International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 11, Issue 08 (August 2015), PP.21-26

Study of Macro level Properties of SCC using GGBS and Lime stone powder

[1]P.Raghava,[2]V.Giridhar Kumar, [3]Dr.T.Chandrasekhar Reddy
[1]*(M.TechStructural Engineering, G. Pulla ReddyEngineeringcollege. Kurnool)*
[2]*(Assistant ProfessorofCivilEngineering, G. Pulla ReddyEngineeringcollege.Kurnool)*
[3]*(ProfessorofCivilEngineering, G. Pulla ReddyEngineeringcollege.Kurnool)*

Abstract:- 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 and how it affects the fresh and mechanical properties of SCC. First SCC is made by replacing cement with GGBS in percentages like 10, 20, 30, 40, 50 and by taking the optimum mix with GGBS lime stone powder is blended to mix in percentages like 5, 10, 15, 20 as a partial replacement to cement. 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 compacting concrete, GGBS, Lime stone powder.

I. INTRODUCTION

The development of self-compacting concrete (SCC) also referred to as ‘‘Self-Consolidating Concrete’’ has recently been one of the most important developments in building industry. Self-compacting concrete (SCC) is a special concrete that can settle into the heavily reinforced, deep and narrow sections by its own weight, and can consolidate itself without necessitating internal or external vibration, and at the same time maintaining its stability without leading to segregation and bleeding. SCC demands a large amount of powder content compared to conventional vibrated concrete to produce a homogeneous and cohesive mix. The common practice to obtain self-compactibility in SCC is to limit the coarse aggregate content and the maximum size and to use lower water–powder ratios together with new generation super plasticizers (SP). During the transportation and placement of SCC the increased flowability may cause segregation and bleeding which can be overcome by providing the necessary viscosity, which is usually supplied by increasing the fine aggregate content; by limiting the maximum aggregate size; by increasing the powder content; or by utilizing viscosity modifying admixtures (VMA) . One of the disadvantages of SCC is its cost, associated with the use of chemical admixtures and use of high volumes of Portland cement. One alternative to reduce the cost of SCC is the use of mineral additives such as limestone powder, natural pozzolans, fly ash and slag, which are finely divided materials added to concrete as separate ingredients either before or during mixing . As these mineral additives replace part of the portland cement, the cost of SCC will be reduced especially if the mineral additive is an industrial by-product or waste. It is well established that the mineral additives, such as fly ash and slag, may increase the workability, durability and long-term properties of concrete.

Therefore, use of these types of mineral additives in SCC will make it possible, not only to decrease the cost of SCC but also to increase its long-term performance. To assess the effectiveness of GGBS in SCC some of the parameters like chemical composition, hydraulic reactivity, and fineness have been carefully examined earlier It was seen that among these, the reactive glass content and fineness of GGBS alone will influence the cementitious/pozzolanic efficiency or its reactivity in concrete composites significantly

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.

II. REVIEW OF LITERATURE

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

HalitYazıcı 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 wt.% could improve the mechanical and physical properties of the specimens.

ALI NAZARI, SHADI RIAHI had studied strength assessments and coefficient of water absorption of high performance self compacting concrete containing different amounts of TiO_2 nano particles have been investigated. The results indicate that the strength and the resistance to water permeability of the specimens are improved by adding TiO_2nano particles in the cement paste up to 4.0 wt%.

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 SCC mixes with different coarse aggregate blending(60:40 and 40:60) (20mm and 10mm) and coarse aggregate content (28% and 32%). They concluded that the coarse aggregate blending did not affect the compressive strength of SCC mixes, but it affected the unit weight, MOE and STS of SCC mixes.

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). The results indicated that the mechanical properties of SCC incorporating QDP (8–10%) were equal to or better than those of SCC prepared with either SF plus QDP or FA alone.

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.

Beeralingegowda, V. D. Gundakalle (2013) had studied the effect of addition of limestone powder on properties of self compacting concrete. In this study, cement content in the SCC mix is replaced with various percentages of limestone powder (LP) (0 to 30%), the fresh and hardened properties and also the durability characteristics of SCC such as acid attack and chloride attack are studied. The experimental results were validated by regression analysis. It is observed that limestone powder can be effectively used as a mineral additive in 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 limestone 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. Test results analyzed with statistical tools confirmed that the workability and rheological properties of self-compacting concrete can be improved through the adoption of various dosages of limestone powder.

