European Journal of Business & Social Sciences
Available at https://ejbss.org/

ISSN: 2235-767X
Volume 07 Issue 10
July2019

Study on Fresh and Hardened Properties of Self Compacting Concrete with GGBS, Silica Fume as Mineral Admixture

M. Ravalika
PG Scholar, Dept of Civil Engineering
Vaagdevi College of Engineering
Warangal, TS, India
Email: matetiravalika@gmail.com
Cell: +91 89771 74159

A. Sravanthi
Asst Prof, Dept of Civil Engineering
Vaagdevi College of Engineering
Warangal, TS, India
Email: sravsvaibhav@gmail.com
Cell: +91 95506 65995

European Journal of Business & Social Sciences
Available at https://ejbss.org/

ISSN: 2235-767X
Volume 07 Issue 10
July2019

Abstract— Concrete has become basic material in day to day life of humans. Low tensile strength and brittle nature are the basic defects in concrete. These defects are enhanced due to improper compaction due to congested reinforcement in detailing. Self-compacting concrete is being developed in recent years to avoid these defects. It is the concrete which consolidates due to its own weight without any compaction. The present investigation is mainly focused on the effect of mechanical properties of SCC with supplementary materials. In this investigation concrete having compressive strength M40 with Ground granulated blast furnace (GGBS) and silica fume (SF) as supplementary materials. GGBS added to the concrete with 0 to 30 % by weight of cement. SF added to the concrete with 0 to 12 % as an admixture.

Index Terms - (GGBS, Silica fumes, Mechanical Properties, consolidates, Super- plasticizers)

I. Introduction

Concrete, one of the principal materials for structures and widely used all over the world, is a heterogeneous material consisting of cement, water, sands and aggregates. Very extensive literature on concretes includes a number of reviews. While the heterogeneous structure of concrete can produce some undesirable effects, concrete remains an indispensable construction material and allows engineers to incorporate many materials into it. A variety of types of concrete exist. Self-compacting concrete (SCC) was first developed in Japan in 1986. The SCC can flow through and fill the gaps of reinforcement and corners of moulds without any need for vibration and compaction during the placing process. The use of SCC is increasing. So called super-plasticizers (SPs) are typically used in SCC to reduce the water/binder ratio. Moreover, supplementary cementitious or inert materials, such as limestone powder, natural pozzolans and fly ash (FA), can be used to increase the viscosity and fresh concrete workability and reduce the cost of SCC. The use of pozzolanic admixtures extends the hydration reaction and produces good micropore structures, resulting in improved durability. Self-compacting concrete (SCC) can be considered as a concrete which has little resistance to flow so that it can be placed and compacted under its own weight with little or no vibration effort, yet possesses enough viscosity to be handled without segregation or bleeding. SCC was developed in Japan in the late 1980s as a solution to achieve durable concrete structures independent of the quality of construction work. In designing a SCC usually new generation polycarboxylic-based super-plasticizers are utilized together with either some chemical or mineral admixtures that provides the necessary viscosity. The fresh mechanical properties of SCC are often determined through the use of rheometers, which measures the viscosity and the yield strength of concrete when it is in plastic state. However, this equipment is lab-oriented and is not usually practical for field-use. Therefore, other field-oriented test methods are used in quantifying the fresh properties and workability of SCC both in the lab and field .Due to increasing energy demand, coal-burning power plants are becoming more widespread near low-calorie lignite mines. However, these plants cause significant technical, environmental and economical problems due to the by-products of electric generation. During coal-fired electric power generation, two main types of coal combustion by-products are obtained, fly ash and bottom ash. Utilization of waste materials in construction industry reduces the technical and environmental problems of plants and decreases electric costs besides reducing the amount of solid waste, greenhouse gas emissions associated with Portland clinker production, and conserves existing natural resources. Self-compacting concrete (SCC) is considered as a concrete which can be placed and compacted under its self weight with little or no vibration effort, and which is at the same time cohesive enough to be handled without segregation or bleeding of fresh concrete. SCC mixes usually contain super plasticizer, high content of fines and/or viscosity modifying additive (VMA). Whilst the use of super-plasticizer maintains the fluidity, the fine content provides stability of the mix resulting in resistance against bleeding and segregation. The use of fly ash and blast furnace slag in SCC reduces the dosage of super-plasticizer needed to obtain similar slump flow compared to concrete mixes made with only Portland cement

II. literature review

Bentz et al.,(1997) that curing conditions have significant effect on the degree of hydration of cement. They showed that for specimens (initially cured at 100% relative humidity (RH) for 6 or 12 h) exposed to 90% RH, hydration process discontinued as all remaining capillary water was lost due to evaporation. Whilst curing under sealed condition, in particular for concretes with W/C ratio of 0.4 or over, or keeping the

European Journal of Business & Social Sciences
Available at https://ejbss.org/
ISSN: 2235-767X
Volume 07 Issue 10
July2019

surface as saturated were adequate.It is estimated that SCC may result in up to 40% faster construction than using normal concrete. The elastic modulus and shrinkage of SCC didn't differ significantly from the corresponding properties of normal concrete.

