EXPERIMENTAL STUDY ON STRENGTH PROPERTIES OF SELF COMPACTING CONCRETE BY USING STEEL FIBERS IN M30 MIX DESIGN

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Abstract— **Over the last few decades, the astonishing of super plasticizers technology allowed great achievements on the conception of concrete mixes exhibiting self- compacting ability .Since the eighties some methodologies have been proposed to achieve self-compacting requirements in fresh concrete mixes based on the evaluation of the flowing properties of these mixes There still persist, however some doubts about the most appropriate strategy to define the optimum composition of a self-compacting concrete(SCC) mix based on a required performance. a mix design method is proposed to develop cost effective and high performance steel fiber the adding of steel fiber 0%,0.3%,0.5%,1%,1.5%,and 2% were used it was observed that compressive strength tensile strength. Steel fiber was on higher side from 2% fiber as compared to that properties aspect 60 through utilization of steel fiber the compressive strength and tensile strength. Self-compacting concrete. It flows under its own weight and homogeneity while completely filling any form work and passing around congested reinforcement. In the hardened state, it equals any or excels standard concrete with respect to strength and durability the effect of fibers on the fresh and hardened properties was studied.**

Key words: self-compacting concrete, Hook and steel fiber, workability.

I. INTRODUCTION

Self-Compacting Concrete (SCC) can be defined as a concrete that is able to flow in the interior of the formwork, filling it in a natural manner and passing through the reinforcing bars and other obstacles flowing and Consolidating under the action of its own weight. Self Compacting Concrete was originally developed with the intention of simplifying Casting operations in Civil Engineering constructions of large dimensions where high Percentage of reinforcement or complex geometries difficult concrete flow soon it became clear though that the great productivity increase associated to SSC technology.

Self-compacting concrete mainly used for highly congested reinforced structures in seismic region SCC can also provide a better working environment by eliminating the vibration noise there are many advantages of using SCC especially the when the material cost is minimized these include reducing the construction time and labor cost eliminating the need for vibration reducing the noise pollution improving the filling capacity of highly congested structural members such concrete requires a high slump that can easily be achieved by super plasticizer in addition to the concrete mixture also to enhance stability a viscosity-modifying admixture is incorporated fibers are generally discontinuous randomly distributed throughout the cement matrices fiber reinforced self compacted concrete (FRSCC) is formed from cement various sizes of aggregate which incorporate with discrete discontinuous fiber the objective of this study is to assess the effects of steel fiber replacement on the fresh and hardened properties of SCCs incorporating steel fiber. The steel fiber were used at different aspect ratio (80, 50) with 2.5% volume making the concrete the comparative study on steel fiber reinforced cum control concrete steel fibers of 50, 60 and 67 aspect ratio at volume fraction of 0%, 1%,2% and 3% were used it was observed that compressive strength tensile strength and flexural strength from steel fiber were on higher side from 3% fiber as compared to that properties were observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67 through utilization of steel fiber the compressive strength increased from 11 to 28%, flexural strength increased from 18 to 58% and tensile strength from 9 to 29%.

Hook and fiber can be used in almost any known application for steel fiber reinforced concrete for ArcelorMittls HE 55/35 and 75/35 are primarily used in shotcrete hook end steel fiber does not perform as well as undulated fibers with regard to shrinkage control but it provides excellent workability when using fiber with up to an aspect ratios up to and including 80 provide satisfactory workability concrete mix and high concrete density is less mandatory then for undulated or for flat-end fibers load transfer in the crack is very good with this fiber shape the first crack the loss of load-bearing capacity occurs quickly but then stabilizes and in some cases even begins to increase again after large crack have developed.

II. LITERATURE REVIEW

Subramanian and Chatopadhyay are research and development engineers at the ECC Division of Larsen & Toubro Ltd (L&T), Chennai, India. Their research was concentrated on several trials carried out to arrive at an approximate mix proportion of self-compacting concrete, which would give the procedure for the selection of a viscosity modifying agent, a compatible super plasticizer and the determination of their dosages.

