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Experimental Studies On Strength, Durability And Behaviour Of Beam Using S.C.C. With E-Glass Fiber Strands

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Abstract

In the recent decade mankind is moving towards rapid industrialization and urbanization, which needs advanced structures to cope up with their demand. Civil Engineers and researchers are thriving to advance day by day in inventing new materials which are durable, strong enough to resist the applied loads and also serve the exact need of that structure. Many structures are being designed with congested reinforcement making the placement of concrete a menace; there arises the need of self compacting concrete. It is found that self-compacting concrete needs to be strengthened in various ways, one way of doing that is addition of fibers. Bountiful research works were done in the past have revealed the usefulness of fibres to improve the structural properties of concrete like ductility, post crack resistance, energy absorption capacity etc. Fiber reinforced concreting combines the benefits of self compacting concrete in fresh state and shows an improved performance in the hardened state due to the addition of fibers. In this investigation Binani Chopped Strands (6 mm), water dispersion glass fibers strands were added to self compacting concrete and Glass Fiber Reinforced Self Compacting Concrete was developed. An attempt has been made to study mechanical properties, durability and structural behavior of beam with E-glass fiber chopped strands self compacting concrete with partial replacement of cement by flyash . Nan-Su method of mix design was arrived and the proportion was fine tuned by using Okamura's guidelines. Three self compacting concrete mixes (0%, 0.03%, and 0.06%) with partial replacement of cement by mineral admixture like fly ash were taken for investigation with and without incorporating glass fibers Strands.

***Keywords**: E-Glass fiber, Chopped strands, SCC.*

1.0 Introduction

Current scenario in the building industry shows increased construction of large and complex structures, which often leads to difficult concreting conditions. When large quantity of heavy reinforcement is to be placed in reinforced concrete members it is difficult to ensure that the form work gets completely filled with concrete that is fully compacted without voids or honeycombs. Vibrating concrete in congested locations may cause some risk to labour and there are always doubts about the strength and durability of concrete placed in such locations. One solution for the achievement of durable concrete structures, independent of the quality of construction work is the employment of Self Compacting Concrete (SCC). SCC is that concrete which is able to flow under its own weight and completely fill the formwork without segregation, even in the presence of dense reinforcement, without the need of any vibration whilst maintaining homogeneity.

Though concrete possesses high compressive strength, stiffness, low thermal and electrical conductivity, low combustibility and toxicity, have limited its use, it is brittle and weak in tension. However the development of fibre-reinforced composites (FRC) has provided a technical basis for improving these deficiencies. Among the more common fibres used are steel, glass, asbestos and polypropylene. When the loads imposed on concrete approach that for failure, cracks will propagate, sometimes rapidly, fibres in concrete provide a means of arresting the crack growth. If the modulus of elasticity of the fibre is high with respect to the modulus of elasticity of the concrete or mortar binder, the fibres help to carry the load, thereby increasing the tensile strength of the material. Fibres improve the toughness, the flexural strength, reduces creep strain and shrinkage of concrete.

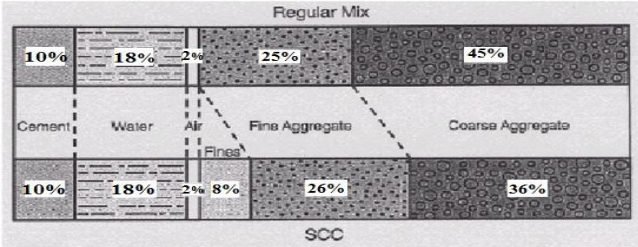
Glass Fiber Reinforced Concrete (GFRC) is composed of concrete, reinforced with glass fibers to produce a thin, lightweight, yet strong material. Though concrete has been used throughout the ages, GFRC is still a relatively new invention. High compressive and flexural strengths, ability to reproduce fine surface details, low maintenance requirements, low coefficients of thermal expansion, high fire resistance, and environmentally friendly made GFRC the ideal choice for civil engineers. The strength of GFRC is determined by glass content, fiber size, fiber compaction, distribution and orientation.