Yazicioglu et al.,(2006) investigated the influence of curing conditions on the mechanical properties of self-compacting concrete, demonstrated that water cured specimens always have the highest values followed by sealed cured specimens and air-cured irrespective of type and age of concrete and test methods. For both concrete compressive and tensile strength tests, the SCC with silica fume gives the highest values followed by SCC with fly ash and then PC concrete for all curing periods and conditions.

Ravikumar et al.,(2009)investigated producing and evaluating SCC made with high volumes of kiln ash. The results of this study suggested that quarry dust (QD), silica fume (SF) and kiln ash (KA) combinations can improve the workability of SCC, more than QD, SF and KA individually. KA can also have a positive influence on the mechanical properties at early ages while SF improved bond between aggregate–matrix resulting from the formation of a less porous transition zone in concrete. SF can better reducing effect on total water absorption while QD and KA will not have the same effect, at 28 days.

Al-Feel and Al-Saffar (2009) study the effect of curing methods on the compressive, splitting, and flexural strength of self-compacting concrete showed that water cured specimens gave the highest results of concrete compressive strength, splitting tensile strength, and flexural strength than specimens cured in air by about 11%, 10%,and 11% respectively. The results also indicated that SCC gave high early concrete compressive strength.

Ren and Wang, studied the application of high fly ash content concrete (HFCC) with dipy construction formwork. Their test results showed that, with the replacement of fly ash increase the strength of HFCC up to 50%.

III. materials

Cement:

Ordinary Portland cement of 53 grade, conforming to IS: 12269-1999 with particle size of 90µ has been used in the present investigation. The specific gravity, standard consistency were 3.12 and 32% respectively.

Fine Aggregates:

Locally available river sand conforming to Zone-II as per IS: 383-1999 has been used. The bulk density, specific gravity, and fineness modulus of the sand were 1.41g/cc, 2.68, and 2.9.

Coarse Aggregates:

Crushed granite aggregate of maximum 16 mm size conforming to IS: 383-1999 has been used. The bulk density, specific gravity and fineness modulus of the coarse aggregate were 1.46g/cc, 2.7 and 7.1.

Fly ash:

Fly ash of Class F conforming to IS: 3812: Part-II-2003 obtained from Ramagundam thermal power plant (India) with a specific gravity of 2.18 and fineness of 6422 cm^2/gm was used.

Micro Silica:

Micro silica conforming to IS: 15388, (Part-II)-(2003) obtained from Elkem Company with size of 150nm and specific gravity of 2.22 and has been used. The dosage of Micro silica was 8% and 5% for by weight of cement in 80 MPa for SCC and VC respectively.

Chemical Admixture:

Modified Polycarboxylate based super-plasticizer confirming to IS 9103-1999 **[15]** was used. The product name is Chryso Fluid optima S-815. Optimum dosage is confirmed by various trail mixes.

G G B S :

Ground-granulated blast-furnace slag is obtained by quenching molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Water:

Water plays a vital role in achieving the strength of concrete. For complete hydration it requires about $3/10^{th}$ of its weight of water. It is practically proved that minimum water-cement ratio 0.35 is required for conventional concrete. Water participates in chemical reaction with cement and cement paste is formed and binds with coarse aggregate and fine aggregates. If more water is used, segregation and bleeding experimental program

IV. experimental program

The investigation was aimed at studying the effect of GGBS and SF on compressive strength, split tensile strength, flexural strength of M40grade of concrete. Mix proportioning of concrete will be done based on NanSu mix design method. To study on strength of concrete the specimens will be tested for 28 days of curing. Standard cubes (150x150x150 mm), cylinders (150 mm diameter, 300 mm height), prisms (100x100x500 mm) will be cast to investigate the behavior on mechanical properties. Tests on fresh properties will be done according to EFNARC specifications. The replacement of GGBS ash will be varied from 0 to 30% with an increment of 10% i.e 0, 10%, 20% and 30% replacement to cement. SF will be varied from 0 to 12% with an increment of 4% i.e 0, 4%, 8% and 12% replacement to cement.

