

# Fibre-Reinforced Self-Compacting Concrete

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**Abstract**— Over the last few decades, the astonishing developments 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. This study was composed of three parts. The first part was based on the design of SCC and FR-SCC with locally available materials of Fly ash in addition to chemical additives. The second part was based on studying the effects of using different percentages of steel fibers on SCC by testing the fresh properties of SCC and FR-SCC matrix such as slump flow, L-box, V-funnel and U-box test. The third part was dealing with the comparison of hardened properties of SCC and FR-SCC mixes such as compressive strength, splitting tensile strength, flexural strength. The results have shown that the addition of fibers improves the compressive strength, splitting tensile strength, and depending on the w/c ratio and admixture content better workability can be obtained for FR-SCC.

**Key words:** Fibre-Reinforced, Self-Compacting Concrete

## I. INTRODUCTION

In modern times of civil engineering, development of new materials and production methods have increased within the field of construction. One example is the use of steel fibers for various applications. Due to its ability to distribute and prevent cracks from appearing steel fibers have proved rather effective as crack controlling reinforcement, particularly in slabs. By replacing parts of the conventional reinforcement by steel fibers a new, more rational way of production has been developed. The favorable properties provided by fibers have lead to increased research efforts aiming at finding other areas of application for steel fiber reinforced concrete. One area where steel fibers may prove effective is as shear reinforcement in concrete beams. Here, the replacement of conventional shear reinforcement may seriously reduce construction time and costs. Quite a few previous investigations have been conducted within this field of application, and some design methods applicable on steel fiber reinforced concrete beams in shear have been reported. Results from these studies have indicated some beneficial effects provided by fibers in terms of improving the shear behavior. However, as most of the shear design procedures have been developed from experimental results, there are reasons to suspect that these will prove to be insufficient, especially regarding the effect of the geometrical dimensions of the beams.

### A. Self-Consolidating Concrete (SCC):

A specially proportioned concrete that can flow easily into forms and around steel reinforcement without segregation. The benefits of SCC in reduced labor needs, increased rate of production and safety, and lower noise levels have

generated great interest from the precast concrete industry. Considerable development in SCC technology has been made through the past decades particularly in Japan, Canada, and Europe, and its applications have become wide spread.

## II. CHARACTERISTIC OF FRESH SCC

SCC mixes must meet three key properties:

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

The main characteristics of SCC are

- 1) Passing ability
- 2) Filling ability
- 3) Resistance to Segregation

### A. Passing Ability

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

### B. 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.

### C. 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 cementitious fines, fly ash in place of coarse aggregate.

## III. MATERIALS USED

The different materials used in this investigation are:

- Cement
- Fine Aggregates
- Coarse Aggregates
- Fly Ash
- Admixtures
- Steel Fiber
- Viscosity Modifying Agent

## IV. PROPERTIES OF THE MATERIAL USED

### A. Cement

| S. No. | Physical properties | Results obtained | IS:8112-1989 SPECIFICATIONS |
|--------|---------------------|------------------|-----------------------------|
|--------|---------------------|------------------|-----------------------------|

|    |                                   |     |           |
|----|-----------------------------------|-----|-----------|
| 1. | Fineness                          | 8%  | 10%       |
| 2. | Normal consistency                | 29% | -         |
| 3. | Vicat's initial setting time(min) | 72  | 30 (min.) |
| 4. | Vicat final setting time(min)     | 220 | 600 (max) |
| 5. | Compressive strength              | 23  | 22 (min.) |
| 6. | Compressive strength 7-day(Mpa)   | 36  | 33 (min.) |
| 7. | Compressive strength 28-day(Mpa)  | 45  | 43 (min.) |

Table 1: Cement

**B. Fly Ash**

| S. No. | Physical Properties                                   | Test Results   |
|--------|---|----------------|
| 1      | Color   | Grey(Blackish) |
| 2      | Specific Gravity                                      | 2.13           |
| 3      | Lime Reactivity of compressive strength after 28 days | 4.90 Mpa       |

Table 2: Fly Ash

**C. Admixtures**

The viscosity modifying agent named Sika stabilizer 229 was used which is specially designed for very high stability and good consistency. The specific gravity of Sika stabilizer 229 is 1.01.

**D. Steel Fibers**

The steel fibers used in the project 60 mm in length and 0.75 mm in thickness. The aspect ratio of steel fiber is 80.

