Properties of Self Compacting Concrete Containing Fly ash and silica Fume

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***Abstract*: The SCC has gained wide use in many countries for different application and structural Configurations SSC require a high slump that can be achieved by incorporating several chemical admixtures. The super plasticizer influences the rheological behaviour; the viscosity and the yield value of the fresh concrete are reduced in certain concrete mix. The super plasticizer ensures high fluidity and reduces water powder ratio. Super plasticizer greatly improves pump-ability and the slump value can be greatly increased. The use of viscosity modifying admixtures increases segregation resistance of concrete and increases the deformability without segregation and then to lead high optimum self-compatibility. Self-compacting concrete plays a major role in increasing the use of industrial by products like slag, fly ash and silica fume. SSC offers possibility for utilization of dusts which are currently waste products demanding with no practical applications and which are costly to dispose off. The SCC technology is now being adopted in many countries. In the absence of suitable standardized test methods it is necessary to examine critically the existing test methods and identify or develop test methods suitable for acceptance as standards which must be capable of rapid and reliable assessment of properties of SCC on a site.**

***Keywords*: SCC- self compacting concrete, Compressive strength test, resistance to segregation, fly ash, superplasticizers**

1. INTRODUCTION

Self-compacting concrete (SCC) is an pioneering concrete that does not involve shuddering for insertion and compaction. It is able to gush under its own load, completely filling form work and achieve the full compaction, even in the occurrence of congested support. The hardened concrete is dense, uniform and has the same property and durability as standard vibrated concrete. Making concrete structure without compaction has been done in the past. Like placement of concrete underwater by the use of termie without compaction. Inaccessible areas were concreted using such techniques. The production of such mixes often used expensive admixtures and very large quantity of cement. But such concrete was generally of lower strength and difficult to obtain. This lead to the development of Self Compacting Concrete (SCC) whose concept was first initiated by Japan in the mid of 1980s. SCC is a high performance concrete that consolidates under its self-weight, and adequately fills all the voids without segregation, excessive bleeding or any other separation of materials, without the need of mechanical consolidation. The key properties of SCC are filling ability, passing ability and resistance to segregation. Filling ability helps SCC to flow through the formwork and completely fill all the spaces within it. Passing ability is the property by which it flows without any blocking. The benefit of resistance to segregation imparts the advantage to the concrete in maintaining a uniform composition hence the paste and the aggregate bind together. The application of SCC aims at obtaining a concrete of high performance, better and more reliable, improved durability, high strength and faster construction. For SCC it is generally important to use superplasticizers in order to obtain high mobility. Some volume of powdered materials such as silica fume, fly ash, glass filler, stone powder, etc. is also involved. Self-compacting concrete has been successfully used in Japan, Denmark, France, U.K., etc. It is widely been accepted because of its enhanced properties also it reduces noise pollution, saves time, labour and energy.