Phase – I: Standard concrete specimens were cast in different dosages of GGBS varying from 0 to 30% by replacing cement. Dosages were incremented at regular interval of 10% from 0 to 30% which include 0, 10%, 20% and 30%.Standard cubes of size150x150x150 mm, standard cylinders of 300 mm height and 150 mm diameter and standard prisms of size 100 x 100 x 500 mm were cast to evaluate compressive strength, split tensile strength and flexural strength (rupture strength of

European Journal of Business & Social Sciences
Available at https://ejbss.org/
ISSN: 2235-767X
Volume 07 Issue 10
July2019

concrete) respectively. The effect of GGBS on properties were being experimentally investigated in phase-I of the study. The effect of GGBS on workability is determined by performing slump cone test and compaction factor test as per Indian standards on fresh concrete. The effect of GGBS on mechanical properties of concrete were examined by conducting compressive test on cubes, split tensile strength (indirect tension test), flexural test on prisms as per Indian standard testing procedure for hardened concrete.

Phase-II: It is been determined from the phase-I of the experimental investigation that replacement of cement with GGBS can be restricted to only 20% to obtain a concrete with good workable properties as well as mechanical properties. In phase-II of experimental investigation is conducted by adding supplementary cementitious material Silica fume. A triple blended concrete is obtained in this phase with cement, GGBS, silica fume. Standard concrete specimens were cast in different dosages of Silica fume varying from 0 to 12% by replacing cement along optimized GGBS dosage 20%. Dosages were incremented at regular interval of 4 % from 0 to 12% which include 0, 4%, 8%, 12%. Standard cubes of size150 x 150 x 150 mm, standard cylinders of 300 mm height and 150 mm diameter and standard prisms of size 100x100x500mm were cast to evaluate compressive strength, split tensile strength and flexural strength (rupture strength of concrete) respectively. The effect of silica fume on properties were being experimentally investigated in phase-II of the study. The effect of silica fume on workability is determined by performing slump cone test and compaction factor test as per Indian standards on fresh concrete. The effect of silica fume on mechanical properties of concrete were examined by conducting compressive test on cubes, split tensile strength (indirect tension test), flexural test on prisms as per Indian standard testing procedure for hardened concrete.

Table 1 - Mix Proportions of M40 grade in kg/m^3

Cement	Fly ash	Fine Aggregate	Coarse Aggregate	Water
595	786	755	5.8	188

V. results and discussion

Workability:

Workability tests were performed on the fresh concrete of SCC by slump cone and compaction factor test. The results of workability tests for M40 grade of concrete with polypropylene fibers and Lime sludge is shown in table 2.

Table 2: Fresh Properties of SCC with GGBS

Mix Designation	Slump Flow (mm)	T_{500} mm (sec)	J-ring (mm)	V-funnel (sec)	V-funnel $T_{5\ min}$ (sec)
EFNARC Limits	**550-850**	**2-5**	**0-10**	**6-12**	**6-15**
SCC Plain	785	2.3	6	7	9
SCC-GGBS 10%	765	2.6	7	8	12
SCC-GGBS 20%	740	2.8	8	10	14
SCC- GGBS 30%	725	3.1	10	11	15

Figure-2: Variation of slump flow with GGBS

Mechanical Properties:

Table 3: Mechanical properties of SCC with optimized GGBS and silica fume

Mix Designation	Compressive Strength (MPa)	Split tensile Strength (MPa)	Flexural Strength (MPa)
SCC - GGBS	56.2	4.16	6.38
SCC-GGBS-SF4%	61.2	4.34	6.66
SCC-GGBS-SF 8%	68.2	4.59	7.03
SCC-GGBS-SF 12%	63.2	4.41	6.77

European Journal of Business & Social Sciences
Available at https://ejbss.org/

ISSN: 2235-767X
Volume 07 Issue 10
July2019

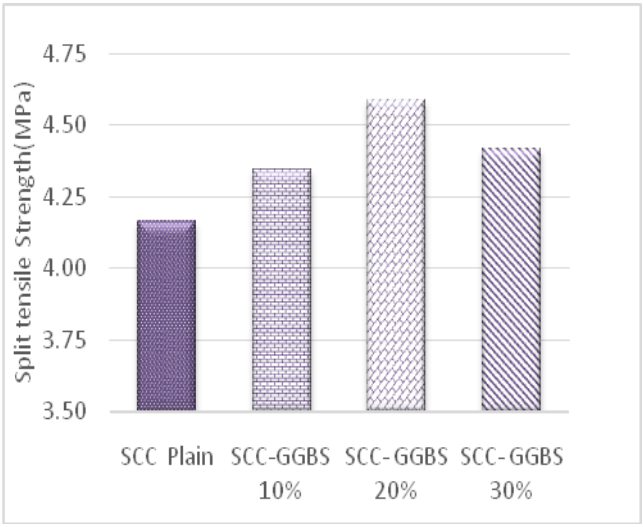


Figure 5: Variation of Split tensile strength with Optimized GGBS and Silica fume

Figure 4: Variation of Compressive strength with Optimized GGBS and Silica fume

European Journal of Business & Social Sciences
Available at https://ejbss.org/
ISSN: 2235-767X
Volume 07 Issue 10
July2019

