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ijirset@gmail.com



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# Experimental Study on Self Compacting Concrete

**B.Mounika<sup>1</sup>, Shaik Mohammad Abrartaha<sup>2</sup>, Dr.K.Rajasekhar<sup>3</sup>**

P.G. Student, Siddhartha Educational Academy Group of Institutions, Tirupati, India<sup>1</sup>

Asst Professor, Siddhartha Educational Academy Group of Institutions, Tirupati, India<sup>2</sup>

Professor, Siddhartha Educational Academy Group of Institutions, Tirupati, India<sup>3</sup>

**ABSTRACT:** Self compacting concrete (SCC) is a development of conventional concrete, in which the use of vibrator for compaction is no more required. Self-compacting concrete was first developed in 1988 to achieve durable concrete structures. Since then, various investigations have been carried out and this type of concrete has been used in practical structures in Japan mainly by large construction companies. The use of self-compacting concrete (SCC) can facilitate the placement of concrete in congested reinforcement in the structural members. This is especially important in deep structural members and wall elements where concrete can segregate and exhibit bleeding and settlement which can result in local structural defects that can reduce mechanical properties. Investigations for establishing a rational mix-design method and self-compatibility testing methods have been carried out from the viewpoint of making self-compacting concrete a standard concrete.

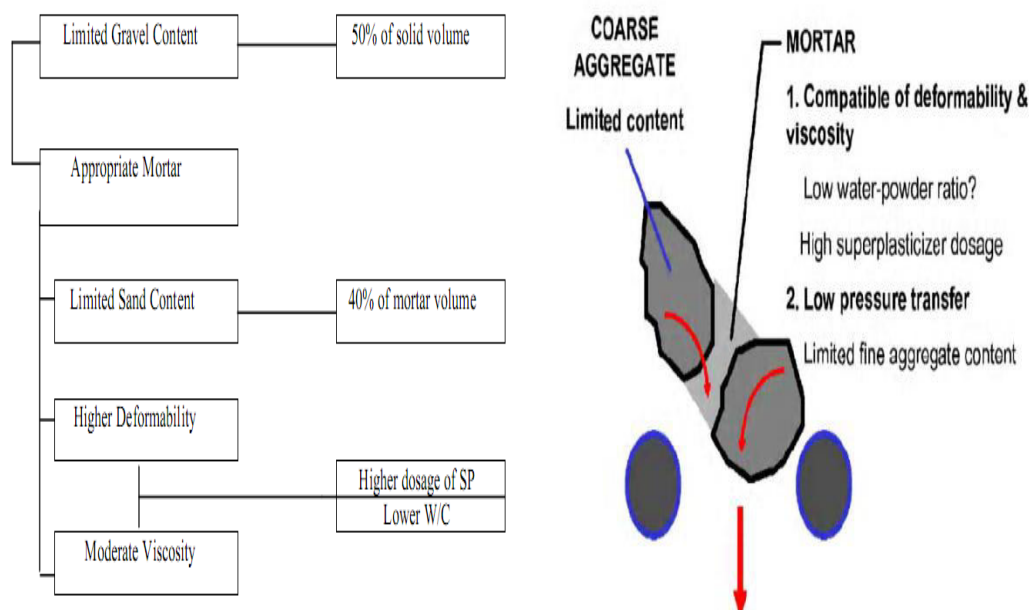
**KEYWORDS:** Self compacting, concrete, structural stability, wall elements, slabs, footings, compression test.

## I. INTRODUCTION

Development of self-compacting concrete (SCC) is a desirable achievement in the construction industry in order to overcome problems associated with cast-in-place concrete. Self-compacting concrete is not affected by the skills of workers, the shape and amount of reinforcing bars or the arrangement of a structure and, due to its high-fluidity and resistance to segregation it can be pumped longer distances. The concept of self-compacting concrete was proposed in 1986 by Professor Hajime Okamura [1], but the prototype was first developed in 1988 in Japan, by Professor Ozawa [2] at the University of Tokyo. Self-compacting concrete was developed at that time to improve the durability of concrete structures. Since then, various investigations have been carried out and SCC has been used in practical structures in Japan, mainly by large construction companies. Investigations for establishing a rational mix-design method and Self-Compactability testing methods have been carried out from the viewpoint of making it a standard concrete. Self-compacting concrete is cast so that no additional inner or outer vibration is necessary for the compaction. With regard to its composition, self-compacting concrete consists of the same components as conventionally vibrated concrete, which are cement, aggregates, and water, with the addition of chemical and mineral admixtures in different proportions. Usually, these concretes have higher workability, superior mechanical properties and greater resistance to chemical attack as compared to traditional concrete.

