© 2017 IJSRST | Volume 3 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Experimental investigation of strength characteristics on Micro Level Properties of Self Compaction Concrete using Lime Stone Powder & GGBS

[1]Poojari Yamuna, [2]A. Hari Krishna

[1]M.Tech Student, Department of Civil Engineering, Intell Engineering College, Anantapur, Andhra Pradesh, India
[2]Assistant Professor, Department of Civil Engineering, Intell Engineering College, Anantapur, Andhra Pradesh, India

ABSTRACT

Concrete is a composite material consisting of aggregates, binding material, water and admixtures. It is the most widely used construction material on earth. One of the major environmental concerns is the disposal of the waste materials and utilization of industrial by products. Lime stone quarries will produce millions of tons waste dust powder every year. Having considerable high degree of fineness in comparision to cement this material may be utilized as a partial replacement to cement. For this purpose an experiment is conducted to investigate the possibility of using lime stone powder in the production of SCC with combined use GGBS. This paper is a study on loss of workability, strength and property correlation between paste and concrete for various admixture and superplasticiser dosages. The mineral admixtures considered are Lime stone powder and GGBS(Ground granulated blast furnace slag) with superplasticiser Masterglenium SKY 8233.Test results shows that the SCC mix with combination of 30% GGBS and 15% limestone powder gives maximum compressive strength and fresh properties are also in the limits prescribed by the EFNARC.

Keywords: Self-Compaction Concrete By Using GGBS, Lime Stone Powder.

I. INTRODUCTION

Concrete is the most widely used construction material on earth. An additive or admixture is a material added into the concrete in small quantities to give desirable properties to the concrete. Admixtures in concrete confer some beneficial effects such as acceleration, retardation, air entrainment, water reduction, plasticity etc. To understand the consequences of admixture- cement interactions, and to optimize the functional properties of admixtures, appropriate descriptions of their mode of action must be developed. This paper is an effort to study paste fluidity, concrete compressive strength, correlation of paste and concrete in the presence of chemical admixture Masterglenium SKY 8233 and mineral admixtures lime stone powder and GGBS.

Limestone filler improves the mechanical and durability features of concretes by providing more compact structure through its pore-filling effect. In the existence of GGBS, it also reacts with cement by binding Ca(OH)2 with free silica by a pozzolanic reaction forming a non-soluble CSH structure. Many researches shown that use of ternary blends of cementitious materials improved the early age and the long-term mechanical properties. In this paper an investigation on the combined use of GGBS and Lime stone powder in Self compacting concrete is done to evaluate the fresh and mechanical properties

Literature Review

Published literature on self-compacting concrete first appeared in 1989, and has been increasing significantly since that time, reflecting the amount of research and practical applications taking place. A vast research is going on the use of various waste materials that can replace cement in self-compacting concrete. This chapter summarizes the most important published information of direct relevance to the experimental work reported in this project. As present investigation deals with the replacement of cement with Ground Granulated Blast Furnace Slag and Lime stone powder partially. An attempt has been made to review briefly the available literature

HalitYaz ıcı had studied the effect of silica fume fly ash on properties of concrete. Test results indicate that SCC could be obtained with a high-volume FA. Ten percent SF additions to the system positively affected both the fresh and hardened properties of high-performance high-volume FA SCC.

A.A.MAGSOUDHI, F.ARABPOUR examined the relationship between the nano technology and the study of properties of self-compacting concrete.

Their results show that mix containing both micro silica and nano silica improves the engineering properties of the self-compacting concrete.

Ali Nazari , ShadiRiahi In this work, compressive, flexural and split tensile strengths together with coefficient of water absorption of high strength self-compacting concrete containing different amount of SiO_2nano-particles have been investigated. Results indicate that SiO_2 nano-particles up to 4 percentage could improve the mechanical and physical properties of the specimens.

PrajapatiKrishnapal, Chandak Rajeev had studied the properties of self-compacting concrete, mixed with fly ash. The test results for acceptance characteristics of self-compacting concrete such as slump flow; V-funnel and L-Box are presented. Further, compressive strength at the ages of 7, 28 days was also determined. They concluded that addition of fly-ash in SCC increases filling and passing ability of concrete, Increase in fly ash, super plasticizer content in SCC reduced water demand and compressive strength of concrete.

J.GURU JAWAHAR,et.al had studied the effect of coarse aggregate blending on short term mechanical properties of concrete. Their investigation mainly focused on finding the unit weight, compressive strength, modulus of elasticity(MOE) and split tensile strength(STS) of .