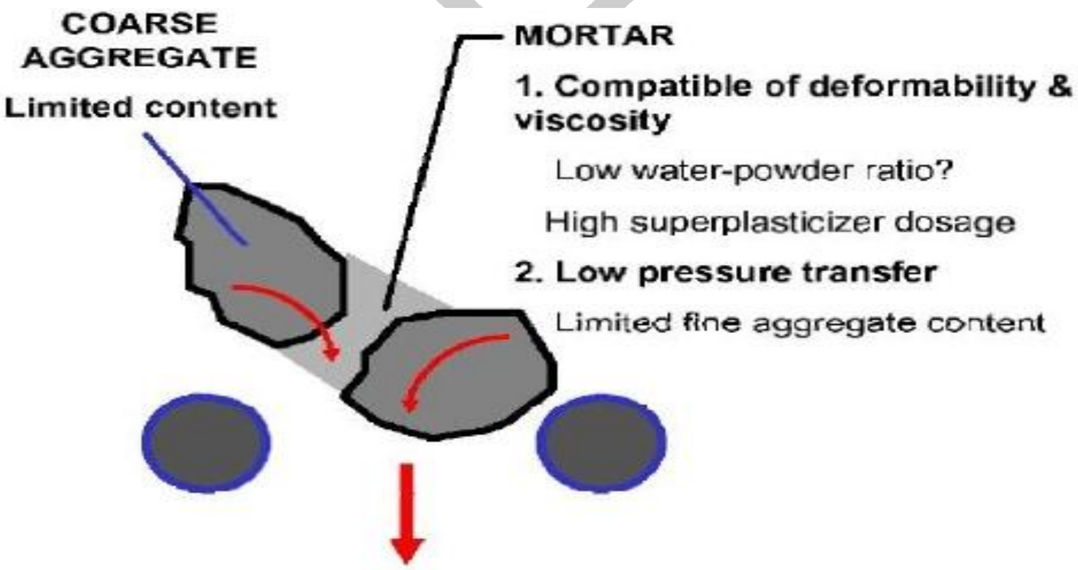

Fig 1: The schematic composition of SCC

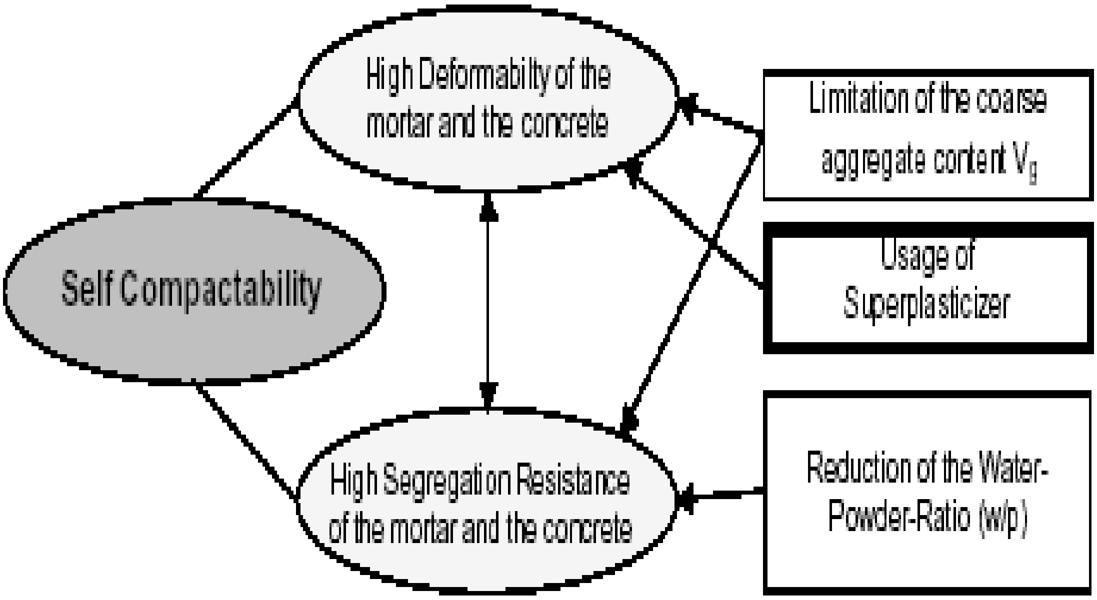

Fig 1.2: Self Compatibility

2. ADVANTAGES OF SCC OVER CONVENTIONAL CONCRETE

- Reduced labour requirements
- Quicker concrete placement
- Improved compaction around congested reinforcement
- Potential to enhance durability through improved compaction of concrete cover.
- Improve build ability, e.g. concreting deep elements in single lifts
- Elimination of vibration, leading to environmental, health and safety benefits.

