STRENGTH CHARACTERISTICS OF HIGH STRENGTH SCC USING SILICA FUME AND GGBS

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ABSTRACT-Self Compacting Concrete (SCC) is evaluated as a substitute to ordinary concrete when compaction of concrete is difficult to execute. The present study is to acquire high strength SCC by replacing cement with Silica fume and GGBS. SCC has experienced significant development in the light of results obtained from numerous studies due to a series of advantages that it has. Over the past few years GGBS and SF have been widely used admixtures to attain high strength concrete. As a reference mix, SCC was designed which used no mineral admixtures, while the rest of the mixes using different dosage of GGBS, SF. The remaining six mixes were made with different dosages of GGBS (i.e., 10%, 20% and 30%) and silica fume (i.e., 5%, 10% and 15%). As workability is main characteristic of SCC, different rheological traits like slump flow, V-funnel, and L-box test are identified. Strength characteristics like compressive strength, tensile strength are evaluated. The maximum compressive strength of 70.12MPa is obtained for a ternary mixture with 30% GGBS and 5% SF at 28 days.

KEYWORDS: **Self compacting concrete (SCC), High strength, GGBS, Silica fume (SF), Compressive strength**

1. INTRODUCTION

In the present decade on behalf of strength, workability is also considered as one of the important criteria, the special type of concrete which was designed to overcome this problem was SCC. Okamura, professor of Ouchy University, Japan, proposed the concept of SCC in 1986. He invented this concept when there is a limited supply of skilled labor. The SSC was particular sort of concrete which can stream beneath its own mass, unaccompanied with bleeding and segregation. Generally, there are several approaches for developing economical pozzolans to reduce the cement content and use of low cost high range water reducers. Salah Altoubat et al. (2016) studied the shrinkage behavior of SCC containing different proportions of GGBS. Sheriff Yehia et al. (2015) in his paper studied the effect of fly ash, GGBS and silica fume on high strength concrete from the overall studies he concluded that by using silica fume the compressive strength can be increased and GGBS improves the flexural strength of concrete. Adam Joe et al. (2015) studied the effect of GGBS and silica fume in SCC, he found that maximum 50% of GGBS were able to use without affecting the self compatibility and silica fume improves the strength up to certain point beyond which the strength was reduced. Till now there are limited studies available about the influence of mineral admixtures regarding the strength of SCC. In the present work high strength SCC is developed by replacing cement with GGBS and Silica fume. By taking optimum mix of GGBS (30%). Cement is replaced with 30% GGBS and 5%, 10% and 15% of silica fume.

2. MATERIALS AND EXPERIMENTAL PROCEDURE

2.1 MATERIALS AND PROPERTIES

In this work we use Ordinary Portland Cement of 53 grade of Ultra Tech brand whose properties are explained in table 1. Locally available coarse aggregate downgraded through 12.5mm sieve was used in this mix. Locally available sand passing through 4.75mm sieve has been used as a fine aggregate. Table 2 gives physical properties of coarse aggregate. In this present paper poly carboxylic ether based super plasticizer i.e. Glenium B-233 has been used whose physical properties are explained in table 3.

Table 1: Physical properties of Cement

Properties	Results
Specific gravity	3.13
Initial setting time	53 min
Final setting time	260 min
Standard consistency	34%

Table 2: Physical properties of Coarse aggregate

Test	Result
Bulk density	1536 Kg/m^3
Specific gravity	2.808
Crushing value	13.83%
Impact test	11.29%
Elongation index	20.34%
Flakiness index	16.95%

Table 3: Physical properties of super plasticizer

Properties	Results
Appearance	Light brown colored liquid
Specific gravity	1.09
Ph	6.9
Type	Poly-carboxylic ether based

2.2. EXPERIMENTAL PROCEDURE

2.2.1. MIX PROPORTION AND PREPARATION OF THE SPECIMEN

The mix design for high strength SCC is done by trial and error method using EFNARC guidelines. The mixtures of cement, GGBS, silica fume, coarse aggregate, fine aggregate were mixed for a period of 6 minutes. Then the pan is allowed to rotate by adding 70% of water to the mix, there after super plasticizer was added to the remaining percentage of water and this solution was mixed to the concrete and two drops of VMA was added to the concrete and allowed to rotate the pan for a span of 2 minutes. Then the rheological properties of concrete were identified afterwards SCC was then poured into steel moulds in layers where as compaction and tamping are not required.

