

# BULK USAGE OF FLY ASH IN SELF COMPACTING CONCRETE FOR M<sub>50</sub> GRADE

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**Abstract**—Production of cement is an exhausted, energy giving process. Manufacturing of certain tones of normal cement need about more tons of raw materials which includes all materials. This paper shows the efforts for developing a SCC mixes of having high performance of fly ash added with other mineral added such as Silica Fume and Ground Granulated Blast Furnace Slag (GGBFS). For replacing cement used materials are GGBFS, silica fume, fly ash etc. can make sure the required concrete physical and chemical properties. In this paper three trial mixes prepared and their physical and chemical properties are enhanced in their first state. In first mixes 50% cement of M50 mix are replaced by fly ash. In second mix adding 20% of GGBFS and 50% of fly ash replacing for cement. In third mix by adding 50% fly ash, 20% GGBFS and 5% of silica fume. Totally 700 kg/m<sup>3</sup> cement content in all three mix. The result for the compressive strength, flexural strength shows better performance of all Self Compacting Concrete

**Keywords**— silica fume, fly ash, and Ground Granulated Blast Furnace Slag (GGBFS)

## INTRODUCTION

Concrete is an important material used in most of the construction activities. There is a huge infrastructural insistent, all constructions must undergo a change in the country. The requirements of a normal concrete like high workability, good strength and more durability can be achieved by adding several mineral and chemical admixtures. Korean researcher has determined the CO<sub>2</sub> emission reductions by more volume of fly ash as a replaced for cement.

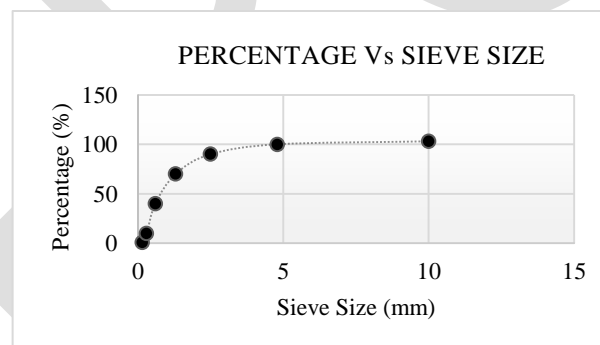


Fig. 1. Fine aggregate Mix Gradation Diagram

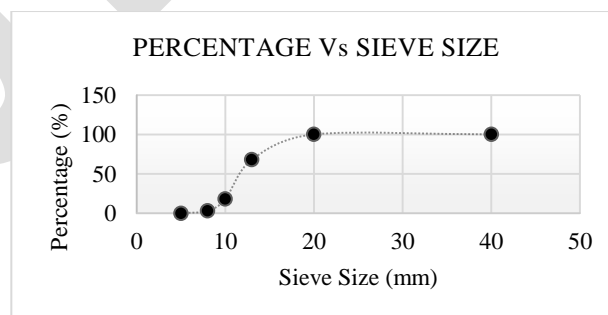


Fig. 2. Coarse aggregate Mix Gradation Diagram

**MATERIAL:** Physical properties of materials are given below

**Cement:** OPC 43 grade

**Fine Aggregate:** The specific gravity of river sand is 2.65 and fineness modulus is 3.11

**Coarse Aggregate:** Specific gravity is 2.6 and FM is 6.9 and the size of the particle 9 to 22 mm

**Fly Ash:** Fly ash collected from Ashtech (India) pvt. Ltd, Ashford center, Mumbai. The specific gravity of 3 and fineness of 1.24 m<sup>2</sup>/g.

**GGBFS:** TANCEM cement company. Ltd from Virudhunagar provided GGBFS, which has the specific gravity of 2.83 and fineness of 420 m<sup>2</sup>/kg. Table 1. Shows the chemical properties of GGBFS

**Silica Fume:** From Guru Corporation, Ahmedabad silica fume is purchased. Specific gravity of 2.22 and fineness 20000 m<sup>2</sup>/kg.