3. LITERATURE REVIEW

Ahmed Fathi (2013) proposed that, self-compacting concrete is the concrete mix that has ability to resist the segregation and to flow under its own weight and not by the vibration. By reducing the aggregate contents and increase the cement amount as well as the addition of chemical admixture such as super plasticizer, we can achieve the required mix. The increase in cement content will lead to increase in total cost. To avoid this problem the cement replacement material can be used. Fly ash, microwave incinerated rice husk ash and silica fume are the famous type of cement replacement material to replace the cement content in the concrete and can increase the workability properties of self compacting concrete mix. All self compacting concrete mixes showed acceptable slump flow value of 650-768 mm that posses a good deformability. The self compacting concrete mixes gave values within the range of 0.8 to 1.0 in L-box test. To achieve the fresh properties, microwave incinerated rice husk requires more water than silica fume. The highest compressive strength and split tensile strength was achieved in 5% silica fume and 30% fly ash with concrete mix. Where as all cement replacement material mixes resulted in high flexural strength, which was due to the negligible bleeding and high cohesiveness. The performance of microwave incinerated rice husk to replace the cement depends on the burning degree which will affect the microstructure of the binder.

Muhammad Nouman Haral (2013) inferred that, an alternative binder in the construction industry is natural pozzolan. Nowadays environmental aspects have become a major concern of many in the construction field. The cement industry contaminates the environment pertained to substantial amount of CO2.It is essential to control the entire process of cement production by minimizing the amount of CO2 introduced to environment. The introduction of supplementary cementitious materials, this can be achieved. The supplementary cementitious materials increase from one day to another and from one application to another because of the demand and the subsequent added-cost. Self compacting concrete should have higher quantity of binder, a higher fine aggregate content and lesser amount of coarse aggregate content. Hence it is essential to incorporate chemical admixtures such as super plasticizers to keep proper workability and viscosity aspects into consideration of self compacting concrete. To achieve fresh concrete properties, higher quantities of finer particles are added. The application of Natural pozzolan as an alternative binder in self compacting concrete mixes up to 20% provide flow able mix. The determination of optimum poly carboxylic ether dosage for various pastes can be found from modified marsh cone test. The flow-ability of the pastes and mixes increases with the increase in Poly carboxylic ether dosage. The slump flow increase with the increase in volume fraction of paste of higher binder content. Higher water volume causes the risk of segregation and settlement of aggregate. The value of T500 decreases with the increase in the paste volume fraction and water binder ratio.

4. MATERIAL USED

1. Cement

Ordinary Portland Cement of Ultratech brand of 43 grade confirming to IS 4031-1988 was used in the present study. The various properties of cement are shown in Table below:

Table 1: Properties of Cement

Sr. No	Property	Result
1	Normal consistency	33 %
2	Intial setting time	42 min
3	Specific gravity	9.99
4	Fineness of cement	5 %
5	Specific area	3250cm^2/gm
6	Soundness of cement	1.00 mm

2. Fine Aggregate

Natural River sand locally available confirming to IS 383-1987 was used of grading zone II. The properties of fine aggregate are shown in table below:

Table 2: Properties of Fine Aggregate

Sr. No	Property	Result
1.	Bulk Density	1625 kg/m3
2.	Fineness modulus	3.20
3.	Specific gravity	2.67
4.	Water absorption	1.15

3. Coarse Aggregate

Coarse aggregate of size 10mm & 20 mm of crushed stone locally available confirming to IS 383-1987 was used.

Table 3: Properties of Coarse Aggregate

Sr. No	Property	Result
1.	Bulk Density	1525 kg/m3
2.	Fineness modulus	3.67
3.	Specific gravity	2.89
4.	Water absorption	0.46 %

4. Water

The canal water used in this study was free of alkalis, acids, salts, organic materials & other impurities.

5. Silica Fume

Silica fume is a byproduct of Ambuja Cement Limited Elkem micro silica has been used in concrete mixes to replace cement. Surface area of silica fume is 20m2/kg. The diameter of silica fume particle is about 0.1-0.2µm. The content of SiO2 reaches up to 95% above.

6. Fly Ash

Class F Fly ash obtained from ―Panipat Thermal Power Station, Panipat, Haryana was used.

7. Super Plasticizer

In this investigation super plasticizer- CONPLAST-SP 430 in the form of sulphonated Naphthalene polymers complies with IS: 9103-1999 and ASTM 494 type F was used to improve the workability of concrete. The properties of super plasticizer are shown in Table 4.