Considering the advantages of SCC and Glass Fiber an attempt has been made to combine SCC and E-Glass Fiber Chopped Strands and to produce Glass Fibre Strands Self Compacting Concrete (GFSSCC) and to investigate the and mechanical properties, durability studies and structural behaviour of both SCC and GFSSCC.

SCC consists of the same components as conventionally vibrated concrete, which are cement, aggregates, and water, with the addition of chemical and mineral admixtures. Usually the chemical admixtures used are super plasticizers and viscosity-modifying agents. Mineral admixtures are used as an extra fine material, besides cement, and in some cases, they replace cement. Researchers have set some guidelines for mixture proportioning of SCC, which include:

i. Reducing the volume ratio of aggregate to cementitious material,
ii. Increasing the paste volume and water-cement ratio(w/c),
iii. Carefully controlling the maximum coarse aggregate particle size and total volume; and
iv. Using various Viscosity Enhancing Admixtures (VEA).

To prepare SCC several alterations should be done in the mix proportion without compromising with strength and other performance requirements. The first alteration to the mix involves decreasing the coarse aggregate content to reduce inter particle friction. Coarse aggregate content should normally 30 to 40 percent by volume of mix. Some fines or fillers are added to reduce the voids. Figure 1.1 shows the comparison of amount of materials used in regular concrete and SCC.



1.1 REQUIREMENTS OF SCC

The concrete mix can only be classified as Self Compacting Concrete if the following three characteristics are fulfilled as per EFNARC-2002.

1.2 FILLING ABILITY

The ability of SCC to flow into and fill completely all spaces within the formwork, under its own self-weight; Slump flow test was used to determine the filling ability of SCC. Normally the diameter of flow should be in the range of 650 to 800 mm. A value of at least 650 mm is required for SCC.

1.3 PASSING ABILITY

The ability of SCC to flow through tight openings such as spaces between steel reinforcing bars without segregation. L box test was used to determine the passing ability of SCC. Normally the blocking ratio should be in the order of 0.8 to 1. But the minimum acceptable value is 0.8.

1.4 RESISTANCE TO SEGREGATION

The ability of SCC to remain homogeneous in composition during transport and placing; V-funnel test was used to determine the stability of SCC. Normally the flow time should be in the range of 8 to 12 seconds.

1.5 OBJECTIVE OF THIS WORK

Despite having numerous advantages, **it does not reach the common man because of the high material cost**. SCC is used only in major projects and it does not serve the whole society due to its high cost. To overcome this limitation, SCC should be made as a **cost-effective material** so that it could reach the common man also and serve the whole society. Replacing the cement partially by local / waste materials like fly ash would reduce the cost of SCC. Moreover using these materials in construction process will reduce their disposal problems thereby reduce the environmental hazards. So this study includes dual purpose of making SCC a cost effective and proper utilization of waste material that would affect the environment and also,

i. To prepare SCC with addition of Glass strands for grades of concrete such as M30.
ii. Testing the SCC & GFSSCC for flow properties.
iii. Testing the SCC & GFSSCC for strength parameters.
iv. Testing the structural behavior of beam using with SCC & GFSSCC
v. Testing the durability of SCC & GFSSCC by Acid tests.

1.6 NEED FOR STUDY:

- In recent decades many varieties of concrete is being developed due to various demands.
- Highly congested reinforcements in heavy structures demand several varieties of SCC.
- SCC domain is rapidly developing with addition of many admixtures and materials to suit various needs.
- SCC is being used in wide variety of structures including marine structures where durability and strength are to be cared.
- SCC is to be developed to suit many other purpose which demands more research in that domain.
- SCC proved to be a cost effective material, if redesigned to suit various structures will increase effectiveness.
- Strength of SCC is to be increased with increase in durability also; these properties are to be tested.