Mix	Proportions	Cement (Kg/m^3)	GGBS (Kg/m^3)	Silica fume (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)	Super plasticizer (lit/m^3)	Water (lit/m^3)	w/c
mix-1	CG_0S_0	581.770	0	0	966.73	725.76	11.635	167.55	0.3
mix-2	$CG_{30}S_0$	407.239	174.531	0	966.73	725.76	11.635	167.55	0.3
mix-3	$CG_{30}S_5$	386.87	174.531	20.361	966.73	725.76	11.635	167.55	0.3
mix-4	$CG_{30}S_{10}$	349.062	174.531	58.177	966.73	725.76	11.635	167.55	0.3
mix-5	$CG_{30}S_{15}$	346.154	174.531	61.085	966.73	725.76	11.635	167.55	0.3

Table 4: Mix proportions of concrete mixes

2.2.2. METHODOLOGY

2.2.2.1. COMPRESSIVE STRENGTH: Assessment of compressive strength is one of the appraisals to recognize the mechanical characteristic of concrete. To carry out this test a 100X100X100 mm specimen is casted and cured for a period not less than 28 days.

2.2.2.2. SPLIT TENSILE STRENGTH: It is a test which is used to determine the tensile strength of the concrete by using a cylindrical specimen of 150X300 mm size which is casted and cured for 28 days.

3. RESULTS AND DISCUSSIONS

3.1. RHEOLOGICAL PROPERTIES: SCC is particular type of concrete which can stream beneath its own weight and unaccompanied with bleeding and segregation hence workability is considered as prominent part of self compacting concrete. The workability of SCC was ascertained by subsequent tests like:

