Self-Compacting Concrete With Fiber Reinforcement

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Abstract: Self-compacting concrete (SCC) represents one of the most outstanding advances in concrete technology during the last decade. At first developed in Japan in the late 1980s, SCC meanwhile is spread all over the world with a steadily increasing number of applications. Due to its specific properties, SCC may contribute to a significant improvement of the quality of concrete structures and open up new fields for the application of concrete. Self-Compacting Concrete gets dense and compacted due to its own self-weight. An experimental investigation has been carried out to determine different characters like workability and strength of Self-Compacting Concrete (SCC). Tests involving various fiber proportions for a particular mix of SCC. Test methods used to study the properties of fresh concrete were slump test, U – tube, V – funnel and L – Box. The properties like compressive, tensile and flexural strength of SCC were also investigated. Test Results shows that the workability characteristics of SCC are within the limiting constraints of SCC. The variation of different parameters of hardened concrete (M30 & M40) with respect to various steel fiber contents were analyzed.

Keywords—Self compacting concrete, steel fiber, super plasticizer, viscosity modifying agent, mechanical properties.

I. INTRODUCTION

Though concrete possess high compressive strength, stiffness, low thermal and electrical conductivity, low combustibility and toxicity but two characteristics limited its use are, it is brittle and weak in tension. However the developments of Fiber Reinforced Composites (FRC) have provided a technical basis for improving these deficiencies. Fibers are small pieces of reinforcing materials added to a concrete mix which normally contains cement, water, fine and course aggregate.[1] Among the most common fibers used is steel, glass, asbestos, polypropylene etc. When the loads imposed on the concrete approach that for failure, crack will propagate, sometimes rapidly, fibers in concrete provides a means of arresting the crack growth. If the modulus of elasticity of fiber is high with respect to the modulus of elasticity of concrete or mortar binder the fiber helps to carry the load, thereby increasing the tensile strength of the material. Fibers increase the toughness, the flexural strength, and reduce the creep strain and shrinkage of concrete. [2] Several European countries recognized the significance and potentials of SCC developed in Japan. During 1989, they founded European federation of natural trade associations representing producers and applicators of specialist building products (EFNARC). The utilization of SCC started growing rapidly. EFNARC, making use of board practical experiences of all members of European federation with SCC, has drawn up specification and guide lines to provide a framework for design and use of high quality SCC, during 2002[3]. Self-Compacting Concrete has been desired as "The Most Revolutionary Development in Concrete Construction for Several Decades".

II. CHARACTERSTIC OF FRESH SCC

SCC mixes must meet three key properties:

1. Ability to flow into and completely fill intricate and complex forms under its own weight
2. Ability to pass through and bond to congested reinforcement under its own weight.
3. High resistance to aggregate segregation.

The main characteristics of SCC are

i. Passing ability

ii. Filling ability

iii. Resistance to Segregation

Passing Ability

The ability of SCC to flow through tight openings such as spaces between steel reinforcing bars without segregation or blocking.

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The flow ability of the mix is tested by the slump flow, T50 slump flow, V funnel.

Filling ability

This property of fresh concrete is related entirely to the mobility of the concrete the ability of SCC to flow into and fill completely all spaces within the formwork, under its own weight.

Resistance to Segregation

The mix has to maintain its stability under high flow conditions i.e. it should not segregate and should remain homogenous in composition during transport and homogeneity. The normal concrete mix when it shows signs of segregation, a percentage of coarse aggregate is replaced by fine aggregate. In this study the stability of the SCC is maintained by using cementations fines, fly ash in place of coarse aggregate.

III. MIX DESIGN FOR SCC

Rational method is used for mix design of M-30 grade of concrete. The optimum percentage of fly ash to give maximum compressive strength was achieved by making trial mixes with fly ash at a constant interval of 3% by weight of cement. The trial mixes were made for fly ash from 12% to 36%. The compressive strength went on increasing up to 33% at it decreased at 36%. The maximum compressive strength was achieved at 33%. Hence, fly ash at 33% by weight of cement was added to concrete in this experiment.