III. MATERIALS USED

Inthepresentinvestigation materialsusedare

1. Ordinary Portland cement 53 Grade
2. GGBS as partial replacement to cement
3. Lime stone powder as partial replacement to cement
4. Naturally available River sand as fine aggregate
5. Crushed Granite as coarse aggregate of size not greater than 12.5 mm
6. Master Glenium Sky super plasticizer(poly carboxylate based)
7. Viscosity Modifying Agent
8. Water

IV. MATERIAL PROPERTIES

(1) Ordinary Portland Cement(OPC) 53 grade conformingtoIS12269:1987 is used in this work. The properties of used cement were

TYPE	**OPC 53 grade (Zuari)**
Normal consistency	32%
Specific Gravity	3.13
Compressive strength	55.6MPa

(2) GGBS brought from JSW Cement plant having specific gravity 2.91
(3) Lime stone powder brought from lime stone quarries having specific gravity 2.68
(4) Thephysical propertiesoffineaggregate (riversand) were.

Specific gravity – 2.65	**Water absorption – 1%**
Fineness modulus – 2.68	Maximum nominal size – 4.75 mm

(5)Thephysical propertiesofCoarseaggregate (Crushed granite) were

Specific gravity	**2.72**
Fineness modulus	4.6
Water absorption (%)	0.3%
Maximum nominal size	12.5 mm

(6) Master Glenium Sky Super plasticizer (poly carboxylate based) having specific gravity 1.03 (as given by the manufacturer)

IV. MIX PROPORTIONING

The mix proportion is a key factor to be considered to achieve SCC. Though the SCC was first developed in 1980'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

MIX DESIGNATION	CEMENT (kg)	GGBS (kg)	LIME STONE POWDER(kg)	WATER (litres)	F.A (kg)	C.A (kg)	S.P (litres)
M0	500	-	-	200	897	733	4.6
M1	450	50	-	200	895	724	4.6
M2	400	100	-	200	893	723	4.6
M3	350	150	-	200	892	721	4.6
M4	300	200	-	200	890	720	4.6
M5	250	250	-	200	887	718	4.6
M6	325	150	25	200	889	747	4.6
M7	300	150	50	200	888	745	4.6
M8	275	150	75	200	887	744	4.6
M9	250	150	100	200	886	742	4.6

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

VII. TESTING PROCEDURES

5.1 Fresh properties

Slump flow, V-funnel, L-box, were used to test the workability, passing ability, of SCCs. Workability of the SCCs was controlled through the slump flow test such that slump flow diameters of all of the mixtures were designed to be in the range of 650-800 mm as to satisfy the EFNARC limitations. For this, trial batches were produced for each mixture till the desired slump flow was obtained by adjusting the dosage of the superplasticizer. Flowability of the mixtures was inspected through the V-Funnel test. L-box test was carried out as an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted. Slump flow, L-box, and V-funnel tests were performed according to the procedure recommended by EFNARC committee. The results of fresh properties for each mix were tabulated below.

Fresh properties of SCC

MIX	Slump (mm) (650-800 mm)	T_{500} (sec) (2-5 sec)	V-Funnel(sec) (6-12 sec)	T_5 (sec)	L-box (0.8-1.0)
M0	640	5	13	15	0.75
M1	680	4.2	10	12	0.82
M2	700	3.5	10	13	0.85
M3	720	2.8	8	10	0.85
M4	730	2.3	7	8	0.88
M5	750	2.2	4.8	6	0.92
M6	720	3	8	10	0.82
M7	720	3	8.2	11	0.8
M8	730	3.6	9	11.6	0.8
M9	735	4	11	12.5	0.74

5.2 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 normal water curing and the average of them was reported herein. Splitting tensile strength of the SCCs was determined on 150 mm dia and300 mm height cylinder specimens at 28 days. The splitting tensile strength reported in the study was the average of three cylinders. 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

Hardened properties of SCC

MIX	Compressive strength (MPa)	Split tensile strength (MPa)	Flexural strength (MPa)
M0	33	2.57	7.9
M1	34.8	2.8	7.73
M2	37.2	2.97	7.95
M3	42.8	3.225	8.25
M4	34.5	2.54	7.95
M5	33.4	2.54	7.93
M6	43	3.25	8.26
M7	44.8	3.15	8.28
M8	46	3.28	8.31
M9	42.6	3.00	8.25

