Analysis of Compressive Strength of High Grade Glass Fibre Reinforced Self-Compacting Concrete

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***Abstract*— A self-compacting concrete (SCC) is the one that can be placed in the form and can go through obstructions by its own weight and without the need of vibration. In this work an attempt has been made to analyse the compressive strength of Glass fibre Self–Compacting Concrete under confined and unconfined states with different percentages of confinement (in the form of hoops). Since the confinement provided by lateral circular-hoop reinforcement, is a reaction to the lateral expansion of concrete,**
lateral reinforcement becomes effective only after considerable deformation in the axial direction.

Keywords*— Glass fibre, Reinforced self-compacting contrete, Admixtures, Compressive strength analysis.

I. INTRODUCTION

Concrete is a vital ingredient in infrastructure development with its versatile and extensive application. It is the most widely used construction material because of its mouldability into required structural form and shape due to its fluid behavior at early ages. However thorough compaction, using vibration, generally essential for achieving the required strength and durability of concrete. Inadequate compaction of concrete results in large number of voids affecting performance of structures. Self compacting concrete provide solution to these problems. SCC is a recently developed concept in which the ingredients of the concrete mix are proportioned in such a way that it can flow under its own weight to completely fill the formwork and passes through the congested reinforcement without segregation and self consolidate without any mechanical vibration. In this work a attempt has been made to analyse the compressive strength of glass fibre self compacting concrete under confined and unconfined states with different percentage of confinements.

II. MATERIALS USED

A. Cement

Ordinary Portland cement of 53 grade available in local market is used in the investigation. The Cement used has been tested for various proportions as per IS 4031- 1988 and found to be confirming to various specifications as per IS 12269-1987.The specific gravity was 3.03 and fineness was 2800cm^2/gm.

Specific Gravity of Cement	3.03
Initial Setting time	Min. 30 min
Final Setting time	Max. 600 min
Normal Consistency	31%
Compressive Strength	54.7 N/mm^2

Physical properties of cement

Chemical property	Results	Limits as per IS
Lime saturation Factor (%)	0.78	0.66 min - 1.02 max
Alumina Iron Ratio (%)	1.2	Min 0.665
Insoluble Residue (%)	0.8	Max 2%
Magnesia (%)	2.1	Max 6%
Sulphuric Anhydride (%)	1.1	2.5% to 35
Loss on ignition (%)	2.0	Max 5%

Chemical composition of cement

B. Fine aggregate

River sand was used as fine aggregate is natural and obtained from local market. The physical properties like specific Gravity, bulk density, gradation fineness modulus are tested in accordance with IS 2386.

C. Coarse aggregate

The crushed angular granite metal of coarse aggregate of 20 mm maximum size as well as 12mm size are obtained from the local crushing plant, is used in the present study. The physical properties of the coarse aggregate like specific gravity, bulk density, gradation fineness modulus are tested in accordance with IS 2386.

D. Fly ash

In the present investigation work, Type-II fly ash was used as cement replacement material. The specific surface area of fly ash is found to be 484.20 m2/N by Blane's Apparatus. The properties of fly ash are confirming to I.S. 3812 -1981of Indian Standard Specification for Fly Ash for use as Pozzolana and admixture. & IS 456-2000 can be used to produce good quality concrete. Typical characteristics of good quality fly ash are as follows:

- Fineness (Blaine's): 48.42 m2/N (Min.)
- Lime Reactivity: 4.5 N/mm2 (Min.)
- Loss on ignition: 5% (Max.)

E. Chemical admixtures

Super plasticizer (Glenium -B233**)** (With base material Poly Corboxylic Eather)

F. Viscosity modifying agent

A Viscosity modified admixture for Glenium -2 (With base material Poly Corboxylic Eather) which is free flowing liquid Chloride Content was used as Viscosity Modifying Agent.

G. Glass fibres

The glass fibres are of Cem-FIL Anti – Crack HD (High Dispersion) Glass Fibres with Modulus of Elasticity 72 GPa, Filament Diameter 14 Microns, Specific Gravity 2.68, Filament length 12mm and having Aspect Ratio of 857: 1. The number of fibres per 1 kg is 212 million fibres.

1	Trade Name	Cem FIL anti-crack High Dispersion Glass Fibres
2	Number of fibres	212 million/Kg
3	Aspect ratio	857:1
4	Specific surface area	105m^2/Kg
5	Typical addition rate	0.6 Kg/m^3 of concrete
6	Tensile strength	1700 N/mm^2
7	Modulus of Elasticity	73 GPa
8	Corrosion resistant	Excellent
9	Specific gravity	2.6
10	Density	26 kN/m^3
11	Filament diameter	14 µm
12	Filament length	12mm

Properties of selected glass fibres

H. Water

Confirming to IS 456-2000.

III. MIX PROPORTIONS

M50 grade SCC mix was designed based on Indian Standard Recommended Method of Concrete Mix Design (IS 10262-1982), and was further modified by fine tuning the relative proportions of fine and coarse aggregate, filler material like fly ash, glass fiber along with super plasticizers and viscosity modifying agents.