Table 4: Properties of Super Plasticizer

Sr. No	Property	Result
1.	Specific gravity	1.220-1.225
2.	Chloride content	NIL
3.	Air entertainment	Approximately 1 % additional air is entertained

5. MIX PROPORTIONING

At present, the maximum content of silica fume and fly ash is 12% and 35 % by the weight of cementing material in concrete. In order to study the influence of the content of silica fume on compressive strength of concrete, silica fume (0%, 4%, 8% and 12% by weight of cement) and Fly ash (0%, 15 %, 25 % and 35 % by weight of cement) was added to concrete partially replace cement. In the process of study the influence of silica fume content on tensile creep of concrete, to avoid other influencing factors on tensile basic creep of concrete, method of fixing content of aggregate, sand ratio, total volume of binding material and water-binder ratio of concrete was adopted. During the process of mixing concrete, cement was replaced with equivalent weight of silica fume. Table **5** shows the compositions of the concrete mixes. The water-binder ratio (w/b) of 0.40 was selected. Mixture slump was around 120mm by using a high-range water-reducing admixture.

Table 5: Mix Proportion of cubes

Specimen	Cement (Kg/m^3)	Fly Ash	Silica Fume	Replacement (%)	Fine Aggregate	Coarse Aggregates	Water	Super plasticizer
C-0	550	-	-	-	910	590	234	1.64
C-1	465	85	-	15	910	590	234	1.64
C-3	415	135	-	25	910	590	234	1.64
C-4	355	195	-	35	910	590	234	1.64
C-5	528	-	22	4	910	590	234	1.64
C-6	506	-	44	8	910	590	234	1.64
C-7	484	-	66	12	910	590	234	1.64

6. COMPRESSIVE STRENGTH TEST

In order to study the effect on compressive strength when fly ash and silica fume is added into self compacting concrete as cement replacement, the cube containing different proportion of fly ash were prepared and kept for curing for 7 and 28 days. The test was conducted on ASTM of capacity 3000KN.