Khayat's et al research was to evaluate the uniformity of in situ mechanical properties of self-consolidating concrete used to cast experimental wall elements. Eight optimized SCC mixes with slump flow values greater than 630 mm and a conventional concrete with a slump of 165 mm were investigated. The self-compacting concrete mixtures incorporated various combinations of cementitious materials and chemical admixtures.The water-cementitious materials ratios ranged from 0.37 to 0.42. Experimental walls measuring 95 cm in length, 20 cm in width, and 150 cm in height were cast. After casting, no consolidation was used for the SCC mixes, while the medium fluidity conventional concrete received thorough internal vibration. Khayat et al found out that all cores from both types of concrete exhibited little variation in compressive strength and modulus of elasticity in relation to height of the wall, indicating a high degree of strength uniformity. However, compressive strength and modulus of elasticity were greater for SCC samples than those obtained from the medium fluidity conventional concrete.

J.Mater worked on the mechanical properties of steel fiber-reinforced concrete the study indicates that the fiber matrix interaction contributes significantly to enhancement of mechanical properties caused by the introduction of fibers the behavior of steel fiber reinforced concrete (SFRC) in this experimental study efforts have been made to evaluate rationally the effect of steel fiber on modulus of elasticity of concrete study on effect of volume fraction and aspect ratio of fibers on modulus of elasticity of concrete in particular has also been deemed as an important part of present experimental investigation.

III. EXPERIMENTAL PROGRESS

Stage 1:

To develop SCC mix M30 grade using Mix design method which satisfies specifications given by EFNARC to qualify SCC and developing a simple mix design for producing SCC with Cement 53 grade.

Stage 2:

In the second stage investigations were done to develop and study the fresh and hardened properties of SCC. In fresh properties, at the stage before solidification, self-compacting concrete is required to have three qualities: high-flow ability, resistance against segregation and possibility, i.e. ability that is necessary to pass the space between reinforcing bars. After satisfying the fresh properties of SCC, the hardened properties of concrete were determined.

3.1 The different materials used in this work are

Cement used in the investigation was cement53 Grade confirming to IS: 12269.The cement was obtained from a single consignment and of the same grade and same source procuring the cement it was stored properly. The Specific gravity of the cement is found to be 3.03

The fine aggregate conforming to Zone-2 according to IS: 383 were used. The fine aggregate used was obtained from a nearby river source. The bulk densities, specific gravity of the sand used were 1.49g/cc, 2.54.

Crushed granite Aggregate was used as coarse aggregate. The coarse aggregate was obtained from a local crushing unit having 20mm MSA, 20mm 16mm, and 10mm well graded aggregate according to IS: 383is used in this investigation. The bulk density & specific gravity of the coarse aggregate sand used were 1.46g/cc, 2.89

Water: Potable water was used in the experimental work for both mixing and curing. According to IS: 456-2000, water for concrete should be of portable quality (pH- 6.8 to 8.0). Ordinary tap water, which is fit for drinking has been used in preparing all concrete mixes and curing in this investigation.

Hook and fiber can be used in almost any known application for steel fiber reinforced concrete for ArcelorMittls. HE 55/35 and 75/35 are primarily used in shotcrete hook end steel fiber does not perform as well as undulated fibers with regard to shrinkage control but it provides excellent workability when using fiber with up to an aspect ratios up to and including 80 provide satisfactory workability concrete mix and high concrete density is less mandatory then for undulated or for flat-end fibers load transfer in the crack is very good with this fiber shape the first crack the loss of load-bearing capacity occurs quickly but then stabilizes and in some cases even begins to increase again after large crack have developed

Aspect ratio = 60Length = 30 mmDiameter = 0.5 mmTensile strength > 1100 Map
Conplast SP430 is used where a high degree of workability and its retention are required where delays in transportation or placing are likely or when high ambient temperatures cause rapid slump loss. In facilitate production of high quality concrete.

Viscosity Modifying Agents: These admixtures enhance the viscosity of water and eliminate the bleeding and segregation phenomena in the fresh concrete as much as possible. VMA is a neutral, biodegradable, liquid chemical additive designed to reduce the bleeding, segregation, shrinkage and cracking that occur in high water/cement ratio concrete mixes. VMA also contribute to stabilization for SCC mixes that are susceptible to segregation at high slump range.