It has proved beneficial economically because of a number of factors as noted below (Krieg [15], 2003 and ENFARC, 2005):

1. Faster construction,
2. Reduction in site manpower,
3. Easier placing,
4. Uniform and complete consolidation,
5. Better surface finishes,
6. Improved durability,
7. Increased bond strength,
8. Greater freedom in design,
9. Reduced noise levels, due to absence of vibration, and
10. Safe working environment.

**Method for achieving self-compactability Mechanism for achieving self-compactability****Objective:**

To produce SCC, the major work involves designing an appropriate mix proportion and evaluating the properties of the concrete thus obtained. The average bond strength is increased in Self-compacting concrete as the porosity is reduced due to the addition of much finer material such as fly ash. Though the bond characteristics of normal concrete are reasonably well established, the bond characteristics of self-compacting concrete using supplementary cementitious materials like GGBS, fly ash and silica fume have not been studied in detail. So the investigations are carried out to evaluate the bond strength of steel reinforcements for M40, and M60 grade of self concrete compacting with and without glass and steel fibers. Fiber reinforcement in the region of the splice/development length played a role similar to ordinary transverse reinforcement in that it restricted the growth of the splitting cracks and increased the splitting bond strength.

**II. EXPERIMENTAL PROGRAM**

The experimental program was designed to study the comparison of bond behavior and bond strengths of M40, and M60 grade of SCC with and without steel and glass fibers. The program consisted of casting and testing a total number of 54 cylinders of size 150mm diameter and 300mm height with 16 mm  $\Phi$  Tor steel bars and 9 cubes of 150x150x150 mm size, were casted in 3 batches. Of these 54 cylinders 27 cylinders for M40 grade of self compacting specimens and 27 cylinders of M60 grade of self compacting specimens, and their corresponding 9 cubes for compressive strength. The specimens were cast with the steel rebar in perfect vertical position with help of fasteners at the top end of mould in order to avoid secondary stresses in the bar.

| S. No | Grade of concrete | Type of concrete  | Embedment Length(mm) | No of cylinders <u>cast</u> (pullout test)<br>150 D x300 mm <sup>3</sup> for 16mm $\Phi$ | No of cubes <u>for</u> (comp. strength)<br>150X150X150 mm <sup>3</sup> |
|-------|-------------------|-------------------|----------------------|--|--|
| 1     | M40               | Without fibers    | 100                  | 3  | 3  |
|       |                   |                   | 150                  | 3  |  |
|       |                   |                   | 300                  | 3  |  |
|       |                   | With steel fibers | 100                  | 3  | 3  |
|       |                   |                   | 150                  | 3  |  |
|       |                   |                   | 300                  | 3  |  |
|       |                   | With glass fibers | 100                  | 3  | 3  |
|       |                   |                   | 150                  | 3  |  |
|       |                   |                   | 300                  | 3  |  |
| 2     | M60               | Without fibers    | 100                  | 3  | 3  |
|       |                   |                   | 150                  | 3  |  |
|       |                   |                   | 300                  | 3  |  |
|       |                   | With steel fibers | 100                  | 3  | 3  |
|       |                   |                   | 150                  | 3  |  |
|       |                   |                   | 300                  | 3  |  |
|       |                   | With glass fiber  | 100                  | 3  | 3  |
|       |                   |                   | 150                  | 3  |  |
|       |                   |                   | 300                  | 3  |  |

| Sieve size (mm) | % Passing recommended by IS: 383[36] | Adopted grading | %Weight retained | Cumulative % Weight retained | Weight retained in <del>gms</del> |
|-----------------|--------------------------------------|-----------------|------------------|------------------------------|-----------------------------------|
| 10-4.75         | 100                                  | 100             | -                | -                            | -                                 |
| 4.75-2.36       | 90-100                               | 100             | -                | -                            | -                                 |
| 2.36-1.18       | 75-100                               | 90              | 10               | 10                           | 100                               |
| 1.18-0.60       | 55-90                                | 65              | 25               | 35                           | 250                               |
| 0.60-0.30       | 35-59                                | 40              | 25               | 60                           | 250                               |
| 0.30-0.15       | 8-30                                 | 10              | 30               | 90                           | 300                               |
| 0.15            | 0-10                                 | 0               | 10               | 100                          | 100                               |





