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Steel Fiber Reinforced Self Compacting Concrete Incorporating Silica Fume

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Abstract

The world of today demanding and challenging civil engineering structures. Its possibilities are extended. Steel fiber serves as a barrier to delay the progression of their cracks different characteristics and properties. In this investigation, therefore, an attempt was made to study the self-compacting concrete. Flexural behavior of steel fiber reinforced incorporating silica fume in the structural elements to have a coarse aggregate substitution by silica fume weight of 25 percent and 35 per cent. A total of eight mixers in which cement content, water content, super plastic dosage were all constant are investigated. The fresh properties of the concrete were assessed by slump flow time and diameter, J-Ring, V-funnel, and L-Box. The percentage of volume fraction (1.0, 1.5) of steel fibre was the variable in this study. Finally, 5 beams are casted study, one with conventional concrete, one with SCC (25% silica fume), the other with SCC (25% silica fume + 1% steel fiber, 25% silica fume + 1.5% steel fiber), one with SCC (35% silica fume), and the other with SCC (35% silica fume + 1% silica fume). Compressive strength, concrete flexural strength was determined for 7and 28day hardened concrete. This analysis is also performed to assess the change in compressive strength by adjusting the amount by adding silica fume.

Keywords: Silica fume, Cement, Self-compacting concrete, fibres, Admixtures.

Introduction

Waste management is world's most difficult and complex issues. To eradicate the problem of waste in our country, the wastes from various industries are being used for the construction. Through these waste products which can withstand the various environmental effects and the structural difficulties are replaced as the material. The SCC is an innovative idea for solving the concreting problem by means of robust strengthening. In the field of concrete technology, the self-compacting concrete is now a new technique referred to as SCC. Concrete that can be mounted at the same time is sufficiently stable to be treated without segregation and bleeding. It is used for facilitating and ensuring proper filling and good structural performance of restrained areas and heavily strengthened structural members. The SCC is unique due to its properties, such as filling capacity, flow efficiency, pumping ability and making concrete output more industrialized. The application of cementation fines such as silica fumes renders the concrete economic. SCC's hardened properties are good too. The aim project is performed compacting free production system thus reducing the overall cost of the project, enhancing the quality of the work, and ensuring safety. SCC possesses high flow ability, segregation resistance and passing ability.

Performance of self-compacting concrete:

Concrete is the construction material with a volume of more than seven billion tons per year. The reason for concrete suffering from cracking can be material's inherent weakness to withstand tensile forces. Once, as it is constrained, concrete shrinks, and can break once. Reinforcement of steel fibres to the cracking problem by making concrete harder and more ductile. Extensive studies and field trials 3 decades have also proved that the introduction of steel fibers to traditional pre-stressed. It's provides improvements to many proper concrete relations, particularly those related to strength, efficiency and durability. The randomly

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oriented steel fibers formed after loading on the component, thus preventing their spread into major cracks. Its contain resistance, splitting / spalling resistance, erosion and abrasion.

Role of silica fume
Silica fume are commonly used worldwide in the field where it required. Silica fume enhances the concrete properties. Reduce concrete permeability to provide with a concrete resistant. The most important property is permeability. Advantage of SCC will result in more industrial production, decrease the technical costs of in situ cast concrete construction, improve the quality, durability, pumping capacity and eliminate some of the potent structures. These will replace fresh concrete manual compaction with new semi-automatic positioning technology and high filling capacity, a high resistance to segregation during and after installation of the concrete and high filling objects.

Literature Review
B. Krishna Rao 2010 are performed build a self-compacting concrete with reinforced steel fiber of fly ash class F. FRSCC mixtures show higher flexural strength than normal compacting concrete. In this paper that the introduction of HVFA decreased an SCC mixtures water requirement. It was noted that self-compaction with steel fiber (three different aspect ratios (15, 25 and 35) and three different volume fractions (0.5 percent, 1 percent, and 1.5 percent) could be achieved). Fiber reinforced SCC specimens were found to increase volume fraction of 1% for aspect ratios. Results indicate that in early ages pozzolanic reactions in the matrix composite were low, but considerable effect was seen in strength by aging the specimens to more than 56 days.

Ratchayut Kasemchaisiri (2008) is contributed to decreased compressive strength and increased porosity of hardened concrete. In terms of toughness, bottom ash SCC mixtures in the drying environment except for the 10 percent bottom ash mixture are SCC control, mainly due to higher. Water curing was performed, the durability of SCC mixtures with bottom ash could be enhanced in the long term by pore refinement. However, the bottom ash replacement level higher than 10 percent may be applied for specific works depending on total concrete cost and construction condition.

H.Oucief, M.F.Habita, B.Redjel, (2006), found that among the two types of fibbers, amorphous steel fibers (30mm) long gave the highest compressive strength, polypropylene fibers gave the lowest compressive strength. Self-compacting concretes containing hybrid fibers to maintain a good workability. Both of these are macro fibers with lengths of 20 and 30 mm respectively for steel fibers and 50 mm for polypropylene (these lengths are available). The ones with high bond and high modulus are amorphous metal fibres. Flexible, ribbon-like and fully stainless. For this reason they can be used in self-compacting concrete with no reservation. Six self-compacting reference mixtures were made, with different dosage and fiber type.

