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Experimental Study on Flexural Behaviour of Glass Fiber Reinforced Concrete Beam using Self Compacting Concrete

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Abstract: **- Self-compacting concrete is one of "the most revolutionary developments" in concrete research; this concrete is able to flow and to fill the most restacked places of the form work without vibration. There are several methods for testing its properties in the green state: the most frequently used are slump flow test, L box and V funnel. This work presents properties of self-compacting concrete, mixed with fly ash and S-Type Glass fiber. The test results for acceptance characteristics of self-compacting concrete such as slump flow; V-funnel and L-Box are presented. Further, compressive strength, split tensile strength and flexural strength at the ages of 7, 14, 28 days was also determined and results are included here. An attempt has been made in the investigation reported in this paper to study the strength behaviour of fibre reinforced SCC structural subjected to flexure for M 60 grade of Concrete**

Keywords— Self-Compacting concrete; Fly ash; S-Glass fiber; Compressive Strength, Split Tensile Strength; Flexural Strength M30

I. INTRODUCTION

Fibre reinforced concrete is relatively a new construction material developed through extensive research and development work during the last two decades. It has already found a wide range of practical applications and proved to be reliable construction material having superior performance characteristics compared to conventional concrete. Incorporation of fibre in concrete has found to improve several properties like tensile strength, cracking resistance, impact and wear resistance, ductility and fatigue resistance. Many fibres like asbestos, steel, nylon, coir, etc. have been used in the past. Out of these asbestos fibres concrete is successful although its exposure is detrimental to the health of human beings. Steel fibres improve ductility, flexural strength and toughness. Corrosion damage and increased density are the drawbacks of the steel fibres. Further development in the field of fibre reinforced concrete was due to introduction of high strength fibres like glass and carbon fibres. The initial studies showed deterioration of glass fibres due to corrosive alkali environment of the cement paste. The alkali resistant glass fibre, which is developed, recently has overcome this defect and can be effectively used in concrete. The production of fibre reinforced concrete should always be considered in two well defined phase's i.e. the fresh phase and the hardened phase. Each phase must be considered carefully at mix design stage and each presents its own particular characteristics and related constructional or structural problems. It is necessary to understand the interaction between the fibres and the surrounding matrix in both phases to know how the fibre properties affect the properties of concrete.

II. LITERATURE REVIEW

A. Pajak et al. (2012)

They investigated the flexural behaviour of self-compacting concrete reinforced with straight and hooked end steel fibers at levels of 0.5%, 1.0% and 1.5% and compare it to normally vibrated concrete (NVC).The laboratory tests were determined according to RILEM TC 162-TDF recommendation. The flexural behaviour of SCC appeared to be comparable to NVC, where the increase of fibers volume ratio causes the increase in pre crack and post crack parameters of SCC. Generally, SCC indicates similar flexural behaviour to NVC where the increase of fibers volume ratio increases the flexural tensile strength.

A formula to predict the flexural tensile strength on SCFRC proposed by Naaman was confirmed for SFR-SCC notched beams. The fracture energy increases with the increase of fiber dosage and is higher for hooked end steel fibers than for straight ones. One more general conclusion about using straight steel fibers in SCC can be made. In this case, the increase in fiber dosage causes the increase of flexural tensile strength.

B. Sravana et al.(2010)

An attempt has been made in the investigation reported in this paper to study the effect of glass fibers on glass fiber reinforced self-compacting concrete Slabs using Alkali- Resistant glass fibers on the strength and behaviour of fiber reinforced SCC structural elements subjected to flexure for various grades of concrete mixes of M 30, M 40.It has been observed that The Ultimate flexural Strength of glass fiber reinforced self-compacting concrete beams at 0.03 % are on higher side when compared with other beams having glass fibers 0%, 0.06% and 0.1 %.The presence of glass fibers in glass fiber reinforced self-compacting concrete slabs have not improved any flexural strength. Development of multiple cracks and micro cracks is prevented with the use of glass fibers.

III. MATERIALS

A. Cement:

Ordinary Portland cement (grade 53) was used and conforms to IS 12269-1987. Its physical properties are as given in table 1.