H.A.F. Dehwah (2012) His paper presents the results of a study conducted to evaluate the mechanical properties of self-compacting concrete (SCC) prepared using quarry dust powder (QDP), silica fume (SF) plus QDP or only fly ash (FA).

Mucteba Uysal.et.al (2010) had studied the effectiveness of various mineral admixtures in producing self-compacting concrete (SCC). For this purpose, fly ash (FA), granulated blast furnace slag (GBFS), limestone powder (LP), basalt powder (BP) and marble powder (MP) were used. It was concluded that among the mineral admixtures used, FA and GBSF significantly increased the workability of SCC.

Anthony Nkem Ede.et.al (2014) they had made attempts enhance the flow-ability of SCC by replacement of cement with varying dosage of lime stone and super-plasticizer. To validate the improvement of SCC fresh properties, slump test is used to assess workability, L-box test for passing ability and V-funnel test for filling ability.

II. METHODS AND MATERIAL

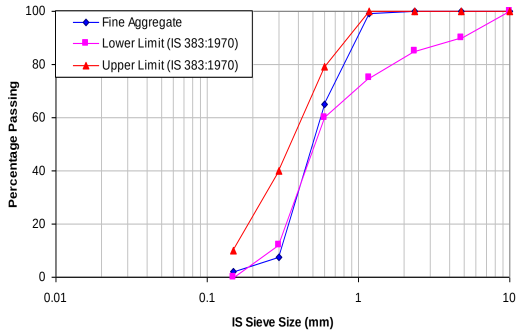
1. Cement

The cement used as ordinary potland cement 53 grade. The following are the various test results conducted as per IS: 12269-1987 to determine the physical properties of this cement.

S. No	Properties	Values
1.	**Specific gravity**	**3.13**
2.	**Standard consistency**	**30%**
3.	**Initial setting time(in min)**	**75**

2. Fine aggregate

Manufactured sand was used as fine aggregate for the experiments. Various tests were conducted to determine the properties of sand. Grading is the particle size distribution of an aggregate as determined by sieve analysis and the taken fine aggregate belongs to zone II. The sieve analysis was done as per IS:2386 (Part-1)-1963. The sieve analysis and properties are shown in table below.



S. No	Properties	Values
1.	Specific gravity	2.65
2.	Fineness modulus	2.68

3.	Water absorption	10%

3. Coarse Aggregate

Crushed granite stones of size not greater than 12.5 mm are used as coarse aggregate. The bulk specific gravity and water absorption of 12.5 mm as per IS 2386 (Part III, 1963)[28] are 2.62 and 0.3% respectively. The gradation of the coarse aggregate was determined by sieve analysis as per IS 383 (1970)[26]

S. No	Properties	Values
1.	**Specific Gravity**	**2.62**
2.	**Fineness Modulus**	**4.6**
3.	**Water Absorption**	**30%**

III. TESTING PROCEDURE

1. Tests on fresh concrete

1.1 Slump Flow Test

Slump flow test is performed to determine the filling ability of the concrete when it is in fresh state. A slump test apparatus consisting of slump cone which is in the form of a hollow frustum made of thin steel sheet and tamping rod placed over a base plate. Fresh concrete is filled in 4 layers with each layer tamped 25 times. Subsidence of the concrete after removing the cone is measured and should be ensured within the limits as per the mix design.

T_{50cm} is the time measured from lifting the cone to the concrete reaching a diameter of 50 cm circle. The measured T_{50cm} gives the deformation rate or viscosity of the concrete.

1.2 V-funnel Test

This test is also performed to determine the filling ability of the concrete. First, the apparatus is cleaned with water and wiped with a cloth such that no wetness is present inside, and trap door at the bottom of the V-funnel is closed, and V-funnel is completely filled with fresh concrete (12 litre). Measure the time taken by the concrete for emptying the V-funnel using a stop watch and that time is termed as the V-funnel time. Again, the V-funnel is filled with same concrete, kept for 5 minutes and the trap door is released, note the time taken by the concrete for emptying the apparatus using a stop watch .This time indicates V-funnel time at T_{5min}.

1.3 L-box Test

This test is done to determine the passing ability of the fresh concrete. About 14 litres of concrete is required to perform this test. L-box test apparatus consists of two sections one is horizontal and the other is vertical separated by gate. In this test, fresh concrete (14 litre) is filled in the vertical section of L-box without any external compaction and level the top portion of the vertical section then the gate is lifted to allow the concrete to flow into the horizontal section of L-box. Measure the heights of concrete retained in both vertical section (H_1) and horizontal section (H_2). The ratio H_2/H_1 gives the blocking ratio of the concrete.