Table 1. Mineral – Chemical Properties

Properties	Flyash	GGBFS	Silica fume
SiO <sub>2</sub>	55.87	50.37	90.46
TiO <sub>2</sub>	3.67	0.07	Nil
Na <sub>2</sub> O	0.66	0.53	Nil
CaO	0.8	12.84	Nil
Fe <sub>2</sub> O <sub>3</sub>	2.83	0.25	Nil
Al <sub>2</sub> O <sub>3</sub>	31.82	25.27	7.89
SO <sub>3</sub>	0.16	0.63	0.2
MgO	2.36	9.43	Nil
K <sub>2</sub> O	1.99	0.3	0.23

**Superplasticizer:** A polycarboxylic which used commercially has a huge range of admixture. The optimal was obtained as 0.7% powder content by rheological apparatus.

**Mix Proportions:**

50% cement and 50% fly ash. – F50

30% cement ,20% GGBFS 50% and fly ash- F50G20

25% cement 5% silica fume, 20% GGBFS and 50% fly ash – F50G20S5

**Testing of Specimens:** Cubes Size 150 \* 150 \* 150 mm are tested in UTM for compressive, flexural strengths at 7, 14, 28, 60, 90 days of curing period. 100 \* 100 \* 500 mm size are tested for flexural strength, under two-point loading, after the curing period of 28 days. For Rapid Chloride Penetration Test, the power passes through the specimen of diameter 100 mm and thickness of 50 mm, the test was done for 6 hours.

Table 2. Mix design details in present study

Mix Mix design	M <sub>50</sub>		
	F50	F50G20	F50G20S5
Fly ash, %	50	50	50
Content, kg/m <sup>3</sup>	400	400	400
GGBFS replacement, %	0	40	40
Content, kg/m <sup>3</sup>	0	160	160
Silica fume replacement, %	0	0	10
Content, kg/m <sup>3</sup>	0	0	50
Super plasticizer, %	0.7		
Content, kg/m <sup>3</sup>	3.8		
w/b ratio	0.31	0.31	0.31
w/c ratio	0.59	0.96	1.18
Cement (kg/m <sup>3</sup> )	400	250	200
Fine Aggregate (kg/m <sup>3</sup> )	824	815	804
Coarse Aggregate (kg/m <sup>3</sup> )	790		

Type I (12 mm)	516	516	516
Type II (14 mm)	221	221	221
Water (kg/m <sup>3</sup> )	175		
Viscosity modifying agent (kg/m <sup>3</sup> )	-	0.37	-
<b>SCC Properties</b>			
Slump flow (mm)	750	774	680
T50 cm slump flow (sec)	6	6	6
J-ring (mm)	6	9	10
U-box (mm)	1	6	4
V-funnel flow (sec)	11	11	12

## RESULTS AND DISCUSSIONS

**SCC - Workability:** While casting SCC samples, workability tests Slump flow, V-funnel test, U-box, J-ring tests are done and the values are given in Table 2. Three mix of SCC shows a good result on passing ability, segregation resistance and flowing. The setting time problem extended which shows F50 mix has good flow properties. In F50G20 mix which is more viscous so viscosity modifying agent is essential. Alternative to use of Viscosity modifying agent, an additional silica fume was added with fly ash and GGBFS.

**Compressive Strength:** For 7, 14, 28, 60 and 90 days curing is done. For F50 the maximum compressive strength of 75 Mpa, for F50G20 the maximum compressive strength is 64 Mpa and for F50G20S5 the maximum compressive strength is 62. All mixes attain there maximum at 90 days of curing