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TABLE 1
PHYSICAL PROPERTIES OF ORDINARY PORTLAND CEMENT

Particulars	Requirement IS 12269-1987	Test Results Obtained
1) Fineness (90-µm sieve)	10%	1.9%
2)Specific Gravity	3.13-3.15	3.11
3) Setting Time Initial	30 (minimum)	43min 26 sec
4)Soundness By Le Chatelier (mm)	10 mm (maximum)	2 mm
5) Compressive Strength 7 Days 28 Days	37 MPa (minimum) 53 MPa (minimum)	41.82 MPa 57.23 MPa

B. *Admixture:Fly ash*

Class F fly ash is obtained from Thermal Power Plant. The physical and chemical properties of fly ash are given in the table 2and conform to IS: 3812-2003

TABLE 2
PHYSICAL PROPERTIES OF FLY ASH

al Properties of fly ash	
	ey Blackish
Specific Gravity	2.26
Chemical Properties of Fly Ash	
Silicon dioxide - SiO2	30 – 60 %
Aluminum oxide - Al2O3	15 -30 %
Un burnt fuel - (carbon)	up to 30%
Calcium oxide – Cao	1-7%

C. *Super plasticizer*

Naphthalene based super plasticizer HYPERPLAST XR-W40 is utilized in this project, which is a product of CERA Company having a specific gravity of 1.11.

D. *Viscisity mdifying agent*

Glenium stream 2 was used in this study. The properties of VMA is given in the table

E. *Aggregates*

Locally available natural sand with 4.75 mm maximum size was used as fine aggregate, and crushed stone with 12mm maximum size was used as coarse aggregate. Both fine aggregate and coarse aggregate conformed to Indian Standard Specifications IS: 383- 1970, table-4 gives the physical properties of the coarse and fine aggregates.

B. *RCC Beam Design*

RCC beam is to be designed based on IS 456. The beam details are to be given below

Data:

Fck = 30 N/mm^2
Fy = 415 N/mm^2
B = 150 mm
D = 200 mm
d, = 10 mm
L = 1.5 m

TABLE 3
PROPERTIES OF VISCOSITY MODIFYING ADMIXTURE: GLENIUM STREAM 2

S.No	Property	Result
1	Form or State	Liquid
2	Colour	Colourless
3	Specific gravity	1.01 + 0.01 at 250C
4	Chloride content	Nil
5	pH	8 + 1
6	Dosage	0.05 to 1.3% by weight of cement

TABLE 4
PROPERTIES OF FINE AND COARSE AGGREGATE

S.No.	Property	FA	CA
1	Specific Gravity	2.66	2.81
2	Bulk Density (kg/m3)	1700	1560
3	Fineness Modulus	2.625	6.64

IV. EXPERIMENTAL STUDY

The main experimental investigation of this project was to study the flexural behaviour of glass fiber reinforced beams. A total of 24 small beams of size (500mm X 100mm X 100mm) are tested, in that 4 beams are casted for conventional concrete and rest of them are of glass fibers of different percentages. Total of two long reinforced concrete beams are casted one is for conventional concrete and other is for optimum percentage of glass fibers.

For finding the optimum value glass fiber percentage in the concrete Compressive test, Split tensile test and Flexural test are to be selected. Cubes are to be used for Compressive test and cylinders for Split tensile test and Flexural test for beams.

A. *Mix design for M30*

The Concrete mix design M30 grade designed based on IS: 10262-2009. The mix proportion of M30 grade concrete is to be given below Table

Parameters for mix design M30
Grade Designation = 30
Type of cement = OPC 53 grade
Admixture = Fly ash
Fine aggregate = Zone-II

TABLE 4
MIX PROPORTIONS FOR M 30 GRADE CONCRETE

Cement	F.A	C.A	Water
1	1.55	1.46	0.45

TABLE 5
CONCRETE MATERIAL WEIGHT FOR M30

Cement	465 kg
Fine aggregate	730kg
Coarse aggregate	694kg
Water	218 kg
Fly ash (15% of cement)	70kg
Super plasticizer(1.25% of cement)	5.81 kg
VMA(0.24% of cement)	1.12 kg

C. *Experimental Programme:*

- Optimum value study of Glass Fibre Reinforced Self-Compacting Concrete beams of M 30 with varying percentages of glass fibres from 0 % to 1.5%
  .
- Load deflection characteristics of Glass Fibre Reinforced Self-Compacting Concrete beams of M 30 with optimum percentages of glass fibre.

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D. Glass fiber dosage taken for optimum study

In optimum value study different percentage of glass fiber are added in concrete and find out the nature of behaviour of concrete. Mainly 6 different percentages of glass fiber samples are selected for this study. The glass fiber dosage taken for optimum study is to be give below

Specimen name (cube, cylinder and beam)	Fiber dosage in %
GFC 0	0
GFC 0.5	0.5
GFC 0.75	0.75
GFC 1	1
GFC 1.25	1.25
GFC 1.5	1.5

V. RESULT & DISCUSSION

In present study flexural strength, compressive strength and tensile strength of M30 grade concrete was to be found out. In that RC beam is used for flexural study and cubes, cylinders and small beams are to be used for compressive, tensile and flexural strength.

