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An Investigation Study on Strength & Cost Analysis of Self Compacting Concrete by Using Ggbs.

M.ASHWIN KUMAR[1], G.VINAY KUMAR[2], V.SWATHI[3]
[1]senior Asst.Professor, Civil Engg, Vidya Jyothi Institute Of Technology.
[2]Asst.Professor, Civil Engg, Vidya Jyothi Institute Of Technology.
[3]Asst.Professor, Civil Engg, Vidya Jyothi Institute Of Technology.
ashwin@vjit.ac.in, vinay.civil@vjit.ac.in, swathicivil@vjit.ac.in.

ABSTRACT: Concrete is a family of binding material, fine aggregate, coarse aggregate, and water. Concrete is normally used in the frame structure. But there is some limitation like self-compaction, surface finishes, maintains strength at the congested area. Due to this limitation, we are trying to make self-compacting concrete with the use of mineral admixture. SCC is concrete that can be placed and compacted under its own weight with minimum vibration effort, assuring complete filling of formwork even when access is hindered by narrow gaps between reinforcement bars. The primary objective of this study is to make use of Ground Granulated Blast furnace Slag (GGBS) as a replacement of cement and understand its effects on the fresh properties, compressive strength weathering. The present study intended to quantify the amount of Ground Granulated Blast furnace Slag (GGBS) to be added to the concrete according to the value of concrete properties measured. The workability of self-compacted concrete is increased as the content of GGBS increased. The compressive strength of SCC with GGBS is increased up to 30% replacement of cement with (gradual % increase % interval) GGBS. The usage of mineral admixtures in the production of SCC not only provides economic benefits but also reduces the heat of hydration (EFNARC guidelines 2002). It is also known that some mineral admixtures may improve rheological properties and reduce thermally-induced cracking of concrete due to the reduction in the overall heat of hydration, and increase the workability and long-term properties of concrete (Recommendation for Construction of Self Compacting Concrete 1998). There is no standardized mix proportion for designing SCC, hence in this work, the Indian standard method of mix design is adopted with Ground Granulated Blast furnace Slag (GGBS) for partial replacement of cement. Further, a comparison of the self-compatibility properties and hardened properties like Compressive Strength, Split Tensile Strength and Flexural Strength for GGBS based SCC, and SF based SCC is made.

KEYWORDS: Ground Granulated Blast furnace Slag (GGBS), SCC (Self-Compacted Concrete), Super Plasticizer, viscosity modifying agent.

Introduction: Present-day self-compacting concrete can be classified as an advanced construction material. As the name suggests, it does not require to be vibrated to achieve full compaction. This offers many benefits and advantages over conventional concrete. These include an improved quality of concrete and reduction of on-site repairs, faster construction times, lower overall costs, facilitation of introduction of automation into concrete construction. An important improvement of health and safety is also achieved through elimination of handling of vibrators and a substantial reduction of environmental noise loading in and around a site. These days, apart from steel, concrete is the most common and widely used as structural material in the construction field. Concrete is defined as composite material made up of composing granular material (the aggregate or filler) embedded in a hard matrix of material (cement) and the water that fills the space between the aggregate particles and glues them together. They are many types of concrete with different materials used and mix design, therefore, the definitions of the concrete itself, not specific to one definition but become more broadly depended on various type materials used in concrete constituent itself. In mix design, good concrete must economical and fulfill the requirements include.

To fulfill all these requirements in the research and also to develop new type concrete become a major interest in most countries. In Japan, researchers have successfully developed a new type of concrete named Self Compacting Concrete, but also create the new properties of concrete that are

very workable, flow-able and self-compacting. Self-Compacting Concrete is classified in high performance, which defines as follows:

- Fresh: Self-compactable and flowable.
- Early age: Avoidance of initial defects.

REASON FOR DEVELOPMENT OF SCC:

The main factors for the development of Self-Compacting Concrete are to achieve high durable, flow-able, workable and self-compacting of concrete and to solve weakness properties of concrete as we know that concrete is a brittle material with low tensile strength, volume stability, low ductility and low strength to weight ratio.

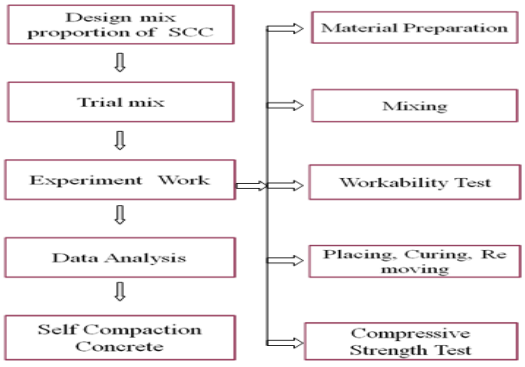

Fig 1. General Stages of SCC

B.H.V. PAI et al. (2014): This paper is based on investigational results of concrete sample cast with use of Ordinary Portland Cement, Silica Fumes (SF), and Ground Granulated Blast Furnace Slag (GGBS). The GGBS and SF based SCC mixes developed 28-day compressive strength 26.23 and 18.32 Mpa respectively. It can be concluded that Compressive, Split tensile and flexural Strengths are good with the Ground Granulated Blast Furnace Slag (GGBS) based Self-Compacting Concrete when compared to the Silica Fumes contained Self-Compacting Concrete. Shriram H. Mahure et al.(2013): Carried out an investigational study on the likelihood of production of innovative concrete (SCC) by using the waste material. Cement Kiln dust and fly ash being kind of industrial waste were identified for use in different percentages as cement replacement for making Self-Compacting Concrete. He targeted concrete of grades M20, M25, and M30, and used Portland type 2 cement, a cement industry waste Cement kiln dust (CKD), blackish color fly ash acquired from Thermal Power Station, Akola India, and modified polycarboxylate superplasticizer.