1.7 RESEARCH SIGNIFICANCE

For new materials like SCC and GFSSCC studies on mechanical properties, durability and structural behaviour are of paramount important for initializing confidence in engineers and builders. The literature indicates that some studies are available on plain SCC and steel FRSCC but sufficient literature is not available on the structural behaviour and mechanical properties of GFSSCC and SCC with different mineral admixtures. Hence considering the gap in existing literature an attempt has been made to study the mechanical properties, durability and structural behaviour of both SCC and GFSSCC

2.0 LITERATURE REVIEW

2.1 Annie Peter.J, et al[5] had compared the structural behaviour such as load-deflection characteristics, crack-widths, spacing of cracks, number of cracks, crack pattern, ultimate load-carrying capacity, moments-curvature relationship, longitudinal strain in both concrete and steel for Self compacting concrete (SCC) and conventionally vibrated concrete(CVC) . They observed through SCC and CVC have different modes of compaction, both mixes yielded to similar strength levels at ages of 1,3,7, and 28 day. The UPV readings taken on SCC were similar to those of CVC showing that SCC had flowed through the reinforcement and felled the beam completely without voids, honey combs etc. The load-deformation behaviour of both SCC and CVC beams were similar up to the peak load stage. Beyond the peak load stage, CVC beams showed no drop in load with increased deformation while SCC beams showed drop in load with increased deformation. While the peak and failure loads were nearly the same for CVC beams, the failure load was nearly 25 percent lower compared to the peak load in SCC beams. Crack widths were within the limits specified by IS 456 at all load stages. The average crack widths of both the types of beams were comparable. The crack spacing of both CVC and SCC were almost the same .

2.2 Ganeshan.N, et al[(3)] made an attempt to study the effect of steel fibres on the strength and behaviour of fibre reinforced SCC structural elements subjected to flexure . Twenty beams were cast for this study, out of which two were plain SCC beams without fibres. The variables in this study were aspect ratio (15.25 and 35) and percentage of volume fraction (0, 0.25, 0.5 and 0.75) of fibres. Based on the Experimental investigation they observed that the first crack load and the post cracking behaviour were found to have improved due to the addition of fibres. A marginal improvement in the ultimate strength was observed. The addition of fibres had enhanced the ductility significantly. The optimum volume fraction of fibres was found to be 0.5 percent.

2.3 Ganeshan.N, et al [(4)] made an attempt has been made to study the effect of steel fibres on the strength and behaviour of Self Compacting Concrete (SCC) flexural elements. Twenty beams were cast for this study out of which two were plain SCC beams without fibres. The variables in this study were aspect ratio (0, 15, 25 and 35) and percentage of volume fraction of fibres (0, 0.25, 0.5 and 0.75).First crack load and the post cracking behaviour were found to have improved significantly due to the addition of fibres.A marginal improvement in the ultimate strength was observed. The addition of fibres enhanced the ductility significantly. The optimum volume fraction of fibres for better performance in terms of strength and ductility was found to be 0.5 percent. Experimental values of the ultimate moment were compared with various analytical models. The comparison indicate that Swami and Taan model compares better with the test results than that of the other models.

3.0 MATERIALS USED IN SCC

3.1 CEMENT

Ordinary Portland cement of 53 grades 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 of are 12269-1987.The specific gravity was 3.14.

3.2 FLY ASH

Fly ash from Tuticorin Thermal Power Station, Tamil Nadu was used as cement replacement material. The properties fly ash is confirming to IS 3812 – 1981of Indian Standard Specification for Fly Ash for use as Pozzolana and Admixture. The specific gravity was 2.054.

3.3 COARSE AGGREGATE

Crushed angular granite metal of 8 to 12.5 mm size from a local source was used as coarse aggregate. The specific gravity of 2.77 and fineness modulus 3.702 was used.

3.4 FINE AGGREGATE

River sand of 2.36 mm size sieve passed was used as fine aggregate. The specific gravity of 2.64 and fineness modulus 3.376 was used in the investigation.