A. Optimum Value Study

Cubes, cylinders and beams are used for the optimum value study. In that cubes were used to find out the compressive strength and cylinders were used to find out the tensile strength and beams are used to find out the flexural strength of M30 grade of concrete. Three different curing periods are selected for cubes and cylinders for testing of specimens such as 7 days, 14 days and 28 days and two different curing periods are selected for beams for testing specimens such as 14 and 28 days.

As per recommendations of IS: 0516 (1959). Standard dimensions of cube (150mmX150mmX150mm), cylinder (150mmX300mm) and beam (500 mm X 100 mm X 100 mm) (3 no in each) are casted with different glass fibre percentages in M30 mix. The samples are taken at the end of 7 days, 14 days and 28 days kept outside and wiped of surface moisture. Three numbers of samples in each of the concrete were subjected to test.

1. compression strength values of cubes (mpa)

S.NO	MIX ID	7Days	14Days	28Days
1	GFC 0	19.85	30.81	31.75
2	GFC 0.5	20.49	31.24	32.41
3	GFC 0.75	20.79	31.69	33.13
4	GFC 1	20.98	32.87	33.53
5	GFC 1.25	20.99	32.92	33.48
6	GFC 1.5	21.07	32.95	33.51

2. *Split tensile strength test result*

S.NO	MIX ID	7Days	14Days	28Days
1	GFC 0	2.15	3.51	3.98
2	GFC 0.5	2.57	4.28	4.51
3	GFC 0.75	2.79	4.23	4.60
4	GFC 1	3.06	4.58	4.87
5	GFC 1.25	3.07	4.60	4.90
6	GFC 1.5	3.09	4.49	4.92

3. *Flexural strength test result*

S.No	MIX ID	14Days	28 days
1	GFC 0	3.67	3.83
2	GFC 0.5	3.83	4.17
3	GFC 0.75	4.17	4.83
4	GFC 1	4.83	5.67
5	GFC 1.25	4.83	5.67
6	GFC 1.5	4.83	6.00

In compressive strength of cube, Split tensile strength of cylinders and Flexural strength of beam 1% of glass fibre was giving the better strength result for M30 grade. In 7 days curing specimen has achieve only 60% strength and for 14 days 90% strength has achieved and for 28 days full design strength.

B. *Flexural Strength Test For Long Beams*

The beam casted was de moulded after 48 hours and water curing was done up to 28 days using gunny bags. The beams were tested 28th day. The beams just before testing were white washed and the support positions were measured and marked.

Mainly two beams are casted for Flexural study in that one is for control specimen and other is for fiber specimen. GFC0 is the control specimen and GFC1 is the fiber specimen. The flexural study calculation is done by taking the ultimate load of beam.The ultimate load of control beam is 65 KN and the maximum deflection is 9.18 mm. The ultimate load of fiber beam is 75 KN and the maximum deflection of the specimen is 5.51 mm.In fiber beam testing the load carrying capacity of fiber beam is more as compare to normal beam and it is also have high deflection. Initial cracks appear is also taken more loads as compare to normal beams

TABLE 7
LOAD (KN) VS DEFLECTION (MM) VALUES

GFC0			GFC1	
Load	Deflection		Load	Deflection
0	0		0	0
2.5	0.14		2.5	0.05
5	0.39		5	0.11
7.5	0.69		7.5	0.16
10	0.96		10	0.25
12.5	1.31		12.5	0.4
15	1.63		15	0.62
17.5	1.87		17.5	0.73
20	2.26		20	0.85

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22.5	2.53(initial)		22.5	0.93
25	2.79		25	1.08(initial)
27.5	3.08		27.5	1.2
30	3.35		30	1.32
32.5	3.67		32.5	1.5
35	3.87		35	1.68
37.5	4.22		37.5	1.82
40	4.53		40	2.04
42.5	5.09		42.5	2.26
45	5.76		45	2.44
47.5	6.3		47.5	2.69
50	6.72		50	2.94
52.5	7.24		52.5	3.16
55	7.7		55	3.42
57.5	8.11		57.5	3.68
60	8.72		60	3.94
62.5	9.18		62.5	4.2
65	9.42(ultimate)		65	4.46
			67.5	4.67
			70	4.83
			72.5	5.18
			75	5.51(ultimate)

VI. CONCLUSION

From experimental results it has been observed that the Compression strength, Split tensile strength and flexural strength is improved 5.3%, 12% and 18% respectively. Deflection in fiber beam is less when compared to control beam. At load of 65 kN, the deflection for control beam is 9.42 mm where as in fiber beam deflection is 5.51mm.

Addition of glass fibres reduces bleeding and it improves the surface integrity of concrete. Also it increases the homogeneity and reduces the probability of cracks.

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