2. Tests on Mechanical Properties of SCC

This section explains the procedure to determine the hardened properties of SCC.

2.1 Compressive Strength Test

Compressive strength test was conducted on the cubical specimens for all the mixes. For each mix three cubical specimens of dimensions 150 mm x 150 mm x 150 mm were cast and tested at 28 days of normal water curing. Compressive strength (f'_c) of the cube was calculated by using the formula shown below.
Compressive strength = maximum load applied to specimen / Area of cross section of specimen

2.2 Split Tensile Strength Test

Split tensile strength (STS) test was done on the cylindrical specimens for all mixes. For each mix three cylindrical specimens of size 150 mm diameter x 300 mm height were cast and tested at days of normal water curing. The load was gradually applied on the specimen till the failure of the specimen occurs. The load at which failure of the specimen takes place is noted. The split tensile strength (f_{ct}) of the concrete was calculated as follows:

$$f_{ct} = 2P/ (\Pi\, l\, d)$$

Where,
f_{ct} = Split tensile strength of concrete (MPa)
l = length of specimen
P = Load at which failure takes place (N)
d = diameter of specimen

4.3 Flexural Strength Test

Flexural strength test was conducted on the beam specimens for all the mixes. For each mix three beam specimens of size 500 mm x 100 mm x 100 mm were cast and tested at 28 days of normal water curing. The load was applied gradually on the beam till the failure occurs. Note the load at which the specimen breaks and the nearest crack distance from the support. The flexural strength of the beam is calculated as follows

Flexural strength = Pl / bd^2 if a >= 40/3
= $3Pa / bd^2$ if a <= 40/3

Where,
P = Maximum load applied (N).
l = Length (mm), d = Depth (mm).
b = Breadth (mm).
a = Length of nearest crack from support.

S. NO	MIX DESIGNATION	CEMENT (kg)	GGBS (kg)	LIME STONE POWDER (kg)	WATER (litres)	F.A (kg)	C.A (kg)	S.P (lires)
1	M0	500	-	-	200	897	733	4.6
2	M1	450	50	-	200	895	724	4.6
3	M2	400	100	-	200	893	723	4.6
4	M3	350	150	-	200	892	721	4.6
5	M4	300	200	-	200	890	720	4.6
6	M5	250	250	-	200	887	718	4.6
7	M6	325	150	25	200	889	747	4.6
8	M7	300	150	50	200	888	745	4.6
9	M8	275	150	75	200	887	744	4.6
10	M9	250	150	100	200	886	742	4.6

IV. MIX PROPORTIONING

The mix proportion is a key factor to be considered to achieve SCC. Though the SCC was first developed in1980‟s there is no standard mix design adopted or developed to achieve SCC. The European Federation of Specialist Construction Chemicals and Concrete systems (EFNARC) provide the guideline for development of SCC. But no method of mix design specifies the grade of concrete in SCC except Nan Su et al method. In this work mix design is developed based on the EFNARC guidelines. In this work GGBS and lime stone powder are used as a mineral additives which replaces cement and water-powder ratio of 0.4 is maintained constant throughout the experiment. First cement is replaced with GGBS in percentages like 10, 20, 30 ,40, 50 and fresh and hardened properties were checked. By taking the optimum mix from the results and keeping that percentage of GGBS constant, replacement with limestone powder is done in percentages like 5, 10, 15, 20. In present work at 30% replacement with GGBS gives the optimum results and for a mix with 30% GGBS and 15% Lime stone powder gives maximum compressive strength. The mix proportions are tabulated below

Mix proportion for 1 m^3 of SCC:

M0 = 100% CEMENT	M5 = 50% GGBS, 50% CEMENT
M1 = 10% GGBS, 90% CEMENT	M6 = 30% GGBS, 5% LIME STONE POWDER, 65% CEMENT
M2=20% GGBS, 80% CEMENT	M7 = 30% GGBS, 10% LIME STONE POWDER, 60% CEMENT
M3=30% GGBS, 70% CEMENT	M8 = 30% GGBS, 15% LIME STONE POWDER, 55% CEMENT
M4 = 40% GGBS, 60% CEMENT	M9 = 30% GGBS, 20% LIME STONE POWDER, 50% CEMENT

