Influence of OPC 53S Cement on the Mechanical Performance of Self-Compacting Concrete

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ABSTRACT

The use of self-compacting concrete (SSC) which is capable of flowing in farm work and congested reinforcement without any mechanical vibrator fill the concrete voids with its high paste content is highly durable and Economical. It is believed that this kind of property is attained by achieving high placing density among the constituents of concrete with satisfactory workability properties. A comparative experimental studies on the arrived M40 grade SCC is carried out with replacement of ordinary port land cement (OPC53) (IS 12269) with OPC53S (per IS4031) varying from different percentages to determine optimum replacement. Fresh properties of SCC reveal the enhancement of workability satisfying permissible limits.

KEYWORDS: OPC53S cement: Chryso S612 Super plasticizer: GGBS: Crusher dust: Cement: Fly ash.

INTRODUCTION

Self-Compacting Concrete (SCC) is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete that requires little vibration or compaction has been used in Europe since the early 1970 but self-compacting concrete was not developed until the late 1980ʺs in Japan. In Europe it was probably first used in civil works for transportation networks in Sweden in the mid1990ʺs. The EC funded a multinational, industry lead project “SCC” 1997 -2000 and since then SCC has found increasing use in all European countries. As on date there is no IS code for SCC, therefore the guidelines given by EFNARC(European Federation of Natural Association Representing For Concrete) are followed Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of SCC ensures high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water cement ratio providing the potential for high early strength, earlier Remolding and faster use of elements and structures. The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction. Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. Use of SCC can also help minimize hearing related damages on the worksite that are induced by vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced.

HISTORY OF SCC

The introduction of the “modern” self-compacting concrete (SCC) is associated with the drive towards better quality of concrete pursued in Japan in late 1980ʺs, where the lack of uniform and complete compaction had been identified as the primary factor responsible for poor performance of concrete structures. There were no practical means by which full compaction of concrete on a site was ever to be fully guaranteed, instead, the focus therefore turned onto the elimination of the need to compact, by vibration or any other means. This led to the development of the first practicable SCC by researchers (Okamura, Ozawa et al.) at the University of Tokyo and the large Japanese contractors (e.g. Kajima, Maeda, Taisei etc.) quickly took up the idea. The contractors used their large in-house R&D facilities to develop their own SCC technologies. Each company developed their own mix designs, trained their own staff to act as technicians for testing on sites, and tailor made their SCC mixes for large projects they tendered for. Importantly, each of the large contractors also developed their own testing devices and test methods. In the early 1990ʺs there was only a limited public knowledge about the SCC, mainly in Japanese, the fundamental and practical know-how was kept secret by the large corporations to maintain commercial advantage. Modern, present-day Self-Compacting Concrete (SCC) can be classified as an advanced construction material. The SCC, as the name suggests, does not require to be vibrated to achieve full compaction. This offers many

benefits and advantages over conventional concrete. These include an improved quality of concrete and reduction of on-site repairs, faster construction times, lower overall costs, facilitation of introduction of automation into concrete construction. An important improvement of health and safety is also achieved through elimination of handling of vibrators and a substantial reduction of environmental noise loading on and around a site.The composition of SCC mixes includes substantial proportions of fine-grained inorganic materials; this offers possibilities for utilization of "dusts", which are currently waste products demanding with no practical applications and which are costly to dispose of. Current Indian scenario in construction shows increased construction of large and complex structures, which often leads to difficult concreting conditions. Vibrating concrete in congested locations may cause some risk to labour in addition to noise stress. There are always doubts about the strength and durability placed in such locations. So it is worthwhile to eliminate vibration in practice, if possible. In countries like japan, Sweden, Thailand, UK etc., the knowledge of SCC has moved from domain of research to application.

WORKABILITY AND REQUIREMENTS OF SELF COMPACTING CONCRETE

The main characteristics of SCC are the properties in the fresh state. The mix design is focused on the ability to flow under its own weight without vibration, the ability to flow through heavily congested reinforcement under its own weight, and the ability to retain homogeneity without segregation. The workability of SCC is higher than "very high" degree of workability.A concrete mix can only be classified as self-complicating if it has the following characteristics.

- Filling ability
- Passing ability
- Segregation resistance

Several test methods have been developed in attempts to characterize the properties of SCC. So far no single method or combination of methods has achieved universal approval to include in national or international organizations. However the list of test methods for workability properties of SCC based on EFNARC specification and guidelines.

