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EFFECT ON FLEXURAL STRENGTH OF STEEL FIBER REINFORCED SELF COMPACTING CONCRETE

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ABSTRACT:

Bearing in mind the increasing worldwide availability of pulverised fly ash (PFA) and rapidly decreasing source of natural and other good quality aggregates, fly ash can be used to produce aggregates (sometimes fly ash will be added to concrete as a fine aggregate). Use of fly ash not only reduces the problems created by it but is also beneficial in many other aspects. Today it is used as mineral admixture and acts as partial substitute for cement. Although the raw materials required for production of cement are generally available in almost all parts of world, Portland cement requires relatively costly materials in terms of energy expanded in its production. It is estimated that total energy consumed, including fuel cost, is about 7500 MJ/Tone for ordinary Portland cement where as it is only 150 to 400 MJ/Tones for fly ash. So use of PFA results in major savings of energy and raw materials. Replacement of each tone of cement saves at least 6000 MJ of energy, which is equivalent to a barrel of oil or a quartertone of coal. Use of fly ash also helps in preservation and protection of environment, which is an issue of paramount importance to the faster construction, it is necessary to have higher early strengths for faster removal of form works, which intern requires higher cementations content of 350 to 550 Kg/m^3..The objective of this study is to optimize the Steel Fiber Reinforced Self Compacted Concrete (SFRSCC) in the fresh and in hardened state. But the references indicate that some studies are available on plain SCC but sufficient literature is not available on SFRSCC with different steel fibers & different aspect ratio.Steel Fiber-reinforced self-compacting concrete (SFRSCC) is a new type of concrete mix that can mitigate two opposing weaknesses poor workability in fiber-reinforced concrete and cracking resistance in plain SCC concrete.

Keywords: Self-compacting,Flyash,Aspect Ratio , Pozzolanic.

I. INTRODUCTION:

Self-compacting concrete (SCC) offers several economic and technical benefits; the use of steel fibers extends its possibilities. Steel fibers acts as a bridge to retard their cracks propagation, and improve several characteristics and properties of the concrete. Fibers are known to significantly affect the workability of concrete. Therefore, an investigation was performed to compare the properties of plain normal compacting concrete (NCC) and SCC with steel fiber. Fly ash has high pozzolanic reactivity and low price as compared to silica fume and fly ash as it is a manufactured product.The objective of this study is to optimize the Steel Fiber Reinforced Self Compacted Concrete (SFRSCC) in the fresh and in hardened state. But the references indicate that some studies are available on plain SCC but sufficient literature is not available on SFRSCC with different steel fibers & different aspect ratio. Hence an attempt is made in this work to study the Effect of different type of steel fiber & aspect ratio on Mechanical properties of Self Compacted Concrete.Mineral Admixtures (MA) depend upon their amorphous content as well as Si02 content; the higher these contents the better will be there hardened (hydrated) state. In fresh fly ash concrete (FAC) mixes, the particle size and their distribution in MAs play a major role. Finer and more spherical shaped particles of MAs are preferred in FAC. However, performance level tests are more important. Development of standard procedures for these tests would be useful in the selection of mineral admixtures for use in development of FAC. At present, most of the codes lay emphasis only on chemical composition and physical properties such as specific gravity, specific surface, etc. After reviewing all above requirement, Fly ash is used as a mineral admixture.

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II. LITERATURE REVIEW:

Pai et al. explored SCC as an answer to the problem of consolidating concrete in heavily reinforced structures. There is feeling amongst certain engineers that of the corresponding normal-strength or high strength or high strength concrete (NSC/HSC). Is it really so? The cost of ingredients of NSC/ HSC differs marginally- SCC material cost just about 10-15 percent higher. If an in- depth analysis of the other components of costs like the cost of consolidation, finishing, etc is carried out, then one would realize that SCC is certainly not Costly Concrete. Further, the advantages of SCC far outweigh those of NSC/HSC.