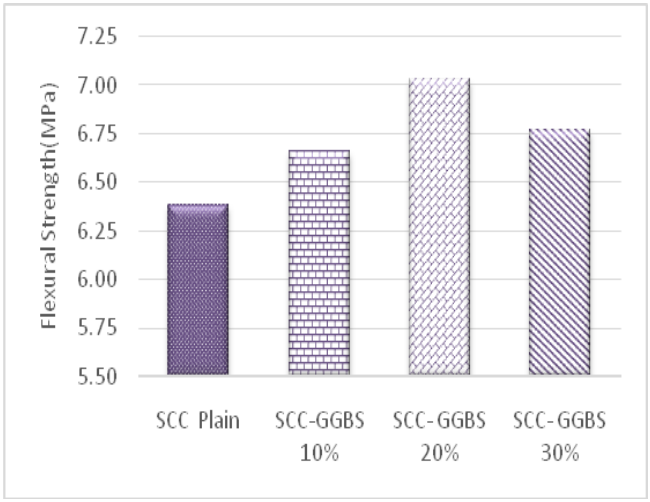


Figure6: Variation of Flexural strength with Optimized GGBS and Silica fume

I. conclusions

A. The workability of concrete is marginally effected with the addition of GGBS and SF.

B. GGBS and SF replacement to cement has increased the mechanical properties of concrete in both phases of investigation.

C. Upto20% replacement of GGBS the strength properties have increased but later with the increase in replacement decrement is observed.

D. Similarly, upto8% replacement of SF the strength properties have increased but later with the increase in replacement decrement is observed.

E. Thus, 20% and 8% are optimum replacement dosages of GGBS and SF in strength characteristic point of view.

F. It is concluded that feasibility of GGBS and SF can be to produce high strength concrete by reducing the cement content.

G. The increase in strength with addition SF is due to formation of excess CSH gel formation in the matrix.

V.II References

[1] IS:269-1958 specification for ordinary, rapid-hardening and low heat Portland cement (revised and reprinted,aug.1965)

[2] IS: 10262-1982, recommended guidelines for concrete mix design, 4th reprint, 1996.

[3] IS: 456-2000, Indian standard plain and reinforced concrete code of practice, 4threvisio, 1st reprint/sep, 2000.

[4] IS: 12269-1987 (reaffirmed1999), specification for 53 grade ordinary Portland cement, first reprint, September, 1993.

[5] IS: 2386-1963 tests for a (all parts), method of aggregates for cement.

[6] Yahia A, Tanimura M, Shimabukuro A, Shimoyama Y. Effect of rheological parameters on self compactability of concrete containing various mineral admixtures. In Skarendahl A, Peterson O,editors. Proceedings of the first RILEM international symposiumon self-compacting concrete, Stockholm, 1999. p. 523–35.

[7] Perssoiv B. Technical Report, Japan Society for the Promotion of Science, Report 9803: 12, Division of Building Materials, Lund Institute of Technology, Lund, 1998.

[8] Nocher M. Flowing Smoothly and Quietly, Advanced Concrete and Masonry Center, Concrete Quarterly, Issue 198, UK, 2001.

[9] Bertil Persson A. Comparison between mechanical properties of self-compacting concrete and the corresponding properties of normal concrete. Cement Concr Res 2001:193–8.

[10] Al-Feel JR, Al Saffar NS. Properties of self-compacting concreteat different curing condition and their comparison with propertiesof normal concrete. Al-RafidainEng 2009;17(3):30–8.

[11] Zhengyue Ren, Lijiu Wang. Research of High Fly Ash Content inConcrete with Dippy Construction Formwork. International Workshop on Sustainable Development and ConcreteTechnology.

[12] Bentz DP, Snyder KA, Stutzman PE. The effect of Curing Conditions, Hydration of Portland cement. In: Presented at the10th international congress chemistry of cement, vol. 2, Sweden,1997.

[13] SalihYazicioglu, Sinan Caliskan, Kazim Turk. Effect of curingconditions on the engineering properties of self-compacting concrete.Ind J Eng Mater Sci 2006;13:259.

[14] Ravikumar MS, Selvamony C, Kannan SU, Basil Gnanappa S.Behavior of self-compacted self curing kiln ash concrete with various admixtures. ARPN J EngApplSci 2009;4(8).

[15] ECP 203 – 2007, The Egyptian Code for Design and Construction of Concrete Structures – Tests Guide, Cairo, Egypt, 2007.

European Journal of Business & Social Sciences
Available at https://ejbss.org/

ISSN: 2235-767X
Volume 07 Issue 10
July2019

European Journal of Business & Social Sciences
Available at https://ejbss.org/

ISSN: 2235-767X
Volume 07 Issue 10
July2019