Self Compacting Concrete – A Useful Technology

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ABSTRACT

Self Compacting Concrete (SCC) is characterized by a low yield stress, high deformability, and moderate viscosity necessary to ensure uniform suspension of solid particles during transportation, placement (without external compaction), and thereafter until the concrete sets. SCC is a flowing concrete mixture that is able to consolidate under its own weight. Self compacting concrete was first developed in 1988 to achieve durable concrete structures by improving quality in construction processes. This technology finds special applications in cases of congested reinforced sections, rafts, highly reinforced columns, bridge piers, tunnel linings, placements and underwater repairs. These are some of the situations where ordinary vibrated concrete cannot be effectively utilized. Considering the current pace of research on SCC in the advanced countries it is likely that SCC would replace the conventional vibrated concrete in the near future altogether.

The use of SCC helps in minimizing hearing related problems at the work sites which are induced as a result of vibration of concrete. Another advantage of SCC is that the time required to place the concrete in large sections is considerably reduced. SCC is relatively a new product that sees the addition of super plasticizers and a stabilizer to the concrete mix to significantly increase the ease and the rate of flow. By virtue of its nature, SCC does not require vibration. SCC is certainly the way forward for both in situ and precast concrete construction. This paper deals with the history of SCC development and its basic principle, different testing methods to test flow ability, resistance against segregation, comparison with ordinary concrete, and future of SCC.

Keywords: Self Compacting Concrete, Testing Methods, Comparison with ordinary Concrete, Future of Self Compacting Concrete

1. INTRODUCTION

The development of new technology in the material science is progressing rapidly. In last three decades, lot of research was carried out throughout globe in order to improve the performance of

concrete in terms of strength and durability. Consequently, concrete has no longer remained a construction material but has rather becomes an *engineered custom tailored material* with several new constituents to meet the specific needs of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, better structural performance and adequate durability. Concrete technology has under gone from macro to micro level study in the enhancement of concrete properties (strength and durability) from early eighties onwards.

In Japan, in early eighties, premature deterioration of concrete structures was detected in almost every part of the country. The main cause of deterioration was found to be inadequate compaction. As a solution of this technical problem, the concept of *Self Compacting Concrete* was introduced. SCC is a type of concrete that flows by itself without segregation, does not need vibration for full compaction and is environmental friendly due to absence of noise. Self compacting concrete provides robustness in construction and is insensitive to workmanship.

2. BASIC PRINCIPLE BEHIND SELF COMPACTING CONCRETE (SCC)

The SCC is that which gets compacted due to its self weight and is de-aerated (no entrapped air) almost completely while flowing in the form work. In densely reinforced structural members, it fills completely all the voids and maintains the horizontality of concrete surface after placing the concrete. In order to reduce the liquid limit and better workability super plasticizers are used in the concrete mixture.