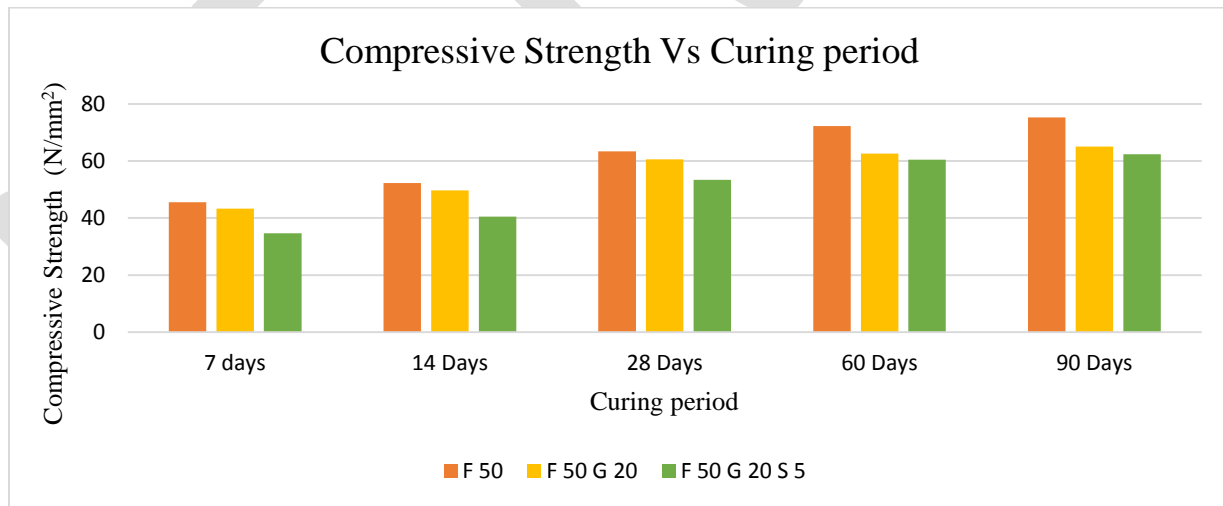


Fig. 3. Cube Compressive Strength at various curing periods

**Flexural Strength:** For 7, 14, 28, 60 and 90 days of curing the test been conducted. The flexural strength of the several self-compacting concrete mix is mostly near to other mixes. Among the three self-compacting mixes, F50 mix has more 28day flexural strength and shown in Fig. 4. The 28-day flexural strength of the three mixes are in the range 5.5-6.9 Mpa, which is higher or equal to 5.5 Mpa flexural estimated strength using BIS 456 (2000) Codal provisions

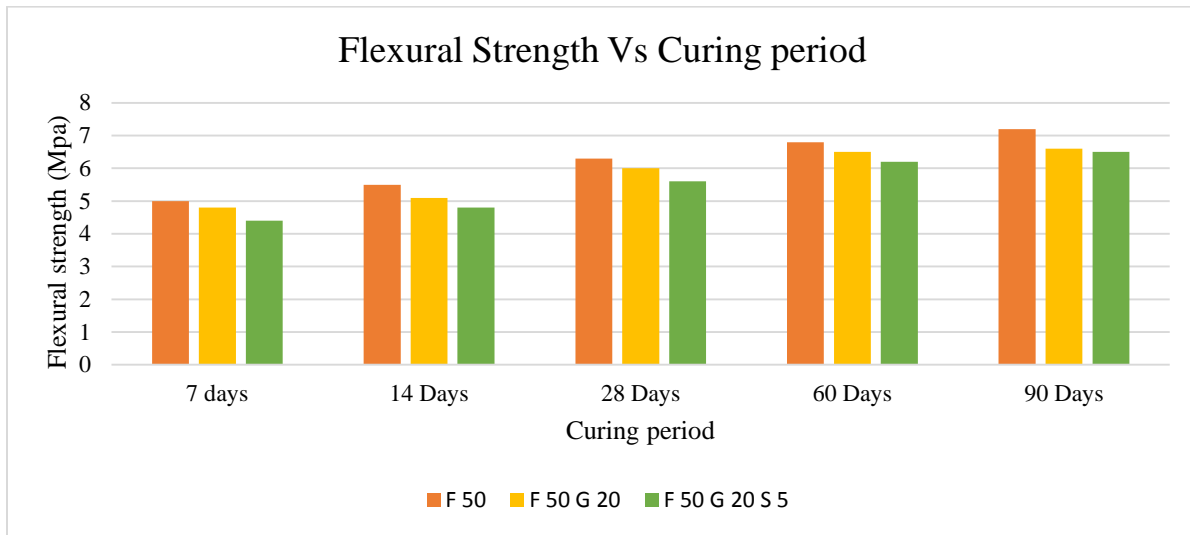


Fig. 4. Flexural Strength at various curing periods

#### I. CONCLUSION

In this study SCC using more volume fly ash, added with GGBFS and silica fume. Various experiments were conducted based on that conclusions are drawn. F50 mixes shows strength properties and high flow, as required for Self-compacting concrete, with superplasticizer, we are removing form work settling time will be extended Use of fly ash-GGBFS based F50G20 mixes improves the self-compacting settling characteristics of self-compacting concrete mixes, but flow properties of self-compacting concrete are not achieved in this F50G20 mix. Silica fume added to the F50G20S5 mixes without viscosity modifying agent improves the flow properties of the self-compacting concrete. Fly ash based F50 mix compressive strength is higher compared with F50G20 and F50G20S5 mixes at 28 days of curing.

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