V. RESULTS AND DISCUSSION

A. Fresh Properties

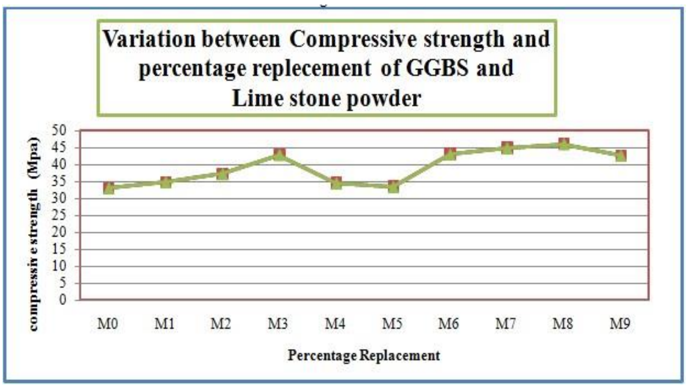
Slump flow, V-funnel, L-box, were used to test the workability, passing ability, of SCCs The results of fresh properties for each mix were tabulated below.

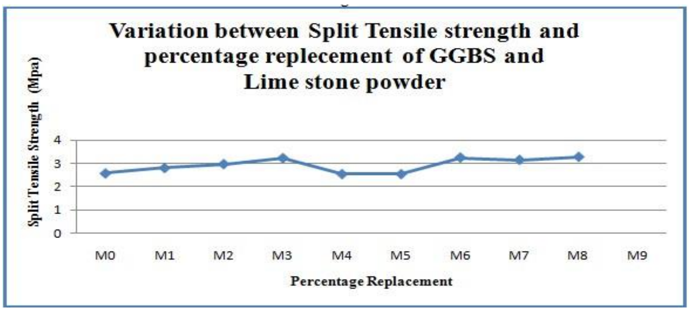
S.NO	MIX	Slump (mm) (650-800 mm)	T_{500} (mm) (2-5 sec)	V-Funnel(sec) (6-12 sec)	T_5 (sec)	L-box (0.8-1.0)
1	M0	640	5	13	15	0.75
2	M1	680	4.2	10	12	0.78
3	M2	700	3.5	10	13	0.85
4	M3	720	2.8	8	10	0.85
5	M4	730	2.3	7	8	0.88
6	M5	750	2.2	4.8	6	0.92
7	M6	720	3	8	10	0.82
8	M7	710	3	8.2	11	0.8
9	M8	695	3.6	9	11.6	0.78
10	M9	685	4	14	12.5	0.74

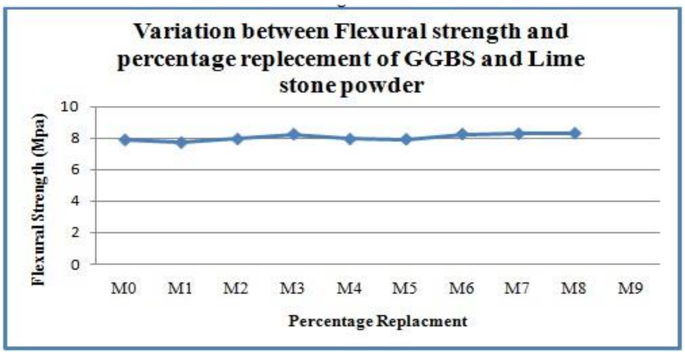
6.2 Hardened properties:

Compressive strength of SCC were measured according to ASTM C 39 by means of a compression testing machine. The test was conducted on three 150 mm cubes at the ages of 28 days. Splitting tensile strength of the SCCs was determined on 150 mm dia and300 mm height cylinder specimens at 28 days. Flexural strength of the SCC was determined on 500 mm x 100 mm x100 mm beam specimens. The test was conducted on one beam specimen after 28 days of normal water curing. Test results were tabulated below

SL.NO.	MIX	Compressive strength (Mpa)	Split tensile strength (Mpa)	Flexural strength (Mpa)
1	M0	33	2.57	7.9
2	M1	34.8	2.8	7.73
3	M2	37.2	2.97	7.95
4	M3	42.8	3.225	8.25
5	M4	34.5	2.54	7.95
6	M5	33.4	2.54	7.93
7	M6	43	3.25	8.26
8	M7	44.8	3.15	8.28
9	M8	46	3.28	8.31
10	M9	42.6	3.00	8.25