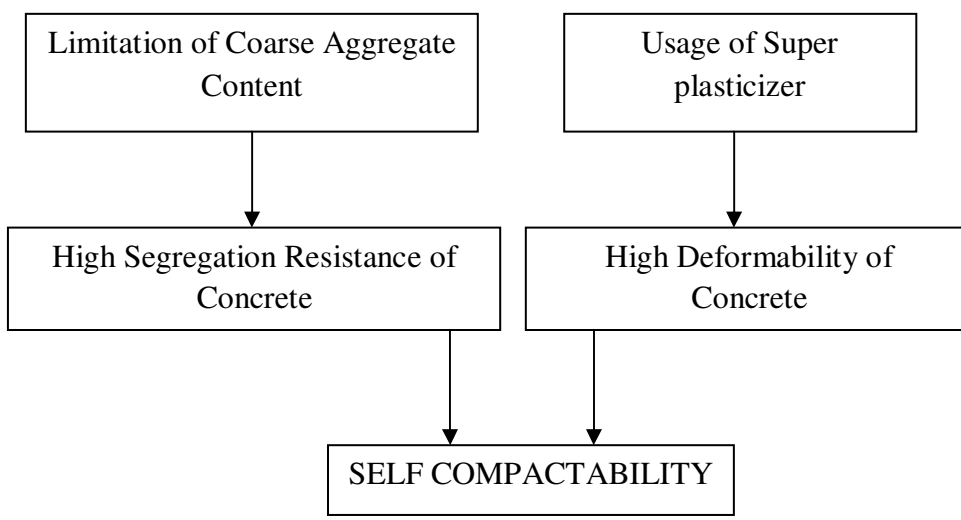

***Figure* shown below shows the basic principle of self compaction concrete.**

Super plasticizer enhances the deformability of concrete and the content of coarse aggregates in the mixture is kept limited in order to ensure the segregation resistance of concrete. These will finally result in the production of concrete which is self compactable and does not need external vibration for compaction.

3. TESTING METHODS

Before solidification, concrete is required to have three qualities i.e. high flow ability, resistance against segregation, and passing ability i.e. ability to pass in between the reinforcing bars. Therefore it is important to test whether the concrete is self compactable or not. Some testing methods for *self compacting concrete* are discussed in brief below.

1. Slump Flow Test

The slump flow test, using the traditional slump cone, is the most common field test and is in the process of being standardized by ASTM. The slump cone is completely filled without consolidation, then the cone is lifted, and the spread of the concrete is measured. The resistance to segregation is observed through a visual stability index (VSI). VSI values range from 0 for "highly stable" to 3 for "less stable".

2. L-Box, U-Box and J-Ring Test

The above mentioned tests are used to measure the ability of concrete to pass through the congested reinforced sections. The *L-box* test assesses the ability of SCC to *flow in confined space.* It also measures the flow of concrete and also the extent to which it is subjected to blocking by reinforcement. The *U-box* test is used to measure the filling ability of *self compacting concrete*. *J-ring* test provides a method to measure the distance of lateral flow of self compacting concrete.

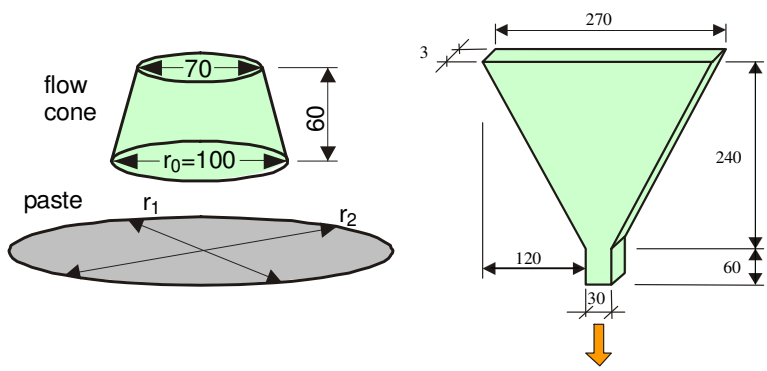

Figure showing Japanese tools to measure the rheological properties of SCC in the fresh state: the cone (left) and the funnel (right)

3. V-Funnel Test

The V-funnel flow time is the period a defined volume of SCC needs to pass a narrow opening and gives an indication of the filling ability of SCC provided that blocking and segregation does not occur. The flow time of V-funnel test is related to the plastic viscosity to some extent. To be term as SCC, the flow time should be less than 6 seconds.

4. COMPARISON BETWEEN SCC AND ORDINARY CONCRETE

Self compacting concrete (SCC) differs from an ordinary concrete in various aspects like in composition, in behaviour, in testing methods etc. A brief comparison is made between SCC and ordinary concrete below:

1. Comparison in terms of composition

S.No.	Components	Composition of Self compacting concrete (%)	Composition of Ordinary concrete (%)
1.	Coarse Aggregate	36	45
2.	Fine Aggregate	26	25
3.	Water	18	18
4.	Cement	10	10
5.	Air	2	2
6.	Fines (VMA, HRWR, SP)	8	-

Where VMA, HRWR, SP are Viscosity Modifying Agent, High Range Water Reducers and Superplasticizers respectively.