Figure 1

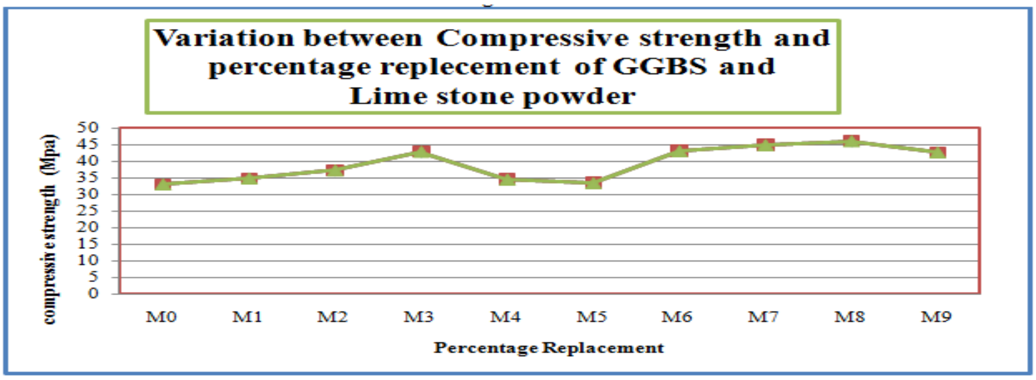


Fig 2

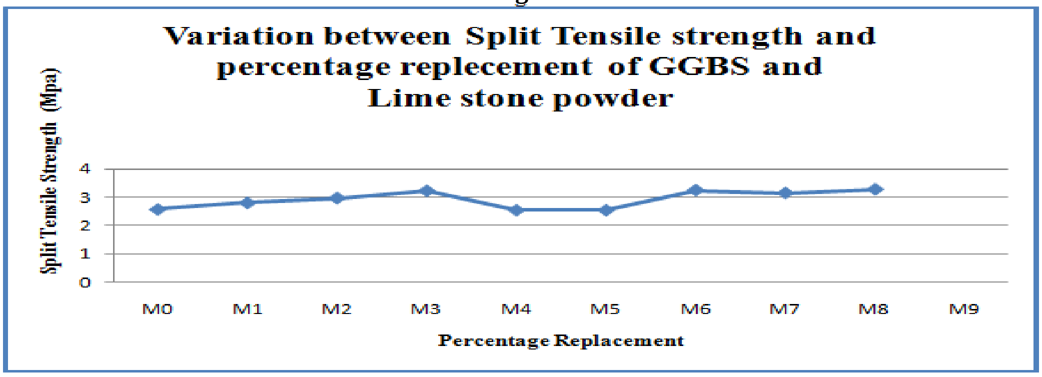
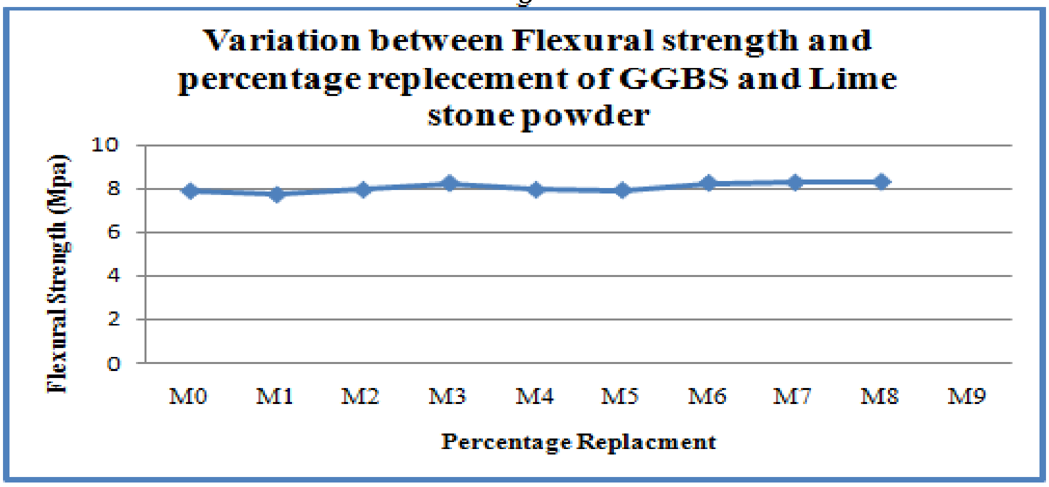