3.2 Mixing of Concrete:

The performance of concrete is influenced by mixing and a proper and good practice of mixing can lead to better performance and quality of the concrete once the mix is done the mixing of the concrete can be carried out in the present study the mixing was done manually.

3.2.1 Procedure for Mixing:

The test procedure for the procedure of mixing as follows

- All the material were weighted and prepared as per the proportion of mix design
- Before the mixing begins the ground surfaced is made wet by sprinkling some amount of water.
- The weighted coarse aggregate are placed on the wet surface.
- Some amount of Steel fiber is mixed to the coarse aggregate.
- Fine aggregate is mixed to the mixture and then remaining quantity of the steel is fiber is mixes.
- The aggregate and the fiber are mixed properly for about 2 minutes.
- The cement is then added to the mixture of aggregates and steel fiber.
- The water is added slowly while the mixing of cement aggregate and steel fiber is going on.
- The mixing process is done of about 2-3 minutes and the concrete mix is ready for placing in the moulds.

3.2.2 Mix proportions

According to Indian Standard mix design method for SCC was used to arrive at initial trial mixes and then mixes were modified accordingly as per EFNARC to achieve optimum mix Proportions satisfying fresh properties hardened properties and also economy. The proportions arrived for different grades of SCC are given in the Table 3.1. As follows

s.no	Mix	C.A/F.A	VMA Kg/m3	CA Kg/m3	FA Kg/m3	Cement Kg/m3	Sp Kg/m3	Water Kg/m3	w/p ratio
1	M30	35/65	2.524	632.80	1175.20	425.73	10.09	191.58	0.45

Table3.1: Mix proportions M30 grade of SCC

3.2.3Tests for Fresh Properties ofSelf-Compacting Concrete:

At the stage before solidification, self-compacting concrete is required to have three qualities: high-flow ability, resistance against segregation and possibility, i.e. ability that is necessary to pass the space between reinforcing bars. Therefore, it is important to test whether the concrete is self-compactable or not and also to evaluate deformability or viscosity for estimating proper mix proportioning if the concrete does not have sufficient self-compatibility. The common tests currently used, although not standardized for assessment of fresh SCC, are described here.

1. Slump flow + T50 (Reference method for filling ability)
2. V-funnel test and V-funnel test at T 5minutes
3. L-box test method

The details of fresh properties of SCC mix for M30 developed shown in Table

S. No.	Method	Units	Fresh Concrete Properties of M30 grade	EFNARC Specifications (Min – max values)
1	Slump flow by Abrams cone	Mm	710	650-800
2	T_{50cm}slump flow	Sec	4.20	2 – 5
3	V-funnel (Time for complete discharge)	Sec	6.79	0 – 10
4	V-funnel at T_5minutes	Sec	9.0	6 – 12
5	L-box(h2/h1)		0.91	0.8 – 1.0

Table3.2:details of fresh properties of SCC mix for M30

From Table 3.1 it can be noted that the fresh properties are satisfied according to EFNARC specifications.

3.3 Tests for hardened Properties of SCC

Compressive Strength : The cube specimens were tested on compression testing machine of capacity 300 tones .The bearing surface of the machine was wiped off clean and any loose sand or other material removed from the surface of the specimen.The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on the specimen was recorded.

Split Tensile Strength: This comes under indirect tension test methods. The test was carried out by placing a cylindrical specimen horizontally between the loading faces of a compression testing machine and the load was applied until failure of the cylinder along the vertical diameter as A concrete cylinder of size 150mm diameter and 300mm height was subjected to the action of a compressive force along two opposite edges. The cylinder was subjected to compression near the loaded region and the length of cylinder is subjected to uniform tensile stress.

Horizontal tensile stress=2P/ΠDL

Where P=Compressive load on the cylinder L=Length D=Diameter of cylinder.

In the present investigation, the split tensile strength test has been conducted on concrete with different sizes of coarse aggregate for M 30 grade of SCC at 7 and 14 days.