2. Comparison in terms of behavior

- In ordinary concrete, segregation resistance comes from aggregate grading but in self compacting concrete it comes from mortar viscosity. Similarly, workability comes through water content in ordinary concrete whereas in SCC workability comes through admixtures.
- SCC is much more sensitive to small changes in materials, mixture proportions, and production variables than conventionally placed concrete. The potential consequences of such variations can be severe.
- The high flow ability of SCC significantly increases the potential for severe segregation. Therefore, the control of workability is much more critical for SCC than for ordinary concrete.

3. Comparison in terms of testing

The main difference between the workability of SCC and ordinary concrete is the ability of SCC to compact under its own mass. This characteristic is best represented in the slump flow test. In contrast to the slump test in case of ordinary concrete, where the change in height of the specimen is determined upon removal of the slump cone, the horizontal flow of SCC is measured.

5. FUTURE OF SELF COMPACTING CONCRETE (SCC)

Self compacting concrete (SCC) is coming out of its infancy. In the pre cast concrete industry this new material has a large impact. Self compacting concrete offers many advantages and can be easily produced and controlled. Worldwide research was carried out in order to explore all the properties of SCC, both as liquid and as hardened material.

Self compacting concrete finds wide scope in the construction of the following important structures:

1. Bridges (Anchorages, arch, beam, girder, tower, pier, joint between pier and girder)
2. Box culverts
3. Multi storeyed buildings
4. Concrete filled steel columns
5. Tunnel (Linings, immersed tunnel)
6. Dams (Concrete around structure)
7. Concrete products (Water tank, slab and segments)

Self compacting concrete provides an innovative concrete that does not require vibration for placing and compaction. After achieving hardened stage SCC becomes dense and homogeneous thereby possessing the same mechanical properties and durability as well as in the case of traditional concrete. SCC offers certain advantages which enables it to be known as '*Future Concrete'*. Some of the advantages of SCC are listed below:

1. From the contractor's point of view costly labor operations are avoided in case of SCC which results in the improved efficiency of the building site.
2. Since no external vibrations is needed in case of SCC, therefore workers does not make use of poker vibrations provides a huge benefit to the working environment.

3. When vibrations are omitted from the casting operations the workers experiences less strenuous work.
4. SCC is believed to increase the durability as compared to the ordinary concrete.
5. SCC shows narrow variations in properties at the site.
6. SCC is most suitable for *concrete filled tube (CFT)* technology construction for high rise building.
7. SCC ensures better quality of in-situ pile foundation.
8. SCC reduces the cost of consumption of resources and cost.

Self compacting concrete (SCC) is favorably suitable especially in highly reinforced concrete members like bridge decks or abutments, tunnel linings or tubing segments, where it is difficult to vibrate the concrete, or even for normal engineering structures. The improved construction practice and performance, combined with health and safety benefits makes SCC a very attractive solution for both pre cast concrete and civil engineering construction. Based on these facts it can be concluded that SCC will have a bright future.

6. CONCLUSION

In spite of its short history, self compacting concrete has confirmed itself as a revolutionary step forward in concrete technology. In present scenario, considering the economy and durability of the conventional concrete structures, it is observed that the qualities, density as well as the compaction of concrete are the main parameters which are among the major factors leading to the deterioration of the building. In order to get rid of these problems Self Compacting Concrete (SCC) offers new possibilities and prospects along with certain advantages. It can be shown by cost analysis, that SCC in precast concrete plants can be more economically produced than ordinary concrete, in spite of the slightly higher material price. It can be a boon considering improvements in concrete quality, significant advances towards concrete construction processes, shortened construction time and lower construction cost.

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