MATERIALS

1. OPC53S cement
2. Crusher dust
3. Fine aggregate
4. Coarse aggregate
5. Super plasticizer(chryoS612)
6. OPC53 grade cement
7. Fly ash
8. GGBS

METHODS OF NEXT INVESTIGATION

i) Physical tests conducted on incineration ash
ii) Preparation of mix design M40
iii) Making number of samples of concrete cubes
v) Testing of cubes to 3, 7, 28 days
vi) Tests to be conducted on materials

TESTS TO BE CONDUCTED ON MATERIALS

Cement: i) initial and final setting time ii) specific gravity
Fine aggregate: i) Sieve analysis, ii) specific gravity.
Coarse aggregate: specific gravity

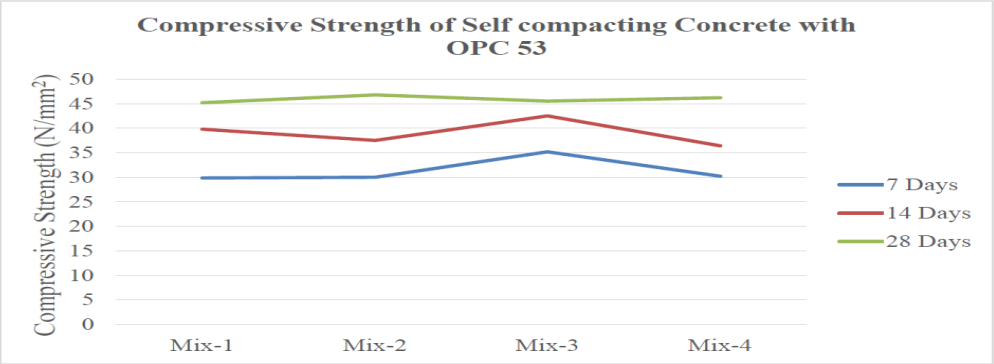
THESE ARE SOME TEST METHODS PROPOSED BY EFNARC GUIDELINES:

a) Slump flow
b) Slump flow T50cm
c) V-Funnel
d) V-Funnel At T5minutes
e) J-Ringf) L-Box
f) U-Box
g) Fill Box

COMPRESSIVE STRENGTH RESULTS

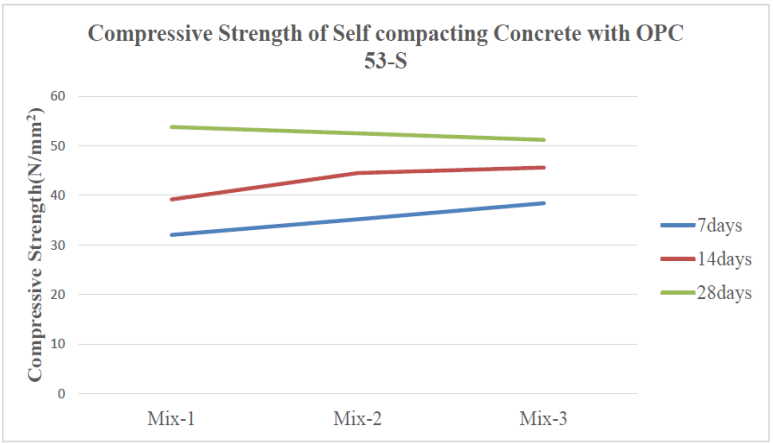
Compressive Strength of Concrete with OPC 53 for different days:

Mix Designation	Compressive Strength(N/mm²)		
Age of specimen	7days	14days	28days
Mix-1	29.86	39.78	45.2
Mix-2	30	37.5	46.8
Mix-3	35.2	42.5	45.5
Mix-4	30.2	36.4	46.2