3.5 ADMIXTURE

The Modified Polycarboxylated Ether based Super Plasticizer (Glenium B233) which is light brown Color and free flowing liquid and having Relative density 1.09±0.01 and pH value as ≥ 6and Chloride Content <0.2% was used as Super Plasticizer. Optimum dosage of **GLENIUM B233** should be determined with trial mixes. As a guide, a dosage range of 500 ml to 1500ml per 100kg of cementitious material is normally recommended.

3.6 VISCOSITY MODIFYING AGENT

A Viscosity modified admixture (Glenium Stream 2) for Rheodynamic Concrete which is colourless free flowing liquid and having.Specific of gravity 1.01±0.01 @ 25º C and pH value as ≥ 6 and Chloride Content <0.2% was used as Viscosity Modifying Agent.**GLENIUM STREAM 2** is dosed at the rate of 50 to 500 ml/100 kg of cementitious material. Other dosages may be recommended in special cases according to specific job site conditions.

3.7 POLYPROPELENE FIBRE STRANDS

Binani Chopped Strands (6 mm) are chopped from continuous "E" - glass fibres. The chopped strands are free flowing and are designed to resist the rigors of compounding whilst allowing the finished moulding to develop satisfactory mechanical properties. 0.03% & 0.06% of Volume of Concrete,glass fiber strands are added in SCC.

4.0 TESTING RESULTS OF MATERIALS

Specific Gravity Of Cement = 3.152
Specific gravity of fly ash (Gf) = 2.054
Specific gravity of fine aggregate (Gfa) = 2.64
Specific gravity Coarse Aggregate (Gca) = 2.77
Water absorption = 0.296%

Percentage of fineness of the cement is = 0.2%
Percentage of fineness of the fly ash is =0.5 %
Fineness modulus of fine aggregate = 3.376
Fineness modulus of coarse aggregate = 3.7018

Bulk Density Test (Without compaction) = 1.45 kg/l
Bulk Density Test (With compaction) = 1.56 kg/l

Consistency Limit Of Cement = 33%
Initial Setting Time Of Cement = 35 minutes
Final Setting Time Of Cement = 8 hours

Initial setting time of cement with SuperPlasticiser = 1 hour 50 minutes
Final setting time of cement with SuperPlasticiser = 8 hour 50 minutes

Initial setting time of cement + fly ash with SuperPlasticiser = 1 hour 30 minutes
Final setting time of cement + fly ash with SuperPlasticiser = 8 hour 30 minutes

5.0 MIX DESIGN FOR M30 CONCRETE BY NAN-SU Method

Nan-Su Method:

Ref:Jagadish Vengala & R.V.Ranganath, Mixture proportioning procedures for self-compacting concrete, The Indian concrete journal, August 2004, pp 13-21.

Total Volume = 1000 litres

Assume air content = 2% (20 litres)
Net Volume = 980 litres

Total mass of concrete
= C.A + Water + Powder + F.A
=734+203+507+927 = 2235 Kg

Mix proportion = 1:1.83:1.45:0.38

Summary of volume fractions:

Vca = 0.265
Vpaste = 0.364
Vfa = 0.351
Dosage of Super plasticizer
– 1.2% of weight of powder
Dosage of VMA
– 0.12% of weight of powder

6.0 WORKABILITY TEST RESULT FOR SCC WITH AND WITHOUT GLASS STRANDS

The required quantities of dry materials were weighed and mixed manually in dry condition. Half of the water quantity was added and the mixture was hand mixed thoroughly. Then, superplasticizer and viscosity modifying agent were added to the remaining water and thoroughly mixed. Then this liquid was added to the concrete and the concrete was mixed again till a coherent mixture was obtained. Then tests were conducted on fresh concrete. These were Abrams slump test, T 50 cm slump, V-funnel test , V funnel at 5 minutes test, U box and L box tests . The results are given in Table