1. Slump flow
2. V funnel
3. L-box test.

Fig (1): Slump flow

Fig (2): V-funnel

Fig (3): L-box

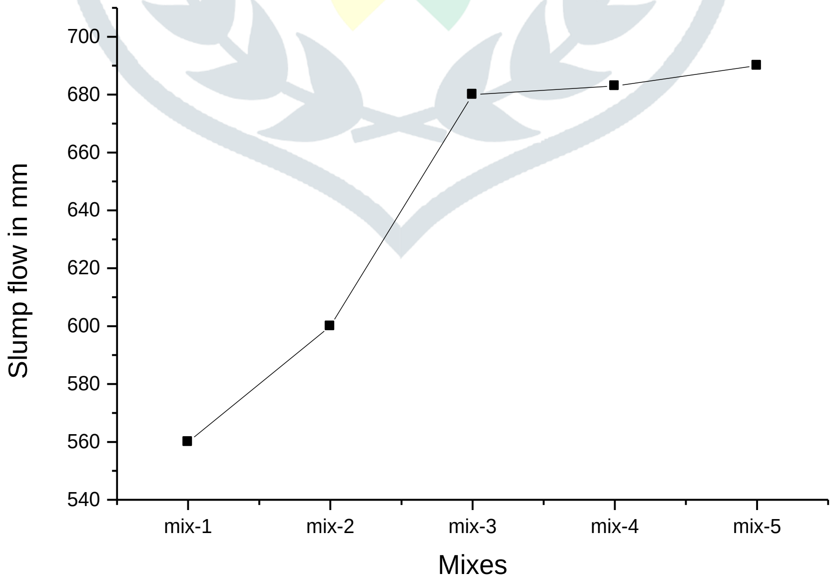

Fig (4): Variation of slump flow

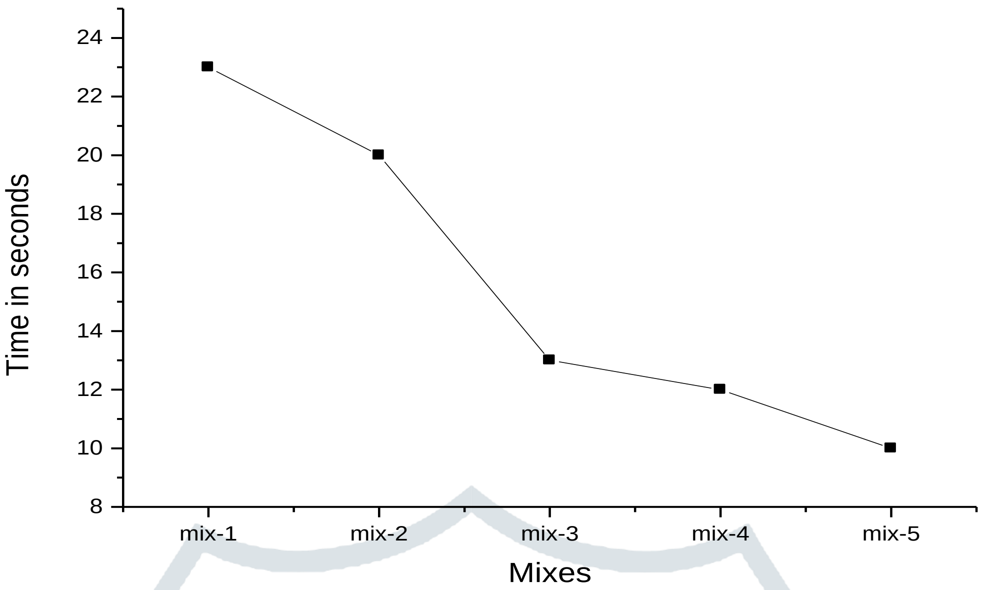

Fig (5): Variation of V-funnel in seconds

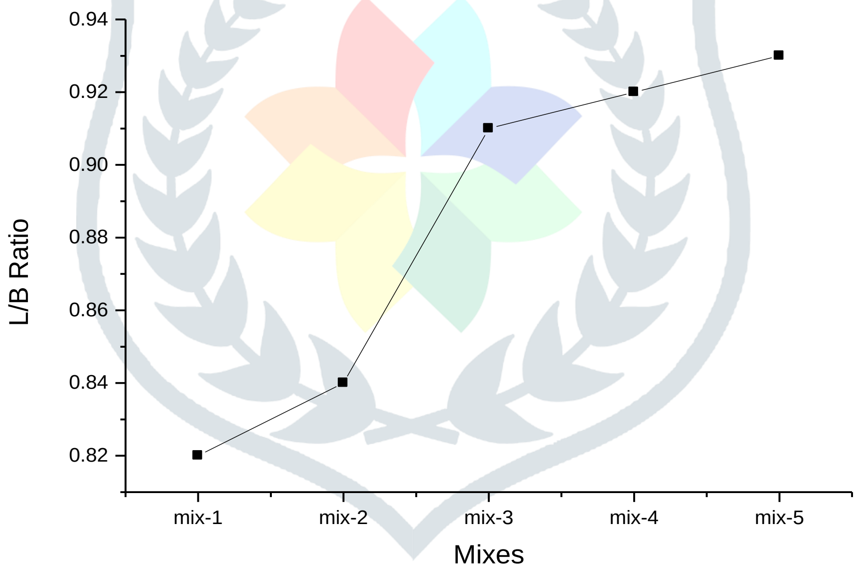

Fig (6): Variation of L/B ratio

3.2. COMPRESSIVE STRENGTH: Cubes are tested for compressive strength and the values are displayed in Table 5. At first the conventional concrete was tested which obtained the strength of 63.167MPa. By keeping this as a reference the cement is replaced with 30% GGBS, then the compressive strength obtained was 69.70MPa. By keeping this GGBS as a constant i.e, 30% and cement replaced with different percentages of 5%, 10% and 15% of Silica fume. Then the compressive strength is calculated for all this mixes. The detail, test results of the various mixes are shown in the graph.