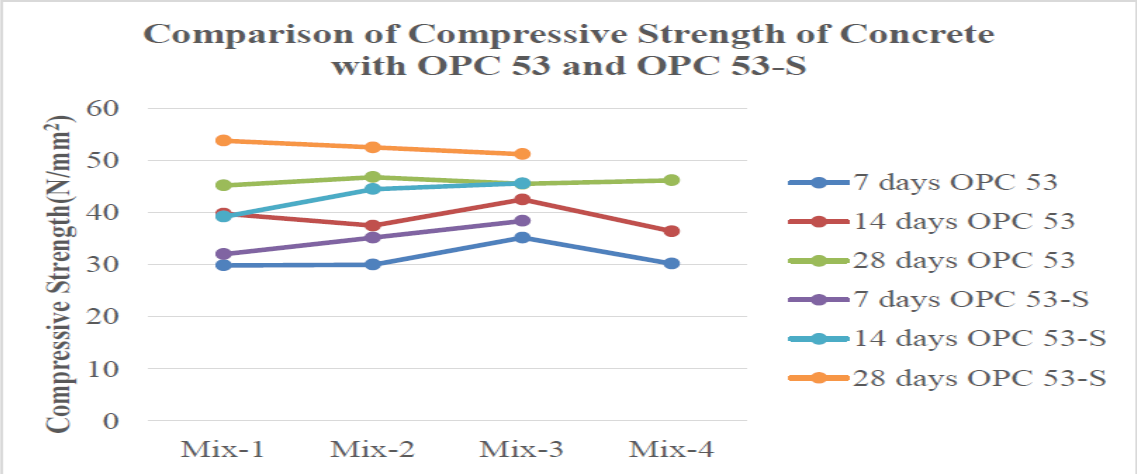
Compressive Strength of Concrete with OPC 53S for different days:

Mix Designation	Compressive Strength(N/mm²)		
Age of Specimen	7days	14days	28days
Mix-1	32.03	39.2	53.8
Mix-2	35.2	44.5	52.5
Mix-3	38.4	45.6	51.2



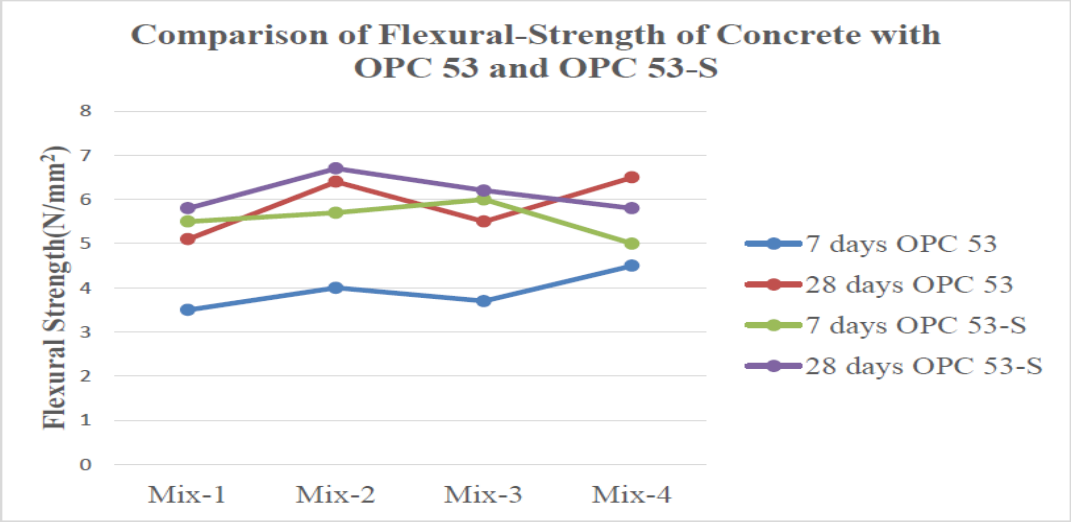
Comparison of Compressive Strength of Concrete with OPC 53 and OPC 53-S for different days, N/mm2:

Mix Designation	Compressive Strength					
Cements	OPC 53			OPC 53-S		
Age of Specimens	7days	14days	28days	7days	14days	28days
Mix-1	29.86	39.78	45.2	32.03	39.2	53.8
Mix-2	30	37.5	46.8	35.2	44.5	52.5
Mix-3	35.2	42.5	45.5	38.4	45.6	51.2
Mix-4	30.2	36.4	46.2	40.2	46.4	50.2