Buquan Miao et al. studied on the mix design and mechanical properties of self-compacting steel fiber reinforced concrete (SFRC). By using super plasticizers and mineral admixtures such as slag and fly ash, three SFRC of different fiber contents (0.5, 1.0 and 1.5%) and one plain concrete with high fluidity (slump 250mm) have successfully been developed without bleeding or segregation. The compressive and flexural strengths, flexural toughness as well as shrinkage and creep of the four mixes of concrete were studied. It has been shown that increasing steel fiber content can improve the flexural strength and toughness of self-compacting SFRC even though its compressive strength could be reduced due to the increase of air content

Eduardo et al. suggested that the behavior of SCC as a structural material can be improved if adequate steel fiber reinforcement is added to SCC mix composition. In fact, the fiber-reinforcement mechanisms can convert the brittle behavior of this cement-based material into a pseudo ductile behavior up to a crack width that is acceptable under the structural design point of view. Fiber addition, however, increases the complexity of the mix design process, due to the strong perturbation effect that steel fibers cause on fresh concrete flow. In the present work, a mix design method is proposed to develop cost effective and high performance steel fiber-reinforced self-compacting concrete SFRSCC

Cunha et al. found that in a recent applied research project joining pre-casting industry, private and public research institutions, and a method was developed to design cost-competitive SFRSCC of rheological and mechanical properties required for the prefabrication of SFRSCC façade panels. To assure safe demoulding process of the panels, the influence of the concrete age on the compression behavior of the SFRSCC should be known. For this purpose, series of tests with specimens of 12 h to 28 days were tested in order to analyze the age influence on the compressive strength, strain at peak stress, Young's modulus, and compressive volumetric fracture energy. The experimental program was divided in two groups of test series, one with SFRSCC of a volumetric fiber percentage of 0.38% and the other with 0.57%. To apply the obtained data in the design and numerical analysis framework, the influence of the age on these SFRSCC properties was modeled

Døssland et al. studied cement-based materials benefit from the addition of steel fibers, but for structural applications the fiber content is normally too low. In SCC fiber content of 0.3 volume percent have been used for pavement concrete and in some cases for insulated concrete walls. They focused the production aspects of SCC with up to 0.8 volume percent fiber used in walls, slabs and roofs together with no or moderate bar reinforcement. The load capacity for structures is dependent on the distribution and orientation of the fibers, and the fibers have a tendency to oriented parallel to the flow. In a slab, the flow gives an orientation of fibers that is mainly horizontal.

Pereira et al. studied a method to design cost competitive SFRSCC for precasting industrial applications is described in this paper. Since demoulding the elements as soon as possible is an important requirement in this industry, the influence of the age on the resistance and toughness of the designed SFRSCC was assessed carrying out an experimental program. Based on the force-deflection relationship obtained in the three point bending notched beam tests performed according to the RILEM TC 162-TDF recommendations, the stress-crack opening relationship of the SFRSCC was determined. The influence of the SFRSCC age on the fracture parameters of this material was analyzed.

III. OBJECTIVES OF INVESTIGATION:

- To compare the properties of SFRSCC with that of Normal SCC.
- To compare the Flexural Strength of SFRSCC composite.

IV. MATERIALS:

1. Cement: The cement used in this experimental work is "ACC 43 grade Ordinary Portland Cement". All properties of cement are tested by referring IS 8112 - 1989 Specification for 43 Grade Ordinary Portland Cement.
2. Fine aggregate: Locally available river sand conforming to Grading zone II of IS: 383–1970. Fineness modulus was found to be 2.76, Specific gravity was 2.59.
3. Super Plasticizer: The properties of SP supplied by the manufacturer Sika India Pvt. Ltd., Mumbai in the literature is given in Table (3.4) which compiles IS: 9103- 1999 (Amended 2003).
4. Water: Potable water available in laboratory is used.
5. Steel Fiber: Dramix steel fibers conforming to ASTM A 820 type-I are used for experimental work. Dramix HK **- 80/60** is high tensile steel cold drawn wire with hooked ends, glued in bundles & specially engineered for use in concrete.
6. Crimped Type Steel Fiber (CR 50/30): Crimped type steel fibers conforming to ASTM A 820 type-I are used for experimental work. CR 50/30 is high tensile steel cold drawn wire with crimped types, glued in bundles & specially engineered for use in concrete.
7. Straight Steel fiber: Rounded type steel fibers conforming to ASTM A 820 type-I are used for experimental work. **SF- 50/80** (Tomato wire) **is** high tensile steel cold drawn wire with crimped types.