Table 5: Variation of compressive strength for different admixtures

Mix	Proportions	Compressive strength (MPa) at 28 days
mix-1	CC	63.16
mix-2	CG_{30}	69.70
mix-3	$CG_{30}S_5$	70.31
mix-4	$CG_{30}S_{10}$	64.5
mix-5	$CG_{30}S_{15}$	63

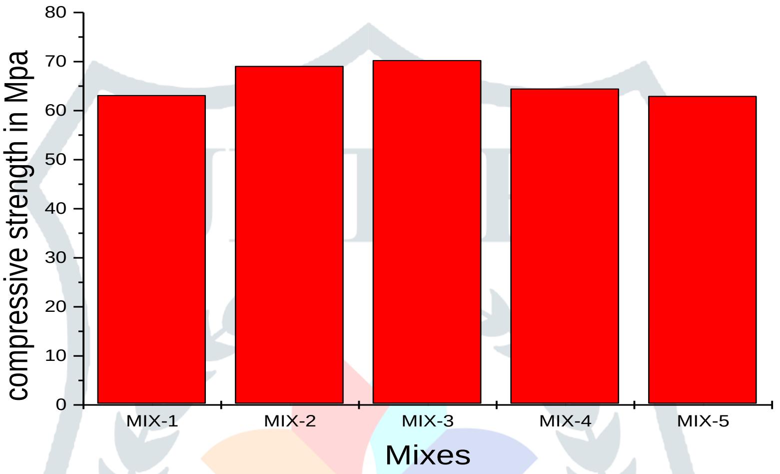

Fig 7: Compressive strength for various admixtures

From the above graph it is said that after replacing cement with GGBS up to 30% the strength was increased to 69.70MPa and after adding 5% silica fume the strength obtained was 70.31MPa. Ternary mixture with 30% GGBS and 5% silica fume obtained highest compressive strength, whereas when the quantity of silica fume is increased then concrete strength is been reduced.

3.3. SPLIT TENSILE STRENGTH TEST

In case of conventional concrete the tensile strength obtained was 3.53MPa. When cement is replaced with GGBS up to 30% the strength is reduced to 3.11MPa. By keeping this as constant and further replacing the cement with silica fume up to 5% the strength is increased to 3.89MPa. And when cement is replaced with silica fume by 10% and GGBS 30% the strength obtained is 4.17MPa and if silica fume is replaced further the maximum tensile strength is obtained i.e. 4.9MPa.The maximum tensile strength is obtained at the ternary mixture with 30% GGBS and 15% silica fume.

Table 6: Variation of split tensile strength for miscellaneous admixture

Mix	Proportions	Split tensile strength (MPa)
mix-1	CG_0S_0	3.53
mix-2	$CG_{30}S_5$	3.61
mix-3	$CG_{30}S_5$	3.89
mix-4	$CG_{30}S_{10}$	4.17
mix-5	$CG_{30}S_{15}$	4.9

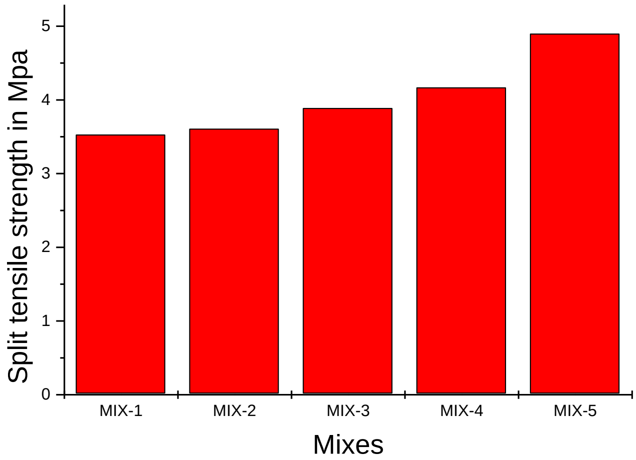

Fig 8: Split tensile strength for various admixtures

4. CONCLUSION

In the present study high strength SCC has been produced by replacing cement with GGBS and Silica fume. In the present study the following conclusion are made below.