At the end after performing the entire test following mix proportion was used for the present study.

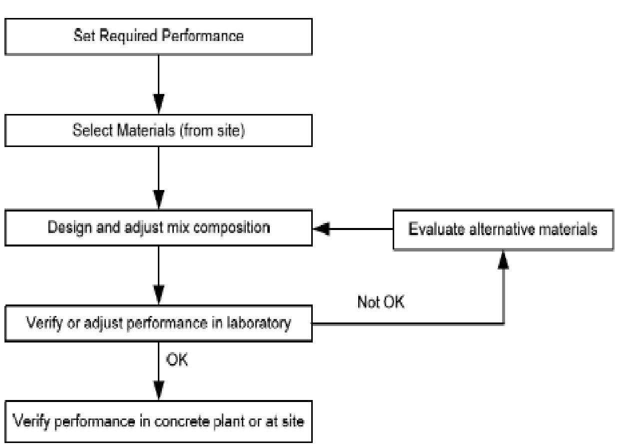

Fig. 1 MIX DESIGN FOR SCC

The quantity of ingredient materials and mix proportions as per EFNARC guide lines is shown in the Table No.1.

Table1 Quantity of Materials per Cubic Meter of Concrete

Material	Proportion by Weight	Weight in Kg/m^3
Cement	1	450.00
F.A.	2.18	983.63
Fly ash	0.33	148.50
C.A. (<12 mm)	1.78	803.00
W/C	0.40	180.00

After finalizing the proportion of ingredients following mix proportions with different designations according to Steel Fiber content were used. The details are shown in Table No.2

Table No.2 Mix Designations Used

Sr.no.	Mix designation	FLA (%)	Steel Fiber content (%)	W/C ratio
01.	M0	33.0	0.0	0.40
02.	M1	33.0	0.5	0.40
03.	M2	33.0	1.0	0.40
04.	M3	33.0	1.25	0.40
05.	M4	33.0	1.5	0.40
06.	M5	33.0	1.75	0.40
07.	M6	33.0	2.0	0.40
08.	M7	33.0	2.25	0.40
09.	M8	33.0	2.5	0.40
10.	M9	33.0	2.75	0.40
11.	M10	33.0	3.0	0.40

IV. TEST ON HARDENED CONCRETE

Tests on Hardened Concrete Testing of hardened concrete plays an important role in controlling and confirming the quality of concrete work. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control programme for concrete, which helps to achieve higher efficiency of the material used and greater assurance of the performance of the concrete with regard to both strength and durability. The hardened property test such as compression test by using compression testing machine,

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split tensile test by using compression testing machine and flexural test by using ultimate testing machine are conducted. The results obtained for the various mixes of SCC, SCC with 0.25%, 0.5%, 0.75%, and 1% Steel Fiber are below.

V. CONCULSIONS

Following conclusion are drawn based on the result discussed above

1. In general, the significant improvement in various strengths is observed with the inclusion of Hooked end steel fibres in the plain concrete. However, maximum gain in strength of concrete is found to depend upon the amount of fibre content. The optimum fibre content to impart maximum gain in various strengths varies with type of the strengths.

2. In general the compressive strength and the flexural strength increase with increase in the percentage of fibre content.

3. In addition to the compressive strength and the flexural strength on the concrete split tension test was also performed on the SFRSCC the results of which are not mentioned in the paper (because the scope is limited to compressive and flexural strength of the SFRSCC) and it was found that the split tensile strength went on increasing with the addition of fibers. The optimum fiber content for increase in split tensile strength is 1.75% and percentage increase is 24.49% of SFRSCC over normal SCC.

4. The increase in compressive strength is 25.75% and increase in flexural strength is 19.47% of SFRSCC over normal SCC for the fiber content of 1.75%.

5. Satisfactory workability was maintained with increasing volume fraction of fibers by using super plasticizer.

6. With increasing fiber content, mode of failure was changed from brittle to ductile failure when subjected to compression and bending.

Fig. 2 casting of specimens

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