Luiz A. P (2004) is analyzed of the concrete infill contribution to the wall capacity. The characteristics of which were obtained in accordance with European standards from six research specimens was 10.2N/mm^2 and the absorption of water was 5.1%. The SFRSCC for mortar content to ensure coarse aggregates and fibers are involved, as well as to provide concrete filling efficiency. The self-compatibility of reinforced concrete infill with steel fibres can be obtained with steel fibre for fiber volumes up to 1.5 per cent.

Hajime Okamura (2003) are introduced that suitable acceptance test method on the job site were both largely developed for self-compacting concrete, the key obstacles to the broad u can be regarded as having been resolved. When self-compacting "standard concrete" instead of a "special concrete."During this test, the height will indicate capability. Results are indicated that the influence of coarse aggregate on fresh concrete flow capacity largely depends on the size of the concrete.

Experimental Investigations
The cement used in all mixtures was available of 53 grades. Setting times were found as 30min and 260 min. C.A and F.A were used. Silica fume, steel fiber (0.92 diameter), tensile strength and specific gravity are 331Mpa and 7.850, super plasticizer and water. Characteristic compressive strength = 30N/mm^2, S.G of Cement, F.A, C.A = 3.15, 2.71, 2.74 and target mean strength = 36.56 N/mm^2; W/C = 0.60. A slump of 150 to 180 mm and 240 kg/m^3 of concrete. Air content is 2 %. 12.5 mm CA. F.M of F.A 2.6 and bulk volume of dry rounded coarse aggregate per unit volume of concrete = 0.57.Therefore the weight of coarse aggregate =802.6 kg/m^3. The first estimate of density of fresh concrete for 12.5mm maximum size of aggregate and for non-air entrained concrete = 2196 kg/m^3; Weight of water =240 kg/m^3;Cement = 400 kg/m^3;C.A = 802.6 kg/m^3 and F.A = = 753.0 kg/m^3

Mix ratio:
C : CA : FA : WATER
1 : 2.15 : 2.27 : 0.6
Cement = 400 Kg/m^3; F.A = 753.50 Kg/m^3
C.A = 802.60 Kg/m^3; Water = 240.00 Lit/m^3

Experimental procedure to achieve self-compacting concrete:
Using the ACI mix design method, was performed at a C.A 50% volume of concrete and F.A 40% by volume of concrete mortar, the water / powder ratio was maintained at 0.90. The ACI was used normal mix of traditional concrete. When the design mix does not give a 100 mm slump the water / cement ratio has been adjusted to give a 100 mm vertical slump. The concrete mix was engineered to provide 30 MPA of compressive strength.
To step towards achieving SCC, C.A was reduced by concrete volume to 45 per cent and thus kept constant. F.A was 40% by mortar volume plasticizer content at 1.14% of the silica fumes. The aim is then to achieve a vertical slump of 160 mm to 180 mm by adding super plasticizer to the normal mix. Weight to be small, say 5 per cent The coarse aggregate is then replaced by a filler material called silica fume by weight starting from a value of 5 %, 10%, 15% etc. slump flow of 600 mm has been tested.

Trial Mix proportions and SCC mix:

Concrete was first designed by the ACI method of mix design. Initially a mix was made with a w/c ratio 0.57 of M30 grade, to get desired slump of 100mm. W/C is about 240 l/m^3 of water, considering the fact that the cement was 400 kg/m^3 and aggregates angular and air dry this quantity of water is considered reasonable. Super plasticizers were introduced slump of 160 to 180mm.

When the super plasticizer was introduced the slump was 195mm, but the mix showed bleeding and segregation. Therefore a 5% percentage of C.A was replaced by F.A. Using silica fume the flow of the concrete mix was increased. In this sequential procedure by replacing the coarse aggregate with varying proportions such as replacement of coarse aggregate 25%, 35%, 40%. of silica fume, the flow of the concrete mix was increased.

Concrete mix was arrived which satisfies the acceptance criteria, so that the segregation and bleeding of the concrete mix was also arrested. Trial mix is also made in the continuation of the obtained mix fiber of 0.5%, 1%, 1.5%. By weight of cement. In this project, totally nine specimens are to be casted. Three are the control specimen. The first one was the control specimen (CC_1). The second was the mix added with 0.6% SP (CC_2). And then the third was the mix in which the percentage of C.A were reduced by 5% and F.A were increased by 5% (CC_3). Mixes which were arrived, based on the methodology adopted with various proportions are shown in tables.

