTRODUCTION

Self-compacting concrete (SCC) is a relatively new building material which is able to flow under its own weight, totally filling the formwork, however maintaining homogeneity even in the existence of congested reinforcement, and then consolidating without compaction. Time required for construction is shorter and production of SCC is without noise and vibrations. Also, SCC yields a good surface finish and gives better freedom in design. Filling ability, passing ability and segregation resistance are the important properties of SCC which are attained by increasing the amount of fines (i.e. particles <0.125 mm), reducing water-powder ratio and using a superplasticizer [1,2]. With increase in content of fines, paste volume in SCC is increased, thus resulting in high shrinkage and creep. To reduce the paste content sometimes a stabilizer (viscosity modifying admixture) is used to improve the segregation resistance of SCC [3]. Fibre-reinforced self-compacting concrete (FRSCC) is a new building material that merges the advantages of the SCC with the positive effects of the fibre addition to a brittle material (concrete). It is a ductile material that in its fresh state runs into the interior of formwork, filling it in a natural way, passing through the obstacles, and consolidating under the action of its own weight. FRSCC can diminish two opposing weaknesses: cracking resistance in plain concrete and poor workability in fibre-reinforced concrete (FRC). FRSCC has found vast application in the construction of tunnel lining and railway sleepers. Another application of FRSCC is in the repair of highway and airfield pavements.

Development of SCC gives major solution for placing concrete at high reinforced places and also its give better durability nature at the time of cast in-situ concrete. The SCC usage not affects the amount of reinforcement content in conventional concrete design. Other then durable advantage the SCC get high amount of resistance in segregation but, it's get high flow ability. So, its possible to pump SCC in long distance and also the SCC used for various products. The various fiber additions on self compaction concrete improve their durability and strength characters. This project use glass fiber for improving strength and also reduce the unit weight purpose.

Self Compacting Concrete generally possesses a high powder content which keeps the concrete cohesive with a high flowability.

- Faster progress, as more amount of concrete free fall is possible
- Better surface finishes because of more fines and better fluidity
- Better molding ability, there by easy to shape the concrete for aesthetics

1.1 NEED FOR THIS STUDY

Addition of fibers improves the strength character of concrete and the problem of developing micro cracks at the time of curing in self compacting concrete was overcome by use of glass in concrete. A Glass fibre has supplies strength to the concrete whereas the matrix protects the fibers.

The main role of the glass fiber addition is increase tensile strength as well as reduces the amount of tensile crack development in concrete. The fibers additions also improve the deformation character of the concrete composite. Addition of glass fiber reduces the water permeability without affecting flow character of concrete and also increases the flexural character due to high modulus of elasticity of glass fiber. The various energies absorbed during curing stage to reduce the creak formation on concrete.

1.2 OBJECTIVES AND SCOPE OF THE WORK

The objectives of this experimental study are to study of various effect of the glass fiber addition on the strength and flow of M70 grade of Self compacting concrete. The following Chapters explains a schematic flow of the work with the objectives laid as explained above. With the above objectives in mind the experimental program is categorized as detailed below.

In this study, high strength (M70) of SCC with three different glass fiber content (0.5%, 1%, 2%) were designed, to determine the best effective percentage of glass fiber addition level on SCC.

2. LITERATURE REVIEW

Subhan Ahmad, Arshad Umar , Amjad Masood (2016) had conducted experimental investigation to comparative experimental study the fresh and hardened properties of normal concrete with self compacting concrete (SCC) and SCC with glass fibers. It was found additional amount of glass fibers slightly reduced the workability properties of SCC. Compressive strength and splitting tensile strength of SCC increased minimum amount compare to the conventional concrete strength.

A. Deepak Raj, M. Mergin Benize, J. Esther Daisy, M. Sri Nikhil (2014) conducted various experimental study on Glass Fiber Reinforced Self Compaction Concrete (GFRSCC). The objectives of this investigation are to study the workability and mechanical characters of plain SCC and GFRSCC. The laboratory tests of slump flow test, sieve segregation resistance test, L-Box test, ultrasonic pulse velocity (UPV) test, density test, compressive strength test, splitting tensile strength test, and flexural strength test. They observed from the result that the flow ability of fiber added concrete is directly proportional to its length and quantity added (i.e.) the result comes under the range of recommended values when the quantity and length of the glass fiber added is high. 1% of S-glass fiber in all sizes is more flow able than 0.25% of S-glass fiber in all sizes. They can noticed that the 1% of 2.4 mm size glass fiber.

