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Durability Studies and Structural Behavior of Corroded Deep Beam on S.C.C with Hybrid Fibers

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Abstract

Nowadays, the performance required for concrete structures is more complicated and diversified. The early stage deteriorations of concrete structures are a result of the manual placing and the inadequate consolidation. The concrete is required to have properties like high fluidity, self-compact ability, high strength, high durability, better serviceability and long service life of concrete structures. Self-compact ability is desirable to attain rationalized and labour saving effects in manufacturing and placing of concrete. Self-Compacting Concrete completely fill the formwork and passes through the congested reinforcement without segregation.

Self-compacting concrete (SCC) is a highly engineered concrete that addresses these requirements. Several studies in the past have revealed the usefulness of fibers to improve the structural properties of concrete like ductility, crack resistance etc. In this project Binani Chopped Strands (6 mm) water dispersion glass fibers and Recron 3s (12 mm) polypropylene fibers will be added to self-compacting concrete. This study was conducted to investigate the use of Binani Chopped Strands (0.06%) and different percentages polypropylene fibres (0.1%, 0.2%, and 0.3%) as volume of concrete. The mix design has been arrived based on nan-su method for high grade of concrete. In SCC, cement is replaced by 40% of fly ash. The admixtures of Glenium 8233 and Glenium stream 2 were used. This experimental study is carried out to evaluate fresh properties, mechanical

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and durability properties (Na2SO4, HCL, H2SO4, marine environment, sorpivityand impact test) of SCC and Hybird Fiber SCC (HFSCC) and to investigate the structural performance of corroded deep beams made with SCC and HFSCC. The laboratory tests conducted on the different number cubes and four numbers of corroded deep beams were conducted. Deep beams were tested under two point load test to investigate the structural performance such as strain in concrete & steel, initial crack & crack patterns, ultimate load and load deflection curve.

Keywords*:* - Self-compacting concrete (SCC),

INTRODUCTION

Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. Use of SCC can also help minimize hearing-related damages on the worksite that are induced by vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced.

When the construction industry in Japan experienced a decline in the availability of skilled labour in the 1980s, a need was felt for a concrete that could overcome the problems of defective workmanship. This led to the development of self-compacting concrete, primarily through the work by Okamura. A committee was formed to study the properties of self-compacting concrete, including a fundamental investigation on workability of concrete, which was carried out by Ozawa et al. at the University of Tokyo. The first usable version of self-compacting concrete was completed in 1988 and was named “High Performance Concrete”, and later proposed as “Self Compacting High Performance Concrete”.

Since the development of SCC in Japan, many organizations across the world have carried out research on properties of SCC. The Brite-Euram SCC project was set up to promote the use of SCC in some of the European countries.

A state-of-the-art report on SCC was compiled by Skarendahl and Petersson summarizing the conclusions from the research studies sponsored by the Brite-

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Euram project on SCC. A recent initiative in Europe is the formation of the project – Testing SCC– involving a number of institutes in research studies on various test methods for SCC. In addition, an organization with the participation from the speciality concrete product industry – EFNARC– has developed specifications and guidelines for the use of SCC that covers a number of topics, ranging from materials selection and mixture design to the significance of testing methods.

Current studies in SCC, which are being conducted in many countries, can be divided into the following categories: (i) use of rheometers to obtain data about flow behaviour of cement paste and concrete, (ii) mixture proportioning methods for SCC, (iii) characterization of SCC using laboratory test methods, (iv) durability and hardened properties of SCC and their comparison with normal concrete, and (v) construction issues related to SCC. These will be relevant to the immediate needs.

In addition, the following questions also need particular attention, from a long-term perspective: (i) development of mixture design guideline tables similar to those for normal concrete, (ii) a shift to more 'normal' powder contents in SCC, from the existing high powder mixtures, (iii) better understanding of the problems of autogenous and plastic shrinkage in SCC, and (iv) development of site quality control parameters such as in 'all-in-one', acceptance tests.