Figure:3. Workability Test in Slump, Ubox,

Figure :4 Lbox & V-funnel

Table 1. Workability Test Result

Sl. No	Methods	Unit	SCC 0 % Glass Strand	SCC with 0.03% glass fibre	SCC with 0.06 % glass fibre	Min. Value	Max. Value
1	Slump flow	mm	700	730	700	650	800
2	T50cm Slump flow	sec	4	3	3	2	5
3	V - funnel	sec	10	7	5	8	12
4	V – funnel at T5 minutes	sec	12	10	8	0	15
5	U- box	(h2-h1) mm	16	11	09	0	30
6	L – box	(h2/h1) mm	1	0.9	0.6	0.8	1.0

7.0 SPECIMEN PREPARATION FOR MECHNANICAL PROPERTIES

After testing the SCC and GFSSCC in fresh state the concrete was poured in moulds of cubes, cylinders, prisms and beams. After 24 hours of casting the specimens were de-moulded and placed in water for curing. After 28 days of curing the specimens were taken out from water and allowed the surfaces for drying. For each SCC and GFSSCC mixes 6 cubes,6 cylinders,4 prisms and Three beams were casted in size 700mm X 150mm X 150 mm.

7.1 COMPRESSIVE STRENGTH TEST

Compressive strength tests were carried out on cubes of 150 mm size using a compression testing machine of 2000 KN capacity as per IS 516:1959.

Table : 2

Sl.No.	Cube	7 days (N/mm²)	28 days (N/mm²)	56 days (N/mm²)
1.	SCC	17.44	34.88	37.49
2.	SCC with 0.03% Glass fibre	17.88	31.17	35.00
3.	SCC with 0.06% Glass fibre	18.00	35.46	38.80

7.2 SPLIT TENSILE STRENGTH TEST

Split tensile strength tests were carried out on cylinders of 150 mm diameter and 300 mm height using a compression testing machine of 2000 KN capacity as per IS 516:1959

Table : 3

Sl. No	Cube	7 days (N/ mm^2)	28 days (N/ mm^2)	56 days (N/ mm^2)
1.	SCC	17.44	34.88	37.49
2.	SCC with 0.03% Glass Strands	17.88	31.17	35.00
3.	SCC with 0.06% Glass Strands	18.00	35.46	38.80

7.3 FLEXURAL STRENGTH TEST

Flexural strength tests were carried out on prisms of size 100×100×500 mm on flexure testing machine of capacity 100 KN as per IS 516:1959.

Table : 4

S.No	prism	28 days (N/ mm^2)	56 days (N/ mm^2)
1.	SCC	5.12	6.75
2.	SCC with 0.03 % Glass Strands	6.31	7.10
3.	SCC with 0.06 % Glass Strands	7.97	8.25

8.0 DURABILITY STUDIES

Experiments were conducted to study the effect of glass fibres strands on the durability parameters of self compacting concrete (SCC). Loss in compressive strength and weights were evaluated. Durability of M30 grade of concrete immersed in H_2SO_4 and HCl solutions for 7 days were evaluated. The methods for finding out the rheology of fresh SCC included aeration measure. Several mixtures were used for Slump Flow, V-Funnel, U - box and L-box for proportioning of ingredients and admixtures for both with and without glass fibre strands concretes. It was noted that adding glass fibres strands improved durability of self-compacting concrete. The weight and compressive Strength losses in cube Specimens reduced with age and in general the durability indicators of glass fibre strands self-compacting concrete mixes were more than those of the self-compacting concrete mixes.

8.1 TEST SPECIMENS

Cubes of 70.6x70.6x70.6 mm were casted. This specimen was tested according to IS 516 and IS 1199. Figure 1 shows the arrangement for immersion of the test specimens in different solution.