V. METHODOLOGY:

Testing Of Concrete: Research Work is divided into 2 parts:

Part A: Testing the properties of Normal Compacted Concrete with and without different types of Steel Fiber.

Part B: Testing the properties of Self Compacted Concrete with and without different types of Steel Fiber.

Test Conducted On Normal Concrete: In present study cube compression test, flexural test on beams ,Cylindrical split tensile test and Shear and Torsion test on beam on plain and different types of steel fiber concrete (SFC) with constant fraction were carried out.

VI. TESTING PROGRAM:

Flexural strength test: Standard beams of size 150 x 150 x 700mm are supported symmetrically over a span of 400mm and subjected two points loading till failure of the specimen. The deflection at the center of the beam is measured with sensitive dial gauge on UTM. The two broken pieces (prisms) of flexure test are further used for equivalent cube compressive strength.

The flexural strength is determined by the formula

$$f_{cr} = P_f L / bd^2$$

Where

f_{cr} = Flexural strength, MPa

P_f = Central point through two point loading system, kN

L = Span of beam, mm

b = Width of beam, mm

d = Depth of beam, mm

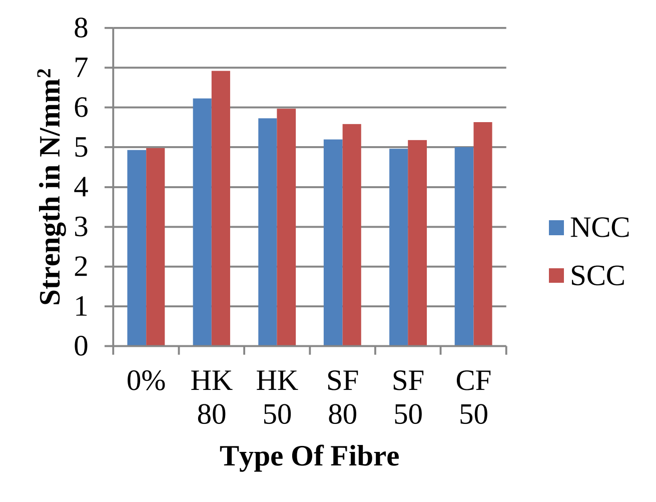
Fig. 1 - Flexural Test Setup

Table No.1: Flexural Strength on Beam of Normal Concrete at the End of 28 Days

Sr. No.	Type Of Fiber	Applied Load At Failure (N)	Flexural Strength (N/ mm²)
1.	0%	33×10^3	4.90
		32×10^3	4.74
		34×10^3	5.03
2.	HK 80	43×10^3	6.30
		41×10^3	6.13
		42×10^3	6.22
3.	HK 50	36×10^3	5.33
		38×10^3	5.50
		37×10^3	5.42
4.	SF 80	34×10^3	5.00
		33×10^3	4.90
		39×10^3	5.70
5.	SF 50	34×10^3	4.96
		31×10^3	4.50
		37×10^3	5.42
6.	CF 50	32×10^3	4.62
		34×10^3	5.00
		36×10^3	5.40

Table No. 2: Flexural Strength on Beam of SSC at the End of 28 Days

Sr. No.	Type Of Fiber	Applied Load At Failure (N)	Flexural Strength (N/ mm²)
1.	0%	35×10^3	5.18
		32×10^3	4.74
		34×10^3	5.03
2.	HK 80	45×10^3	6.67
		43×10^3	6.37
		50×10^3	7.74
3.	HK 50	41×10^3	6.07
		40×10^3	5.93
		40×10^3	5.93
4.	SF 80	38×10^3	5.63
		37×10^3	5.48
		38×10^3	5.63
5.	SF 50	36×10^3	5.33
		35×10^3	5.18
		34×10^3	5.03
6.	CF 50	37×10^3	5.48
		41×10^3	6.07
		36×10^3	5.33



Graph No.1: Comparative Chart of Flexural Strength at the End of 28 Days

VII. CONCLUSIONS:

- In all above cases, the strength of SCC is higher than NCC because of addition of superplastisizer in SCC to maintain flowability gives proper compaction of concrete which enhance all properties of SCC.
- The SCC developed flexural strengths ranging from 4.98 to 6.92Mpa at the end of 28 days and the NCC developed flexural strengths ranging from 4.93 to 6.23Mpa at the end of 28 days.

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