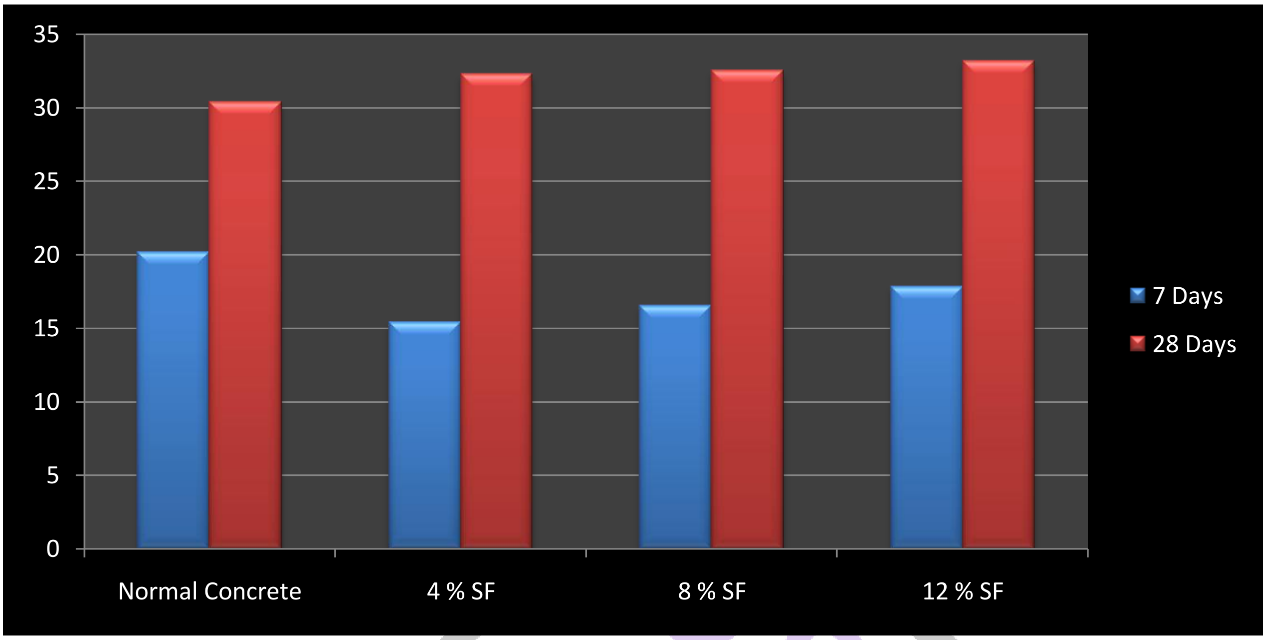

Figure 4.1: Compressive strength of concrete by using Silica Fume

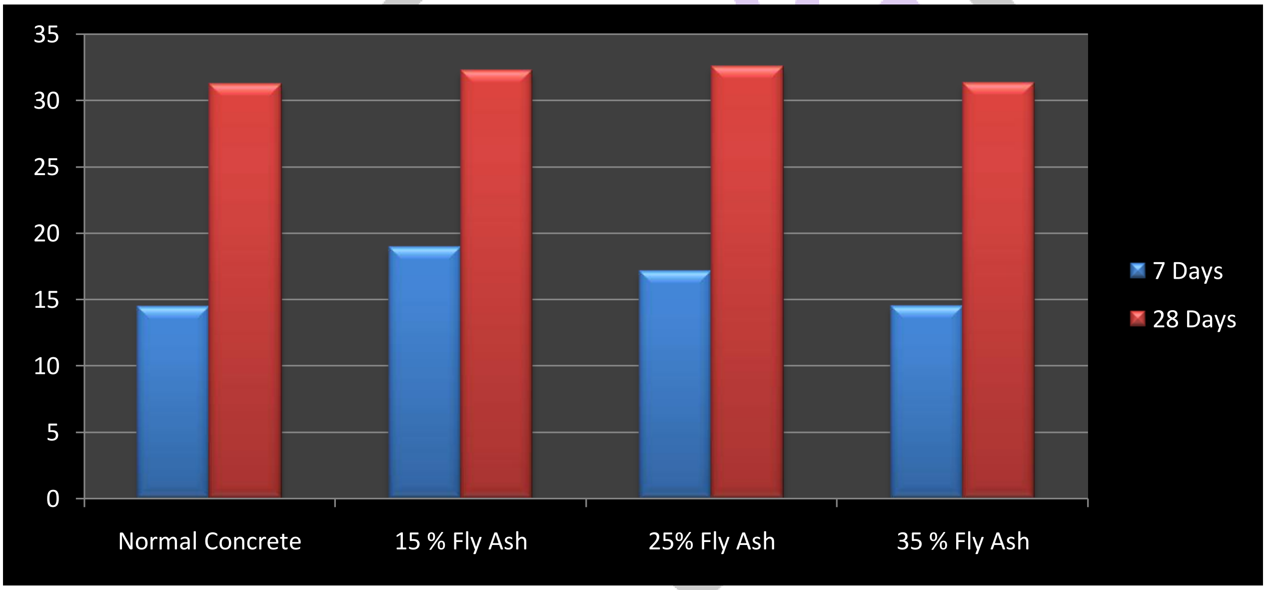

Figure 4.1: Compressive strength of concrete by using Fly ash

Conclusions

1. . At various percentages of replacement levels of fly ash and silica fume content, the workability criteria are satisfied at same percentage of super plasticizer.

2. Self-compacting concrete (SCC) with mineral admixture / waste materials exhibited acceptable and satisfactory results and verified by different tests.

3. To increase the stability of fresh concrete (cohesiveness) using increased amount of fine materials in the mixes.

4. For 35% fly ash replacement, the fresh properties observed were good as compare to 15% and 25% fly ash replacement. Hence if we increase the FA replacement we can have a better workable concrete.

5. An increase of about 24% strength at 28 days and 30% at 56 days was observed withthe decrease of fly ash content fro m 35% FA to 15% FA.

6. 35% FA replacement shows 2 times less shrinkage in 20 days than that of 0% FA replacement.

7. From the results it is obtained that increasing the amount of fly ash results in a systematic reduction in shrinkage.

8. SCCs with Silica Fume (SF) exhibited satisfactory results in workability, because of small particle size and more surface area.

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