ADVANTAGES OF SCC:

- Improved filling capacity of highly congested structural members
- Improved health and safety of site
- Allows lighter and more slender structures
- Faster construction time
- Reduced formwork and equipment cost.
- Less man power
- Improved durability and good structural performance
- Homogeneity of hardened SCC is better.
- SCC can be placed at a faster rate with no mechanical vibration and less screeding, resulting in savings in placement costs.

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- Improved and more uniform architectural surface finish with little to know remedial surface work
- Improved consolidation around reinforcement and bond with reinforcement
- Improved pump ability
- Resulting cost savings

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

- Filling Ability
- Passing Ability
- Resistance To Segregation
- Construction Aspects

Need For Study

- To achieve high grade concrete, prepare SCC and SCC with hybrid fibers with various proportions like GF 0.06% + (0.1% PP, 0.2 %PP, 0.3 % PP)
- To study the fresh properties of SCC with Hybrid fiber reinforced SCC.
- To study the hardened properties of SCC with Hybrid fiber reinforced SCC.
- To study the durability properties of SCC with Hybrid fiber reinforced SCC.
- Testing the Structural behavior of corroded Deep beam
- Comparing the conventional SCC with HFSCC.
- From the results of the Literature survey it is found that the addition of any sort of fibers does increase the Mechanical and the durability properties of the concrete.
- In this study we have adopted the combined type (Cement 60%, Fly Ash 40%) of SCC prepared.
- Most of the research is done mainly with the Glass & steel fiber material.
- It is found that no one have done the research with Glass and polypropylene Fibers,

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- In this study Glass and Polypropylene fibers are being used to check the Mechanical & durability property of SCC.

- And also, study the corroded deep beam behavior with hybrid fibers.

MATERIALS USED IN SCC

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 403 1-1988 and found to be confirming to various specifications of are 12269-1987.The specific gravity was 3.14.

Coarse Aggregate

Crushed angular granite metal of 6 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.

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.

Admixture

The Modified Polycarboxylated Ether based Super Plasticizer (Glenium 8233) 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 Plasticiazer.

Optimum dosage of GLENIUM SKY 8233 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.

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.

BINANI CHOPPED GLASS 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

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finished moulding to develop satisfactory mechanical properties.



Fig: - 1 Binani Chopped Glass Fibre Strands

POLYPROPELENE FIBRE

Recron3S (12mm) prevents the micro shrinkage cracks developed during hydration, making the structure/plaster/component inherently stronger.

A structure free from micro cracks prevents migration of water or moisture throughout the concrete. Addition of Recron 3 s to concrete and plaster arrests cracking caused by volume change (expansion and contraction), simply because 1 kg of Recron 3s offers millions of fibres which support mortar/concrete in all directions



Fig: 2 Polypropelene Fibre

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. Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash.

In an industrial context, fly ash usually refers to ash produced during combustion of coal. Since the particles solidify while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 µm to 100 µm.

TESTING RESULTS OF MATERIALS

- Specific gravity of cement (Gc) = 3.152

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- Specific gravity of fly ash (Gf) = 2.054
- Specific gravity of F.A (Gfa) = 2.64
- Specific gravity C.A (Gca) = 2.77
- % of fineness of the cement = 0.2%
- % of fineness of the fly ash = 0.5 %

CONSISTENCY LIMIT, INITIAL & FINAL

Setting Time

- Consistency Limit =30%
- Initial Setting Time = 35 minutes
- Final Setting Time = 8 hours
- Initial setting time of cement + Fly ash = 1 hr 30 min
- Final setting time of cement + Fly ash = 6 hr 00 min
- Initial setting time of cement + fly ash + SP = 2 hr 30min
- Final setting time of cement + fly ash + SP = 8 hr 40min

Nan-Su Method

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

***Mixproportion* =1:1.72:1.37:0.45**

Cementetious material- (0.6-cement and 0.4-fly ash)

Fine aggregate - 1.72

Coarse aggregate- 1.37

Dosage of Superplasticiser-1.4% of weight of powder

Dosage of VMA - 0.10% of weight of powder

Dosage of Glass Fiber strands- 0.06 % in Vol. of Concrete

Dosage of Polypropylene Fibers- 0.10%, 0.20 % & 0.30% in Vol. of Concrete

METHOD OF CASTING

The Concrete mix was prepared according to ix design and the mould was placed on a plane surface and then concrete was poured inside very slowly and it was compacted.