Fig 3



VII. CONCLUSIONS

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

REFERENCES

[1]. HalitYazıcı ” The effect of silica fume and high-volume Class C fly ash on mechanical properties, chloride penetration and freeze–thaw resistance of self- compacting concrete”, Construction and Building Materials 22 (2008) 456–462, Elsevier

[2]. A.A.MAGSOUDHI.et.al “The comparision of properties of self compacting using micro silica and Nano silica”

[3]. Ali Nazari , ShadiRiahi“The role of SiO_2 nanoparticles and ground granulated blast furnace slag admixtures on physical, thermal and mechanical properties of self compacting concrete”, Materials Science and Engineering A 528 (2011) 2149–2157,Elsevier

[4]. Ali Nazari, ShadiRiahi “TiO_2nano particles effects on physical, thermal and mechanical properties of self compacting concrete with ground granulated blast furnace slag as binder”, Energy and Buildings 43 (2011) 995–1002, Elsevier

[5]. J.GuruJawahar,et.al.” Effect of Coarse aggregate blending on short term properties of SCC”

[6]. Prajapati Krishnapal, Chandak Rajeev “ Development and Properties of Self Compacting Concrete Mixed with Fly Ash”,ISSN 2278 – 9472; Vol. 1(3), 11-14, Sept. (2012).

[7]. H.A.F.Dehwah “Study of mechanical properties of SCC containing quarry dust powder, silica-fumes and fly-ash as binary and ternary blending”, Construction and Building Materials 26 (2012) 547–551,Elsevier

[8]. Mucteba Uysal.et.al “The effect of mineral admixtures on mechanical properties, chloride Materials 28; (2012); 321–326, Elsevier

[9]. B. Beeralingegowda, V.D.Gundakalle “Study of effect of limestone powder on properties of self compacting concrete”, ISSN: 2319-8753; **Vol. 2, Issue 9, September 2013.**

[10]. Anthony Nkem Ede.et.al “Study of effect of limestone powder and super plasticizer dosage on properties of self compacting concrete”, Civil and Environmental Research ISSN 2224-5790 ISSN 2225-0514 ,Vol.6, No.2, 2014.

[11]. (11) IS 383 (1970). Specification for coarse and fine aggregates from natural sources for concrete. Bureau of Indian Standards, New Delhi.

[12]. IS 456 (2000). Plain and reinforced concrete code for practice. Bureau of Indian Standards, New Delhi

[13]. (13)EFNARC. Specification and guidelines for self-compacting concrete. EuropeanFederation of Producers and Applicators of Specialist Products for Structures, 2002, 2005.

[14]. (14) Bureau of Indian Standards. Specification for 53 grade ordinary Portland cement, IS-12269 1987, New Delhi, India

[15]. (15) Concrete technology text book by M.S Shetty

BIOGRAPHIES

P.RAGHAVA is currently pursuing M.Tech (Structural Engineering) in Civil Engineering at G.Pulla Reddy Engineering College (Autonomous), Kurnool A.P. He is presently investigating the effect on Macro level properties of self compacting concrete using GGBS and Lime stone powder as a part of the intended course work for the completion of M.Tech degree.

V.Giridhar Kumar is presently working as Assistant Professor in the Department of Civil Engineering, G.Pulla Reddy Engineering College (Autonomous), Kurnool A.P. He has 13 years experience in teaching and in construction. He worked earlier as Site Engineer (Civil), Reynolds Engineers and consultants, Hyderabad and as Assistant Engineer (civil), CES (India) limited, Hyderabad for 3 years. His interested research areas include the Finite Element Methods and Modeling, material composites in concrete applications research. He is member of The Institution of Engineers (India), Kolkata.

Dr.T.Chandra Sekhar Reddy graduated from JNTU College of Engineering, Anantapur, obtained his Post graduation degree from NIT, Warangal and Doctoral degree from JNTUA, Anantapur. He is serving as Professor in Civil Engineering department of G.Pulla Reddy Engineering college, Kurnool since 1987. He had 29 years teaching experience and 2 years Industry experience. His areas of interest includes cement composites, Fibre reinforced concretes, Nano- materials and Neural Networks.