Slump flow EquipmentJ-Ring equipment



| S. No | Method                               | Unit | M40 | M60 | EFNARC Specification |
|-------|--------------------------------------|------|-----|-----|----------------------|
| 1.    | slump flow by Abrams cone            | mm   | 680 | 750 | 650-800              |
| 2.    | T50cmSlumpFlow                       | sec  | 4   | 3   | 2-5                  |
| 3     | J-ring                               | mm   | 2   | 2.5 | 0-10                 |
| 4.    | V-funnel                             | sec  | 6   | 4   | 6-12                 |
| 5.    | Time increase, V-funnel at T5minutes | sec  | 5   | 8   | +3                   |

| S. No | Method                               | Unit | M40 | M60 | EFNARC Specification |
|-------|--------------------------------------|------|-----|-----|----------------------|
| 1.    | slump flow by Abrams cone            | mm   | 660 | 730 | 650-800              |
| 2.    | T50cmSlumpFlow                       | sec  | 4   | 3   | 2-5                  |
| 3     | J-ring                               | mm   | 2   | 2.5 | 0-10                 |
| 4.    | V-funnel                             | sec  | 6   | 4   | 6-12                 |
| 5.    | Time increase, V-funnel at T5minutes | sec  | 6   | 9   | +3                   |

Fresh Properties of Self-Compacting Concrete without fibers.Fresh Properties of Self-Compacting Concrete with glass fibers

Compressive Strength:Details of Average compressive strengths without fiber

| Specimen designation | Avg. comp. Strength.          | Specimen designation | Avg. comp. Strength.          |
|----------------------|-------------------------------|----------------------|-------------------------------|
| M40                  | $f_{ck}$ (N/mm <sup>2</sup> ) | M60                  | $f_{ck}$ (N/mm <sup>2</sup> ) |
| M40-1                | 48.67                         | M60-1                | 69.12                         |
| M40-2                |                               | M60-2                |                               |
| M40-3                |                               | M60-3                |                               |

Table 4.2 Details of Average compressive strengths with Steel fibers

| Specimen designation | Avg. comp. Strength.          | Specimen designation | Avg. comp. Strength.          |
|----------------------|-------------------------------|----------------------|-------------------------------|
| G40                  | $f_{ck}$ (N/mm <sup>2</sup> ) | G60                  | $f_{ck}$ (N/mm <sup>2</sup> ) |
| G40-1                | 50.13                         | G60-1                | 70.94                         |
| G40-2                |                               | G60-2                |                               |
| G40-3                |                               | G60-3                |                               |

| Specimen designation | Avg. comp. Strength.          | Specimen designation | Avg. comp. Strength.          |
|----------------------|-------------------------------|----------------------|-------------------------------|
| S40                  | $f_{ck}$ (N/mm <sup>2</sup> ) | S60                  | $f_{ck}$ (N/mm <sup>2</sup> ) |
| S40-1                | 51.65                         | S60-1                | 71.92                         |
| S40-2                |                               | S60-2                |                               |
| S40-3                |                               | S60-3                |                               |

Details of Average compressive strengths with Glass fibers

### III. CONCLUSIONS

A detailed experimental program was taken up to understand the role of embedment length on the bond stress of self compacting concrete. Based on the study, the following conclusions can be drawn regarding the bond behavior of self compacting concrete.

- 1) There is an increase in ultimate slip with increase in embedment length for all grades Self Compacting Concrete (M40 and M60) without fibers, with glass and steel fibers.
- 2) There is an increase in bond strength with increase in grade of Self Compacting Concrete (M40 and M60) without fiber, with steel and glass fiber.
- 3) There is an increase in the ultimate slip with the addition of fibers (steel and glass) to Self Compacting Concrete, this is due to crack arresting property of the fibers
- 4) The bond strength increases with decrease in embedment length for all grades Self Compacting Concrete (M40 and M60) with (steel and glass) and without fiber.

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