Table 1: Various mix proportions for the specimen

Mix	Cement	Fine aggregate	Coarse Aggregate	w/c	Silica fume	SP%	Remarks
CC_1	1	1.88	2.01	0.60	-	-	Control Mix
CC_2	1	1.88	2.01	0.60	-	0.6	SP added mix
CC_3	1	1.98	1.91	0.60	-	0.6	CA reduced by 5% & FA increased by 5% by weight
SCC_1	1	1.98	1.45	0.60	0.49	0.6	25%(by weight of CA replaced by silica fume
SCC_2	1	1.98	0.94	0.6	0.69	0.6	35%(by weight) of CA replaced by Silica Fume
SCC_3	1	1.98	0.94	0.6	0.69	1.00	25%(by weight) of CA replaced by Silica fume
SCC_4	1	1.98	0.94	0.6	0.69	1.00	1% (by weight of cement) fiber added
SCC_5	1	1.98	0.94	0.6	0.69	1.00	1.5% (by weight of cement) Fiber added

Table 2: Material Content for the Various Trials

Mix	Cement Kg/m^3	F.A Kg/m^3	C.A Kg/m^3	W/C Lts	Silica fume	SP Lts/m^3	Fiber content
CC_1	400	753.50	802.6	240	_	_	_
CC_2	400	753.50	802.6	240	_	2.4	
CC_3	400	791.20	762.5	240	_	2.4	_
SCC_1	400	791.20	686.25	240	76.25	2.86	_
SCC_2	400	791.20	610.00	240	152.5	3.32	_
SCC_3	400	791.20	571.888	240	190.63	3.54	_
SCC_4	400	791.20	571.888	240	190.63	4.43	_
SCC_5	400	791.20	571.888	240	190.63	4.43	1.00
SCC_6	400	791.20	571.888	240	190.63	4.43	1.50

The mixes were then prepared for the self-compacting concrete by substituting Silica fume and Steel fiber for the C.A and cement. The replacement should be made for 25%, 35% and 40%. The slump that fresh concrete determined the percentage. The slump began to decrease after a certain percentage and the percentage was taken as 25 percent, 35 percent and 40%. The steel fiber of silica fume was replaced by 1 percent, 1.5 percent. The mix SCC_1 was the replacement of coarse aggregate by 25% Silica fume. The next mix was to substitute the coarse aggregate with Silica fume by 35 per cent, and all other parameters remained constant (SCC2). The SCC3 is formed by replacing the coarse aggregate with silica fume at 25 percent and also cement with steel fiber at 1 percent. The next mix was 25 per cent replacement of silica fume and 1.5 per cent replacement of steel fiber (SCC4). And the rest are the SCC with different combinations. The (SCC_5) was prepared with replacement of 35% of silica fume and 1% steel fiber.SCC_6 has been prepared for cement by replacing coarse aggregate with 35 per cent silica fume and 1.5 per cent steel fiber. Thus the mixes are prepared and the beams are casted for different combinations.

Results and Discussions

The use of a special concrete was designed and the hardened properties of the SCC was investigated in this project. An SCC mix was developed with 0.6 percent SP and 25 percent silica fume was substituted. In addition to SCC, 1% of the steel fiber added mix and was used for the flexural beam study. SCC's compressive strength was improved by fibre. The SCC also exhibits greater compressive strength compared to the convent. An SCC mix was produced of 0.6% SP and by replacing 25% silica fume. Along with SCC, 1%, 1.5% of steel fiber added mix satisfies of the flexural beam. The SCC also shows greater compressive strength relative to standard concrete.

Table 3: Test Results for Conventional Concrete

S.No	Specimen	Ultimate load(KN)	First crack load(KN)	Stiffness
1	CC	50.4	8	0.69
2	CC (0.6 % SP)	51.7	11	0.8
3	CC (5% FA)	54.3	12	0.813

Table 4: Test Results for Self-Compacting Concrete.

S.no	Specimen	Ultimate load (KN)	First crack (KN)	Stiffness
1	SCC(25% silica fume)	56.5	10	0.617
2	SCC (35% silica fume	57.45	12	0.793
3	25% silica fume + 1% steel fiber	58.56	12	0.74
4	25% silica fume+1.5% steel fiber	58.80	13	0.895
5	35% silica fume + 1 % steel fiber	59.12	12	0.854
6	35% silica fume+ 1.5% steel fiber	59.67	14	0.899

Conclusion

First Crack Load increased with fiber applied to SCC. Total strength, rigidity found to be improved by adding steel fiber maintaining the mix self-compatibility. SCC by congested reinforcement concreting. Using SCC increases concrete pumping efficiency, thereby reducing labor costs and increasing safety. Use of SCC also in general practice. The method of analyzing reinforced and pre-stressed concrete beams was evaluated using the finite element method. A reinforced concrete beam model was calibrated to experimental data and predictions of initial cracking, steel yielding and beam flexural failure were compared with the experimental results. Deflections and stresses at both points of the beam together with the initial and progressive cracking of the finite element model compare well with experimental data obtained from the reinforced concrete beam. The reinforced concrete beam failure mechanism is well modelled using FEA and the expected failure load is very similar to the failure load measured during experimental testing.

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