8.2 ACID ATTACK OF SCC AND GFSSCC

Acid attack was determined by immersing test specimens of size 70.6x70.6x70.6 mm test cube in a H_2SO_4 (5%) solution and HCL (5%) solutions. The deterioration of self compacting concrete and glass fibre self compacting concrete specimens were measured as the percentage reduction in weight and compressive strength at 7 days.

8.3 DURABILITY FACTOR OF SCC AND GFSSCC

After casting, the specimens were cured in water for 28 days. They were then immersed in H_2SO_4 (5%), and HCL (5%) solution. Then specimens were removed from each solution, brushed with a soft nylon brush and rinsed with tap water. This removed loose surface material from the specimen. The specimens were tested at 7 days for compressive strength.

Figure : 4 – Test specimens after immersed in different solutions

TABLE 5 : WEIGHT LOSS PERCENTAGE OF SCC & GFSSCC MIXES AFTER IMMERSED IN DIFFERENT SOLUTIONS

Description	Grade of concrete	5% HCL solution	5% H_2SO_4 solution
		7 Days	7Days
SCC	M30	5.0	7.5
SCC with 0.03% of Glass fiber	M30	3.06	6.46
SCC with 0.06% of Glass fiber	M30	3.02	3.90

TABLE 6 : COMPRESSIVE STRENGTH LOSS PERCENTAGE OF SCC & GFSSCC MIXES AFTER IMMERSED IN DIFFERENT SOLUTION

Description	Grade of concrete	5% HCL solution	5% H_2SO_4 solution
		7 Days	7Days
SCC	M30	10.53	57.9
SCC with 0.03% of Glass fiber	M30	9.13	51.07
SCC with 0.06% of Glass fiber	M30	7.94	45.11

9.0 BEHAVIOR IN FLEXURE OF SCC & GFSSCC BEAMS

An experimental investigation is taken up to study the effect of glass fibers on the deflection and ultimate load characteristics of glass fiber strands self compacting beams with mild steel tensile reinforcements. Three flexure-deficient beams (700mm X 150mm X 150 mm) were tested till failure. The parameter studied was load-deflection characteristics. Three levels of fibers were included viz 0.00 %, 0.03 % and 0.06 % by volume. Locally available fly ash, superplasticizer and viscosity modifying agent were mixed.

The beams were tested in flexure using 400 KN capacity UTM under two point load to get the structural characteristics.

Provided Ast = 4 Nos of 8mm dia bars = 201.06mm² > 37.17mm²(Min. Ast)
Actual Moment carrying capacity = 7.77 KNm.
Provided Shear Reinforcement = 1005 mm²

Figure:5 -Reinforcement Gauges

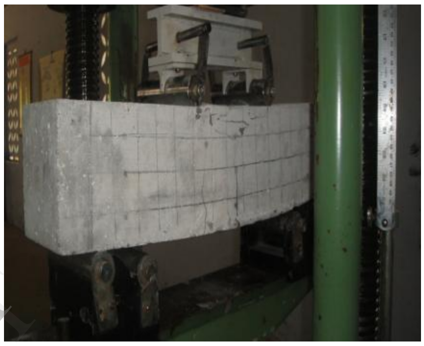


Figure:6 – TwoPoint loading setup of Beam

9.1 SCC

When load was applied to the Specimen initial crack started at 4800kg. There were 3 major cracks and 3 minor cracks after the Specimen was fully loaded upto Ultimate load. The Ultimate load carried was 12800kg.The width of crack was 0.3cm at failure.

9.2 SCC WITH 0.03% OF GLASS FIBRE STRANDS

When load was applied to the Specimen initial crack started at 5600kg. There were 4 major cracks and 7 minor cracks after the Specimen was fully loaded upto Ultimate load. The Ultimate load carried was 13200kg. The width of crack was 0.6cm at failure.

9.3 SCC WITH 0.06% OF GLASS FIBRE STRANDS

When load was applied to the Specimen initial crack started at 6400kg. There were 4 major cracks and 5 minor cracks after the Specimen was fully loaded upto Ultimate load. The Ultimate load carried was 13600kg. The width of crack was 0.6cm at failure.