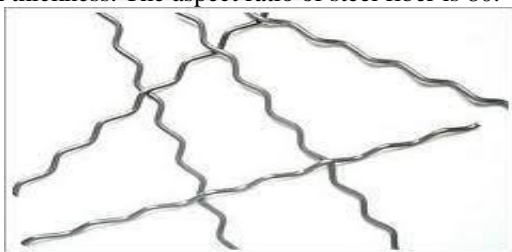


Fig. 1: Steel Fibre

**E. Mix Proportion Used**

| Ingredient       | Kg/m <sup>3</sup> |           |           |           |           |
|------------------|-------------------|-----------|-----------|-----------|-----------|
|                  | SCC               | FR-SCC 20 | FR-SCC 30 | FR-SCC 40 | FR-SCC 50 |
| Cement           | 400               | 400       | 400       | 400       | 400       |
| Water            | 190               | 190       | 190       | 190       | 190       |
| Silica Fume      | 75                | 75        | 75        | 75        | 75        |
| Fine Aggregate   | 850               | 850       | 850       | 850       | 850       |
| Coarse Aggregate | 770               | 770       | 770       | 770       | 770       |
| Steel Fiber      | 0                 | 20        | 30        | 40        | 50        |
| Superplasticizer | 5.0               | 5.5       | 5.75      | 6.0       | 6.5       |

Table 3: Mix Proportion Used

**F. Experiment Work**

**1) Self-Compatibility Test**

The concrete ingredients was mixed to perform the following fresh properties test

**Slump flow test**

- V-funnel test
- U-box test
- L-box test

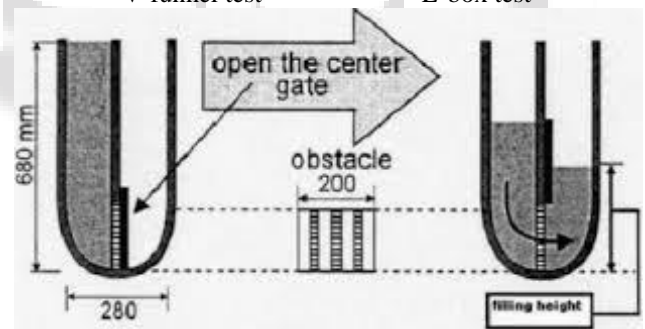


Slump flow test



V-funnel test

L-box test



U-box test

Fig. 3: Test

**2) 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.

- Compressive strength test
- Split-tensile strength
- Flexural strength test



Fig. 4: Compressive strength test

## V. RESULT ANALYSIS

### A. Self-Compatibility Test

| Test Methods                   | SCC  | FR SCC 20 | FR SCC 30 | FR SCC 40 | FR SCC 50 |
|--------------------------------|------|-----------|-----------|-----------|-----------|
| Slump flow                     | 750  | 725       | 715       | 705       | 690       |
| T50 cm Slump flow              | 2.8  | 3.1       | 3.5       | 3.8       | 4.1       |
| V – funnel test                | 7.2  | 7.8       | 8.2       | 9.1       | 9.4       |
| V – funnel test at T5 min(sec) | 10   | 13        | 14        | 12        | 13        |
| U – box test                   | 22   | 20        | 22        | 25        | 28        |
| L–box test( $h_2/h_1$ )        | 0.92 | 0.80      | 0.82      | 0.85      | 0.88      |

Table 4: Self-Compatibility Test

### B. Test on hardened concrete

| S. No | Concrete type | Compressive strength 28 days ( $N/mm^2$ ) | Split tensile strength 28 days ( $N/mm^2$ ) | Flexural strength 28 days ( $N/mm^2$ ) |
|-------|---------------|---|---|--|
| 1.    | SCC           | 28.88                                     | 1.7   | 4.6                                    |
| 2.    | FR-SCC20      | 29.33                                     | 1.7   | 4.2                                    |
| 3.    | FR-SCC30      | 30.22                                     | 1.76  | 4.6                                    |
| 4.    | FR-SCC40      | 29.11                                     | 1.81  | 4.8                                    |
| 5.    | FR-SCC50      | 31.32                                     | 1.88  | 5.2                                    |

Table 4: Test on hardened concrete

## VI. CONCLUSION

Many researchers all over the world have done some researches on this subject. Self-compacting concrete is a fluid mixture suitable for placing in structures with congested reinforcement without vibration. Self-compacting concrete development must ensure a good balance between deformability and stability. Also, compactibility is affected by the characteristics of materials and the mix proportions; it becomes necessary to evolve a procedure for mix design of SCC.

In this study various proportions of steel fibers were used to produce fiber reinforced self-compacting concrete. The effect of various proportions of steel fibers on fresh properties such as slump flow, slump flow t50 sec, V-funnel, V-funnel at T5 min, L-box and U-box test, and on

hardened properties such as compressive strength, splitting tensile strength, flexural strength tests were examined.

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