3.4. Concrete mix design

3.4.1 Requirement of Concrete Mix Design:

The requirement which form the basis of selection and proportioning of mix ingredients are:

The minimum compressive strength required from structural consideration.

The adequate workability necessary for full compaction with the compacting equipment available.

Maximum water-cement ration and maximum cement content to give adequate durability for the particular site conditions.

Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

3.4.2 Concrete Mix Design - M 30 Grade of Concrete:

3.4.2.1. Requirements:

a) Characteristic compressive strength required in the field at 14-days: 30Mpa
b) Maximum size of aggregate: 20 mm (rounded)
c) Degree of workability: 0.9 (compaction factor)
d) Degree of quality control: very good
e) Type of exposure: mild

3.4.2.2. Test data of materials:

a) Specific gravity of cement: 2.74 (53 grade OP Cement)
b) Compressive strength of cement at 7-day Satisfies the requirement of IS269 1989(37N/mm^2)

c) Specific gravities of coarse aggregate: 2.95
d) Specific gravities of fine aggregate: 2.59

3.4.2.3. Steps taken in the mix proportioning: Trail mix-1

a)TargetmeansstrengthforM30gradeconcrete
b) Water- cement ratio:
c) Determination of Cement Content

d) Determination of Coarse and Fine aggregate:
e) Converting into SCC Proportions

IV. RESULTS AND DISCUSSIONS:

4.1 Compressive Strength Results:

a) Compressive strength test results:

Adding steel fiber	Compressive strength, N/mm^2	Compressive strength, N/mm^2
	7days	14days
0%	20.49	33.57
0.3%	20.63	33.08
0.5%	20.8	34.31
1%	21.98	39.9
1.5%	23.25	32.5
2%	23.49	31.8

b) Split tensile strength test results:

L – Box test adding steel fiber	H1 (mm)	H2 (mm)	H = H2/H 1Ratio
SF (Normal)	7.5	7	0.93
SF-0.3	7.6	7	0.92
SF-0.5	7.9	7.2	0.91
SF-1	8	7.9	0.98
SF-1.5	8.2	9	1
SF-2	7.9	7.3	0.92

Adding steel fiber	Split tensile strength, N/mm^2	Split tensile strength, N/mm^2
	7days	14days
0%	1.94	1.9
0.3%	2.08	2
0.5%	2.13	2.3
1%	2.26	2.4
1.5%	2.1	2.3
2%	2.5	2

4.2 Fresh Concrete test results:

Slump-Flow classes (Class) adding steel fiber	Slump-flow by Abrams Cone(mm) Horizontal Slump(mm)	T50Time(sec)
SF (Normal)	682.5	2
SF-0.3	685.10	2.1
SF-0.5	692.5	2.5
SF-1	697.5	3.9
SF-1.5	702.5	4.4
SF-2	694.5	3.7

Table 4.1: Slump flow test results according to EFNARC

V-Funnel test adding steel fiber	Flow Time(mm)	T50Time(sec)
SF (Normal)	11	15.5
SF-0.3	11	14.1
SF-0.5	10	14.5
SF-1	9	10.5
SF-1.5	12	16.56
SF-2	10	14.5

Table 4.2: V-funnel test results according to EFNARC

Table 4.3: L-Box test results according to EFNARC

V. CONCLUSION:

This research project is to determine the strength characteristics of steel fiber reinforced concrete for potential application in the structural concrete based on the experimental results of following conclusions were drawn.

1. The compressive strength of steel fiber concrete is found to be maximum at 1.5%
2. Higher percentages of steel from 1.5% affect the workability of concrete and may require super plasticizer to maintain the workability.
3. With the use of steel fiber in concrete it has shown an improvement in mechanical properties such as compressive strength.

4. A reduction in bleeding improve the surface integrity of SCC, improves its homogeneity and probability of cracks.

5. The SFRSCC mixes have a slump flows in the range of 660-680, 675-670, 680-679, 690-688, 700-692, 683-689, 670-673.

6. A flow time ranges are 2.89, 2.9, 3.3, 2.4, 4.1, 2.9, 2.7, The addition of glass fibers was noticed to enhance the fresh properties of SCC by reducing bleeding.

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