1. When the cement is replaced up to 30% by GGBS in the conventional mix the compressive strength of the concrete was increased from 63.167MPa to 69.70MPa.
2. The SCC with 65% cement, 30% GGBS and 5% Silica fume has attained maximum 28 days compressive strength of 70.31MPa. Further increasing the Silica fume % the compressive strength of the self compacting concrete has been reduced.
3. The highest compressive strength value is obtained for the SCC with ternary mixture i.e. 65% Cement, 30% GGBS and 5% SF at 28 days.
4. The maximum tensile strength of 4.9MPa is obtained at when cement is replaced with silica fume up to 15%.

REFERENCES

1. Ali Nazari,Shadi Riahi(Dec,2010), Tio_2 Nano particles Effects On Physical, Thermal And Mechanical Properties Of Self Compacting Concrete With Ground Granulated Blast Furnace Slag As Binder
2. Swaroopa Rani (Jan, 2011), Behavior Of Self Compacting Concrete Made With Ggbs And Rha Under Axial Compression And Flexure
3. Othamane,Said Kenai(Sep,2011), Effects Of Granulated Blast Furnace Slag And Superplasticizer Type On The Fresh Properties And Compressive Strength Of Self-Compacting Concrete
4. Iliana Rodríguez Viacava, Antonio Aguado De Cea (May 2012), Self-Compacting Concrete Of Medium Characteristic Strength
5. Dinakar, C.Sahoo (July,2012),Design Of Self Compacting Concrete Using Ggbs And Silica Fume
6. Kali Prasanna Sethy, P. Dinakar(July,2012), Design Of Self-Compacting Concrete With Ground Granulated Blast Furnace Slag
7. Darshan H.R., M.Rame Gowda (July, 2014), Development And Study Of Behavior Of Self-Compacting Concrete Using Ggbs
8. Prathik Deshmukh(Sep,2014), Strengthening Of Self Compacting Concrete Using Ground Granulated Blast Furnace Slag (Ggbs) For Cost Efficiency
9. Nileena, Praveen Mathew(Oct,2014), Effect Of Ggbs And Gbs On The Properties Of Self Compacting Concrete
10. Hui Zhao,Wei Sun(Feb,2015) , The Properties Of The Self-Compacting Concrete With Fly Ash And Ground Granulated Blast Furnace Slag Mineral Admixtures
11. M.Adamsjoe, A.Mariarajesh (June, 2015), Study On The Effect Of Ggbs & M Sand In Self Compacting Concrete
12. Biswadeep Bharali(Sep,2015), Experimental Study Of Self Compacting Concrete Containing Ggbs And Alum Sludge
13. Gidion Turuallo, Marios N.Soutsos(Nov,2015), Supplementary Cementitious Materials: Strength Development Of Self-Compacting Concrete Under Different Curing Temperature
14. T.S.Ranganatha(No,2016), Experimental Study On Self Compacting Concrete (Ssc) Using Ggbs And Fly Ash
15. Salah Altoubat, Deena Badran(Dec,2016), Restrained Shrinkage Behavior Of Self-Compacting Concrete Containing Ground-Granulated Blast-Furnace Slag
16. Sina Dadsetan, Jiping Bai (Aug,2017), Mechanical And Micro structural Properties Of Self-Compacting Concrete Blended With Metakaolin, Ground Granulated Blast-Furnace Slag And Fly Ash