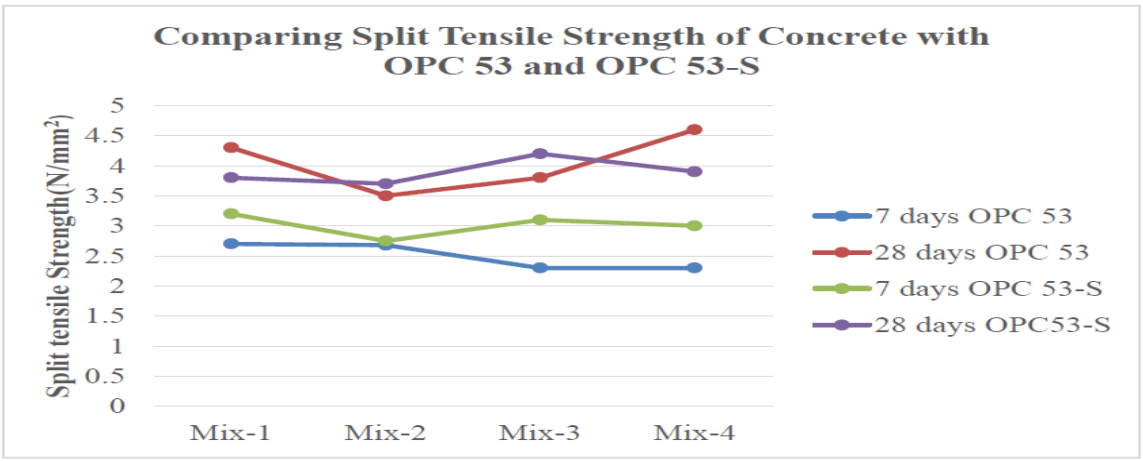
Flexural Strength of Concrete with OPC 53 and OPC 53-S at 28 days age of curing:

Mix Design	Flexural Strength(N/mm^2)			
Cements	OPC53		OPC 53-S	
Age of Specimen	7days	28days	7days	28days
Mix-1	3.5	5.1	5.5	5.8
Mix-2	4	6.4	5.7	6.7
Mix-3	3.7	5.5	6	6.2
Mix-4	4.5	6.5	5.0	5.8



Split Tensile Strength of Concrete with OPC 53 and OPC 53-S for different days, N/mm^2:

Mix Design	Flexural Strength(N/mm^2)			
Cements	OPC53		OPC 53-S	
Age of Specimen	7days	28days	7days	28days
Mix-1	2.70	4.3	3.2	3.8
Mix-2	2.68	3.5	2.75	3.7
Mix-3	2.3	3.8	3.1	4.2
Mix-4	2.3	4.6	3.0	3.9



CONCLUSION

- All the trial mixes 1, 2, 3 are satisfying the requirements of Self compacting concrete as per *EFNARC* Norms.
- From tables it is observed that Mix 1, 2, 3 is Satisfying 28days of Compressive Strength, split tensile strength, flexural Strength of OPC 53 & OPC 53-S grade of cement.
- 28 days of compressive strength of SCC is 46.8 N/mm2 and that of normal concrete is 46.2 N/mm2 of OPC 53 cement.

- Similarly with OPC 53-S cement the compressive strength of SCC is 46.8 N/mm2 and that of normal concrete is 46.2 N/mm2 of OPC 53-S cement.
- 28 days of Split tensile of SCC is 4.6 N/mm2 and that of normal concrete is 4.5 N/mm2 of OPC 53 cement.
- Similarly with OPC 53-S cement the split tensile strength of SCC is 4.2 N/mm2 and that of normal concrete is 3.9 N/mm2 of OPC 53-S cement.
- 28 days of Flexural strength of SCC is 6.4 N/mm2 and that of normal concrete is 6.2 N/mm2 of OPC 53 cement.
- Similarly with OPC 53-S cement the Flexural strength of SCC is 6.5 N/mm2 and that of normal concrete is 5.8 N/mm2 of OPC 53-S cement.
- The super plasticizer Chryso and Master Glanieum 8487 of BASF can be used for making of SCC mixes with both OPC 53 and OPC 53-S cements.

SCOPE FOR FURTHER STUDY

- Although several studies were conducted on behavior of Self-Compacting Concrete and by replacing Cement with mineral admixtures were studied earlier. Different physical and mechanical properties on Self-Compacting concrete were also studied and found the optimum dosage of Super plasticizer. The following points are observed in further study
- Effect of different types of admixtures are to be checked to improve the flow ability of Self-compacting concrete further and make the mix more cohesive.
- The grade of Cement (OPC) used in present study is 53 and OPC 53-S. The study can be further investigated with 43 and 33 grades of OPC
- By using different mineral admixtures and chemical admixtures depending upon the availability and cost different trial mixes can be performed
- The present Studies has been carried on M40 grade of concrete and also can be performed for higher grades of concrete.
- Experiments can be encouraged with different proportions and of replacement of cement in terms of other mineral and chemical admixtures

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