VI. CONCLUSION

1. From the test results it was concluded that when cement is replaced with GGBS by 30% both fresh and hardened properties were optimum and having compressive strength of 42.8 Mpa for the phase of GGBS. Beyond 30% replacement of GGBS strength properties were tend to decrease. Hence the optimum replacement percentage of GGBS that can replace cement is 30%.
2. Combined mix of 30% GGBS and 15% Lime stone powder gives maximum strength parameters and fresh properties for the mix is also in the limits prescribed by the EFNARC.
3. Mix M8 (30% GGBS, 15% Limestone stone powder, 55% Cement) has the maximum compressive strength (46 MPa) and maximum split tensile strength (3.28 MPa) and maximum flexural strength (8.31 MPa).
4. The percentage increase in compressive strength for the mix M8 is found to be 40% and it is satisfactory.
5. It is also noticed that when we replaced cement by 50% GGBS gives a compressive strength of 33.4 MPa which is greater than for control mix M0 (100% cement). Hence it is concluded that for medium strength applications we can replace cement by GGBS by about 50% which results in reduce in cost and release of carbon dioxide into environment.

VII. REFERENCES

[1]. Aarre T, Domone PLJ. Testing-SCC: Summary report on work package 2: Development of mix designs and material selection. 2004.

[2]. ACI 301. Specifications for Structural Concrete. 2010.

[3]. ACI 237R-07. Self-Consolidating Concrete. 2007.

[4]. Aiad I. Influence of time addition of superplasticizers on the rheological properties of

fresh cement pastes. Cement and Concrete Research, Vol. 33, No. 8, 2003, pp1229-1234.
[5]. ASTM C 618. Standard specification for coal fly ash and raw or calcined natural pozzolan for use in concrete. 2003.
[6]. Bonen D, Shah S. The Effects of Formulation on the Properties of Self-Consolidating Concrete. Concrete Science and Engineering: A Tribute to Amon Bentur, Proceedings of the International RILEM Symposium, K. Kovler, J. Marchand, S. Mindress and J. Weiss, eds, RILEM Publications, France. 2004, pp43-56.
[7]. Carlsward J, Emborg M, Utsi S, Oberg P. Effects of constituents on the workability and rheology of self-compacting concrete. In: The 3rd International RILEM Symposium on Self-Compacting Concrete. Wallevik OH, Nielsson I, editors, RILEM Publications S.A.R.L, Bagneux, France. 2003, pp143-153.
[8]. Cetin A, Carrasquillo RL. High-performance concrete: influence of coarse aggregates on mechanical properties. ACI Mater. J., Vol. 95, No. 3, 1998, pp252-261.
[9]. Chopin D, De Larrard CF, Cazacliu B. Why do HPC and SCC require a longer mixing time? Cement and Concrete Research,Vol. 34, No. 12, 2004, pp2237-2243.
[10]. Collepardi M, Borsoi A, Collepardi S, Troli R. Strength, shrinkage and creep of SCC and flowing concrete. In: The 2nd North American Conference on the Design and Use of Self-consolidating Concrete and the 4th International RILEM Symposium on Self-compacting Concrete. Shan SP, editor, A Hanley Wood Publication, U.S.A. 2005, pp 911-920.
[11]. Aarre T, Domone PLJ. Testing-SCC: Summary report on work package 2: Development of mix designs and material selection. 2004.
[12]. ACI 301.Specifications for Structural Concrete. 2010.
[13]. ACI 237R-07. Self-Consolidating Concrete. 2007.
[14]. Aiad I. Influence of time addition of superplasticizers on the rheological properties of fresh cement pastes. Cement and Concrete Research, Vol. 33, No. 8, 2003, pp1229-1234.
[15]. ASTM C 618. Standard specification for coal fly ash and raw or calcined natural pozzolan for use in concrete. 2003.
[16]. Bonen D, Shah S. The Effects of Formulation on the Properties of Self-Consolidating Concrete. Concrete Science and Engineering: A Tribute to Amon Bentur, Proceedings of the International RILEM Symposium, K. Kovler, J. Marchand, S. Mindress and J. Weiss, eds, RILEM Publications, France. 2004, pp43-56.
[17]. Carlsward J, Emborg M, Utsi S, Oberg P. Effects of constituents on the workability and rheology of self-compacting concrete. In: The 3rd International RILEM Symposium on Self-Compacting Concrete. Wallevik OH, Nielsson I, editors, RILEM Publications S.A.R.L, Bagneux, France. 2003, pp143-153.
[18]. Cetin A, Carrasquillo RL. High-performance concrete: influence of coarse aggregates on mechanical properties. ACI Mater. J., Vol. 95, No. 3, 1998, pp252-261.
[19]. Chopin D, De Larrard CF, Cazacliu B. Why do HPC and SCC require a longer mixing time? Cement and Concrete Research,Vol. 34, No. 12, 2004, pp2237-2243.
[20]. Emborg M. Final report of task 8.1 Mixing and transport. 2000