C.Selin Ravikumar and T.S. Thandavamoorthy (2013) examined the glass fiber concrete and its various characters. Generally the Glass fiber gets higher tensile strength and fire resistant characters, this character reduce the amount of the loss of damage during fire accident of concrete structures. In this experimental study use glass fibers size 450 mm length. It's added to the concrete by volume fraction range of up to 1% to determine its fire resistant characteristics and strength. Comparative study of the strength characters and fire-resistance performance of normal concrete and glass fiber concrete was made. From the fire resistant test results the compressive strength was reduced, after increasing temperature the concrete at 300C for 2 hours. In case the fiber content was not include then the compressive strength of the concrete reduced up to 32%. For every 0.5% addition of glass fiber, the decrease rate of the compressive strength is 25 per cent compares to it's original strength. Similarly, 1 percent amount of glass fiber addition, decrease the compressive strength in the range of 10% over it's original strength. From This study results the fire resistance of the fiber reinforced get increased when compare to the conventional concrete mix. So, glass fiber content in concrete has a good fire resistant character.

3. METHODOLOGY

This experimental study is to investigate the fresh concrete stage and harden concrete strength properties of various grade of concrete with the different amount of glass fiber to be added in self-compacting concrete. The methodology includes,

1. Literature collection
2. Collection of materials
3. Testing of materials
4. Self Compacting Concrete fresh state tests
5. Casting of specimen
6. Testing of specimen for hardened stage
7. Result analysis.

3.1 MATERIAL PROPERTIES

The following table gives details about the various material properties

Table -1: Material properties

Material	Specific gravity	Water absorption%
Cement	3.15	---
Flyash	2.20	---
CoarseAggregate	2.75	0.60
Fine Aggregate	2.65	1.20
Admixture	1.20 to 1.25	

3.2 MIX PROPORTION

Table -2: Mix proportions

W/c	Cement	Fine agg.	Coarse agg.
0.35	1.0	1.26	1.60

3.3 MATERIAL REQUIREMENT

Table -3: Material requirement

Material		Kg/m³
Cement		415
Flyash		110
Water		196
Fine aggregate		705
Coarse aggregate	12.5mm	447
	20	447
Admixture(0.5%)		2.8

3.4 MIX PROPORTIONS OF SELF COMPACTING MIXES

In this experimental study was done M70 SCC mix proportion with various percentage of glass fiber reinforcement. The following table give the detail about the various percentage of glass fiber reinforcement details

Table -4: Various mix proportion

SCC 70	(0% glass fiber of volume of concrete)
0.5%SCC70	(0.5% glass fiber of volume of concrete)
1.0% SCC70	(1.0% glass fiber of volume of concrete)
2.0% SCC70	(2.0% glass fiber of volume of concrete)

4. RESULTS AND DISCUSSION

4.1 FRESH CONCRETE PROPERTIES OF SCC

Many different test methods was generally developed to find out various properties of the fresh concrete mix of self compaction concrete (SCC). But, no single or combination of various methods was achieved for universal approval of SCC testing. Similarly, no single method was found to obtain all fresh concrete mix details. Each and every mix design should be tested by more than one test method to obtain different workability parameters.

Table -5: Slump cone results of Concrete

S.No	Mix ID	Slump value (mm)	Time (sec)
1	SCC 70	680	3
2	0.5%SCC70	650	3
3	1.0% SCC70	600	4
4	2.0% SCC70	560	6

Table -6: Lbox& Vfunnel results of Concrete

S.No.	Mix ID	L-Box (h2/h1)	V Funnel (sec)	V-Funnel at 50mmm (sec)
1	SCC 70	0.9	8	3
2	0.5%SCC70	0.95	8	4
3	1.0%SCC70	0.98	10	6
4	2.0%SCC70	1.30	12	8

Fig -1: Slump cone Test

Fig -2: L-box and V-funnel test

4.2 HARDEN CONCRETE PROPERTIES OF SCC

4.2.1 COMPREESIVE STRENGTH RESULT

Results of 7 days and 28 days compressive strength are presented in table 7 and 8 and illustrated in Fig.3

Table -7: 7days Compressive strength

	7days compressive strength (N/mm²)	Average (N/mm²)
SCC 70	46.8	46.27
	45.46	
	46.5	
0.5%SCC70	51.8	50.89
	50.0	
	51.1	
1.0% SCC70	56.3	55.98
	550	
	56.3	
2.0%SCC70	62.9	61.58
	60.9	
	61.6	

Table -8: 28days compressive strength

Mix id	28days Compressive strength (N/mm²)	Average (N/mm²)
SCC 70	73.31	73.68
	72.56	
	75.18	
0.5%SCC70	76.97	77.36
	76.18	
	78.93	
1.0% SCC70	80.82	81.32
	79.98	
	82.87	
2.0%SCC70	84.85	85.28
	83.98	
	87.02	