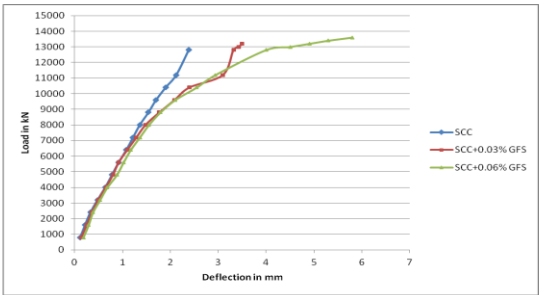


Figure : 5 - Load – Deflection curve

Figure : 6 – Crack pattern of Beam

10.0 DISCUSSION OF TEST RESULTS AND CONCLUSION

10.1 DISCUSSION OF TEST RESULTS

Results of experimental investigations are discussed in the following sections with respect to the characteristics of SCC & GFSSCC mixes in the fresh and hardened states.

10.2 CHARACTERISTICS OF SCC MIXES IN FRESH STATE

The filling ability, passing ability & segregation resistance values of GFSSCC mixes compared to SCC mixes indicate that the presence of glass fibres did not have any pronounced effect upto 0.03% this may be due to the low dosage of fibre addition (0.03%) and also may be due to the high dispersing nature of the fibres and some effect have appeared when 0.06% of glass fibre strands added.

10.3 CHARACTERISTICS OF SCC MIXES IN HARDENED STATE

10.3.1 COMPRESSIVE STRENGTH

The compressive strength values obtained by testing standard cubes made with different SCC and GFSSCC mixes. All the mixes have shown strength above 30 MPa, which is the required strength. The mix, without glass fibers, containing the mineral admixture of FLY ASH (45%) has shown lower compressive strength compared to other GFSSCC mixes. The mix with 0.06 % glass fibers, containing the mineral admixture of FLY ASH (45%) has shown higher compressive strength compared to other SCC & GFSSCC (0.03%) mixes. Further the GFSSCC mixes compared to normal SCC mixes have shown an improvement in compressive strength by 1.5 to 2.0%.

10.3.2 TENSILE STRENGTH

The tensile strength of mixes is obtained (i) by conducting split tensile test on standard cylindrical specimens and also by (ii) by conducting two point bend test on standard prisms. The results indicated that the incorporation of glass fibres in to the SCC mixes increased the split tensile strength and flexural strengths by 44.2 to 63.33 % and 18.85 to 35.75 % respectively. The increase is significant and it may be due to high tensile strength of glass fibres strands.

10.3.3 DURABILITY

The durability of mixes is obtained by conducting acid attack test on standard cube specimens of size 70.6x70.6x70.6mm. The results indicated that the incorporation of glass fibres in to the SCC mixes increased the durability by 13.8 to 52.0 %. The increase is significant and it may be due to incorporation of glass fibres strands.

10.3.4 STRUCTURAL BEHAVIOUR

The structural behaviour of mixes is obtained by conducting two point load test on standard beam specimens. The results indicated that the incorporation of glass fibres in to the SCC mixes increased the load carrying capacity by 3.03 to 5.88 %. The increase is significant and it may be due to high tensile strength of glass fibres strands.

CONCLUSIONS

- All the SCC and GFSSCC mixes developed satisfied the requirements of self compacting concrete specified by EFNARC.
- From above discussion of test results, it can be observed that addition of the glass fibers strands tested improves the compressive

strength, tensile strength, durability load carrying capacity of ordinary reinforced cement concrete in flexure even with small dosage levels of 0.03% & 0.06 %.

- With the above discussion we found out that the results obtained in 0.06% is more when compared to the results obtained for 0.03%. Hence we conclude that the results may be higher when glass fibre is added at the percentage more than 0.06. So we have ideas to continue our project in future with higher percentage of glass fibres strands with dosage level of 0.09%

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