Material	Quantity (kg/m^3)
Cement	425
Fine Aggregate	794.93
Coarse Aggregate	896.40 (627+269) (70%+30%)
Water	190
Fly ash	209
Glass Fibres	0.60
Super plasticizer	85 ml (0.04132 m^3)
Viscosity modifying agent	3 ml

IV. MODELS OF SPECIMENS

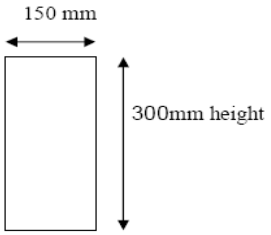
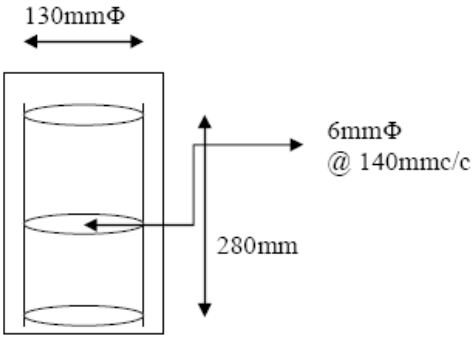
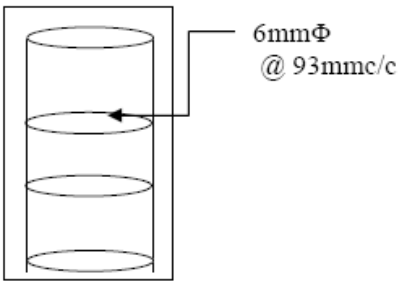


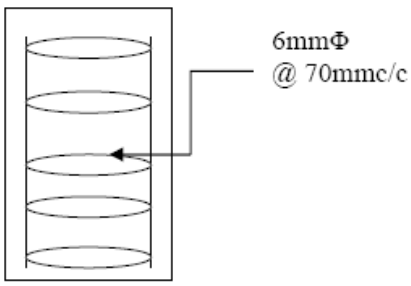
Fig 1: Cylinder without confinement



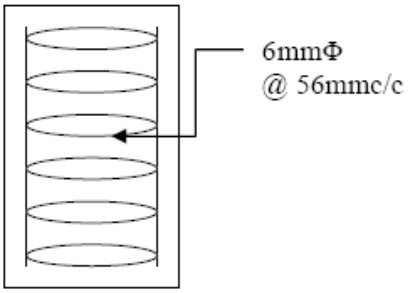
(a) 0.798% confinement



(b) 1.062% confinement



(c) 1.327% confinement



(d) 1.591% confinement

Fig 2: Cylinder with confinement

Steel as a confining material is used in Concrete and the properties of concrete was studied. The concrete bond strength should be sufficient to prevent bond failure. The effectiveness of bond is affected by the position of the embedded bars and the quality of concrete as cast. An adequate concrete cover is necessary in order to properly transfer bond stresses between steel and concrete. The main reasons for taking steel as a reinforcing material is:

- its thermal coefficient of expansion is similar to that of concrete.
- it develops good bond with concrete.
- it is cheaply and easily available in the market.
- it is economical comparing to all the aspects.

V. COMPRESSIVE STRENGTH

In the present investigation the size of 100 x 100 x 100 mm are used. In the compressive test, the cube while cleaned to wipe of the surface water, is placed with the cast faces in contact with the planes of the testing machine, i.e. the position of the cube then tested is at right angles to that as cast.

The specimens were removed from the moulds and submerged in clean fresh water until just prior to testing. The temperature of water in which the cylinders were submerged was maintained at 27o C+2o C and 90% relative humidity for 24 hours. The specimens were cured for 28 days.

VI. RESULTS AND DISCUSSIONS

The compressive strength values obtained by testing standard Cylinders of GFRSCC with and without confinement are tabulated in tables

Sl. No	Designation	Volume of Confinement reinforcement %	Cylindrical Compressive Strength in MPa
1	GFSCC $_{p}$	0	43.0072
2	GFRSCC $_{(3R)}$	0.798	46.4025
3	GFRSCC $_{(4R)}$	1.062	49.7980
4	GFRSCC $_{(5R)}$	1.327	52.0614
5	GFRSCC $_{(6R)}$	1.591	57.7202

Compressive strength of cylinders tested at UTM

Sl. No	Designation	Compressive Strength of Cubes in N/mm^2
1	GFSCC$_P$	61.17
2	GFSCC$_P$	53.77
3	GFSCC$_P$	52.96
4	GFSCC$_P$	55.81
5	GFSCC$_P$	52.86
6	GFSCC$_P$	51.34
7	GFSCC$_P$	55.80
8	GFSCC$_P$	55.92
9	GFSCC$_P$	55.10
10	GFSCC$_P$	55.96
11	GFSCC$_P$	58.25
12	GFSCC$_P$	57.79
13	GFSCC$_P$	58.69
14	GFSCC$_P$	64.03

Compressive strength of cubes tested under compression testing machine

All the specimens with confinement have shown strength above 50 MPa, which is the required strength. The mix, with and without confinement, containing the mineral admixture of Fly ash (33%) has shown higher compressive strength compared to other SCC mixes. Further the GFRSCC with confinement compared to Plain GFSCC has shown an improvement in compressive strength by 7.52% to 44.30%.

VII. CONCLUSION

IT HAS BEEN VERIFIED, BY USING THE SLUMP FLOW AND U-tube tests, that selfcompacting concrete (SCC) achieved consistency and self-compactability under its own weight, without any external vibration or compaction. Also, because of the special admixtures used, SCC has achieved a density between 2400 and 2500 kg/m^3, which was greater than that of normal concrete, 2370-2321 kg/m^3.

Self-compacting concrete can be obtained in such a way, by adding chemical and mineral admixtures, so that its compressive strengths are higher than those of normal vibrated concrete. An average increase in compressive strength of 60% has been obtained for SCC.

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