A total number of cubes 170 cubes,35 cylinders & 30 prism were casted for concrete grade M30 with various % of adding fibers.

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PROPOSED EXPERIMENTS:

Mechanical properties of concrete Cubes

s.no	% of Fibers	Days after curing			Total noof cubes in each %
		28	56	90	
1	0	3	3	3	9
2	0.06%GF	3	3	3	9
3	0.1 %PP	3	3	3	9
4	0.2 %PP	3	3	3	9
5	0.3 %PP	3	3	3	9

Cylinders

s.no	% of Fibers	Days after curing			Total nos of cubes in each %
		28	56	90	
1	0	3	3	3	9
2	0.06%GF	3	3	3	9
3	0.1 %PP	3	3	3	9
4	0.2 %PP	3	3	3	9
5	0.3 %PP	3	3	3	9

Test on fresh concrete

s.no	Method	Scc	Scc with			
			0.06% glass	0.06% glass+0.1% pp	0.06% glass+0.2% pp	0.06% glass+0.3 % pp
1	Slump flow	700	680	670	665	660
2	T50cm Slump Flow	3	3.5	4	4	4
3	V- funnel	8	9	9	10	10
4	V- funnel at T5 min	11	9	8	11	12
5	U – box	13	12	8	14	16

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6	L-box	0.95	0.91	0.92	0.90	0.88
7	J-ring	2	2	3	5	7

Compressive strength test

S.No.	Cubes	28 days(N/ mm²)	56 days(N/ mm²)
1.	SCC	31.53	34.44
2.	SCC (0.06% GF)	37.20	38.37
3.	SCC (0.06% GF+ 0.1%PP)	38.37	40.11
4.	SCC (0.06% GF+ 0.2%PP)	33.57	34.44
5.	SCC (0.06% GF+ 0.3%PP)	29.21	28.78

Split Tensile test

S.No	Cylinders	28 days (N/ mm²)	56 days(N/ mm²)
1.	SCC	2.64	2.22
2.	SCC (0.06% GF)	2.57	2.50
3.	SCC (0.06% GF+ 0.1%PP)	2.64	2.64
4.	SCC (0.06% GF+ 0.2%PP)	2.36	2.91
5.	SCC (0.06% GF+ 0.3%PP)	2.36	2.78

Corroded deep beams:

- Beam Size 700 x 350 x 100 mm
- We have casted the 6 beams.3 beams for normal behavior and 3 beams for corrosion behavior. Accelerated corrosion tests have been used successfully to determine the susceptibility of reinforcing and other forms of structural steel to corrosion. The accelerated corrosion setup used in this investigation consisted of plastic tanks, electrolytic solution (5% sodium chloride (NaCl) by the weight of water) and steel placed at the bottom of each tank.
- Based on the half cell potentiometer the corrosion test will be done

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Fig: - 3 Reinforcement detailing

DISCUSSION OF TEST RESULTS & CONCLUSIONS

- All the SCC and HFSCC mixes developed satisfied the requirementsOf self-compacting concrete specified by EFNARC.

- we have adopted the combined type (Cement 60%, Fly Ash 40%) of SCC prepared.

- This study was conducted to investigate the use of Binani Chopped Strands (0.06%) and different percentages polypropylene fibres (0.1%, 0.2%, and 0.3%) as volume of concrete.

- From the above results the polypropylene fiber improved the workability.

- Based on the mechanical property the GF+0.1 & 0.2%PP give good result.

WORK TO BE STUDIED

Durability Studies

- Sulphate resistance
- Acid test (HCL,H2SO4)
- Marine environment
- for this study we are immersed the cubes in chemicals for 28,56 & 90 days.
- Sorpivity test
- Permeability test

Corroded beam behaviours

1. Crack load
2. Ultimate load
3. Load-deflection relationship
4. Stress-strain relationship
5. Propagation of crack
6. Load-crack width relationship

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