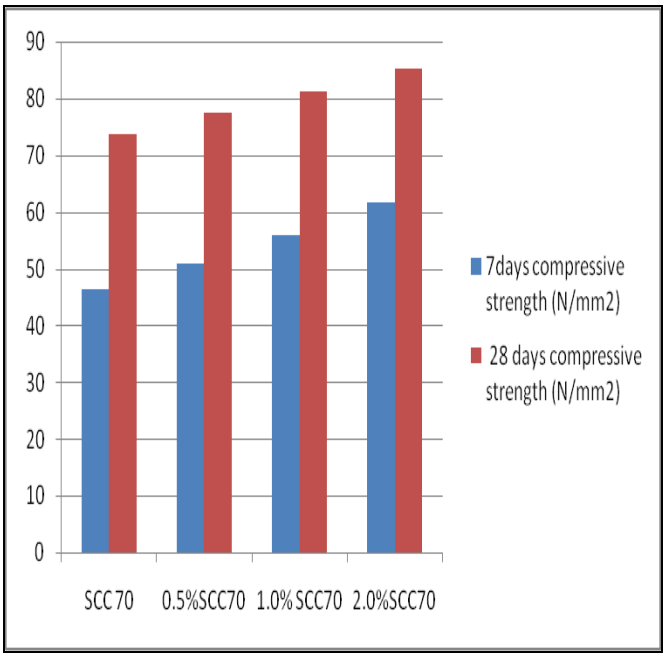

Fig -3: Compressive strength result Graph

Fig -4: casting and testing of concrete

4.2.2 SPLIT TENSILE STRENGTH

Results of 7 days and 28 days split tensile strength are presented in table 9 and illustrated in Fig.5

Table -9: Split tensile strength

S.No	Mix ID	7 days strength (N/mm²)	28days strength (N/mm²)
1	SCC 70	5.5	6.3
2	0.5%SCC70	5.8	6
3	1.0% SCC70	6	7
4	2.0% SCC70	6.1	7.25

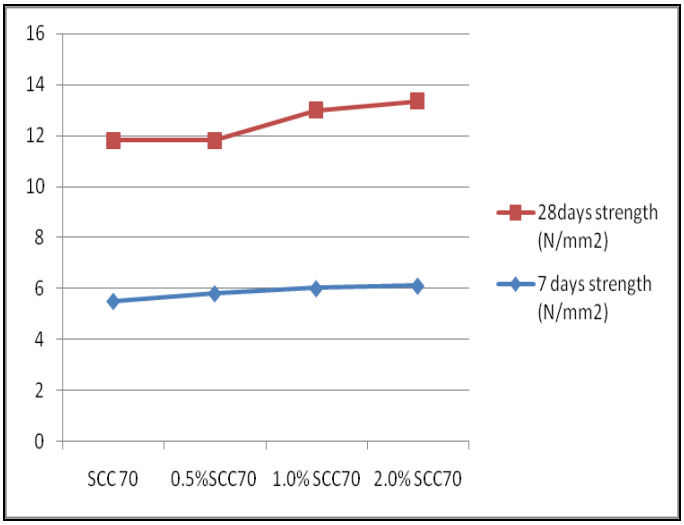

Fig -5: Split tensile strength graph

Fig -6: Split tensile test arrangements

4.2.3 SPLIT TENSILE STRENGTH

Results of 28 days flexural strength are presented in table 10 and illustrated in Fig.7

Table -10: Flexural strength

S.No	Mix ID	28 days strength (N/mm²)
1	SCC 70	7.6
2	0.5%SCC70	7.8
3	1.0% SCC70	8
4	2.0% SCC70	8.2

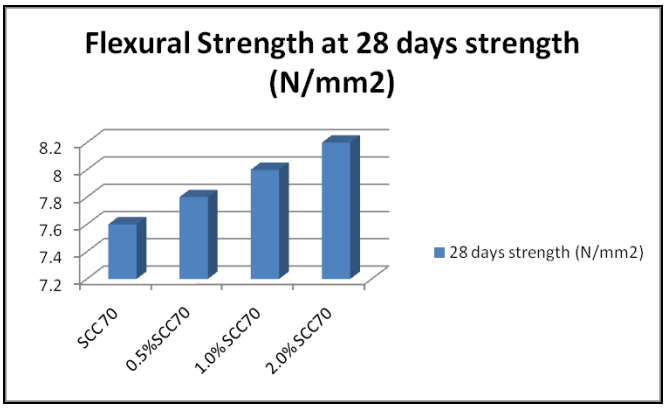

Fig -7: Flexural strength graph

5. CONCLUSION AND FUTURE SCOPE

The main purpose of this experimental study is to investigate and mechanical properties and workability characters of SCC and Glass fibre reinforced Self Compacting Concrete. The various laboratory tests are conducted like L-Box test, slump

flow test, compressive strength test, splitting tensile strength test, and flexural strength test of various test specimen was found. From the various test result the following solution was obtained:

a) Glass fiber reduces the possibility of cracks during curing period and improves the surface integration to reduce the bleeding properties.

b) Workability of self-compacting concrete decreases when the amount of increase in glass fiber volume fraction. However, the higher workability obtain by adding high range water reducers.

c) The glass fiber addition increases the compressive strength and tensile strength of the SCC.

d) The addition of glass fibers improves the durability characters and the fracture parameters of concrete future work.

e) The optimum water cement ratio can be determined to produce self-compacting concrete using glass fiber reinforcement with required workability.

Various characters like modulus of elasticity, shrinkage and creep properties of SCC with glass fiber reinforcement can be taken for further research work.

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