The main objectives of this work are:

I. To study Self-Compacting Concrete based on the current mix proportion using local materials.
II. To study the fresh property such as workability of Self-Compacting Concrete.
III. To investigate the hardened property such as compressive strength of Self-Compacting Concrete.

MATERIALS AND METHODOLOGY:

Materials:

The materials used in this investigation are

- 53 grade ordinary Portland cement
- Fine aggregates
- Coarse aggregates
- Superplasticizer (CONPLAST SP430)
- GGBS
- Water

Test on materials

There are different types of tests carried out on materials like coarse aggregates; fine aggregates and cement are as follows

- Sieve analysis.
- The specific gravity of fine aggregates.
- The specific gravity of coarse aggregates.
- The specific gravity of cement.
- Normal consistency of cement.
- Initial and final setting time of cement

Mix design procedure:

In the present study, we have obtained M25 for the source of Self Compacting Concrete.

The standard procedure as per IS: 10262-2009 was followed and detailed calculation of mix design of Self Compacting Concrete was shown below.

The adopted replacement of mix proportion per acquired Self Compacting Concrete is categorized below.

Proportions of GGBS in replacement of cement content.

GGBS(%)	CEMENT(%)
2.5	97.5
5	95
10	90
15	85

20	80
25	75
30	70

SP has been taken 10 ml for 1 kg of cement according to quantity of cement as per IS: 9103

I.MIX DESIGN OF M25 GRADE CONCRETE:

Grade designation : M25.
Type of cement : OPC 53 grade.
Max nominal aggregate size: 20mm.
Min cement content : 310 kg/m^3.
Max w/c ratio : 0.5.
Workability : 50-75 mm.
Exposure condition : Normal.
The degree of supervision : Good.
Type of aggregate : Crushed angular.
Max cement content : 540 kg/m^3
Chemical admixture type : Super-plasticizer.

II. TEST DATA FOR MATERIALS:

Cement used : OPC 53 grade (JSW)
Specific gravity of cement : 2.92
Specific gravity of water : 1
Specific gravity
a) Coarse aggregate : 2.62
b) Fine aggregate : 2.39
Water absorption
a) Coarse aggregate : 0.5%
b) Fine aggregate : 1.0%

III.TARGETSTRENGTH FOR MIX PROPORTIONING:

Target mean strength

f^1c = 1.65 S.D + fck
= 1.65*4+25
= 31.6 N/mm^2

Characteristic strength @ 28 days = 25 N/mm^2

IV SELECTION OF W/C RATIO: From table 5 of IS 456
Max w/c ratio : 0.5

V. SELECTION OF WATER CONTENT:

Max water content 186 lit
Estimated water content : $186 + \frac{3}{100} * 186$
: 191 litre
SP used : 1% by wt of cement

VI. CALUCULATION OF CEMENT CONTENT:

W/c ratio : 0.5
Cement content : 383 kg/m^3 from table 5 of IS-456,
Minimum cement content for normal exposure condition=310 kg/m^3
383 kg/m^3 > 310 kg/m^3
Hence ok.

VII.PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT:

From table 3, volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate (zone III) for w/c ratio of 0.50 =0.64.
Volume of coarse aggregate = 0.64
Volume of fine aggregate = 1-0.64
= 0.36

VIII. MIX CALCULATIONS: The mix calculations per unit volume of concrete shall be as follows:

Volume of concrete = $1m^3$

Volume of cement = $\frac{mass\ of\ cement}{specific\ gravity\ of\ cement} * \frac{1}{1000}$

= $\frac{383}{2.92} * \frac{1}{1000}$

= $0.13m^3$

Volume of water = $\frac{mass\ of\ water}{specific\ gravity\ of\ water} * \frac{1}{1000}$

= $\frac{191.58}{1} * \frac{1}{1000}$

= $0.191m^3$

Volume of SP = $\frac{3.83}{1.145} * \frac{1}{1000}$

= $0.003m^3$

Volume of all in aggregate = [a-(b + c + d)]
= [1-(0.13+0.191+0.003)]
= $0.676m^3$

Mass of coarse aggregate = e *volume of coarse aggregate specific gravity of coarse aggregate*1000

= 0.676*0.64*2.62*1000

= 1133.5 kg

Mass of fine aggregate = e * volume of fine aggregate * specific gravity of fine aggregate*1000

= 0.676*0.38*2.39*1000

= 581.63 m^3

IX. MIX PROPORTIONS FOR TRIAL MIX (1 cum):

Table:1 Mix proportion for 1 cum

MIX IDENTITIES	NOMINAL MIX
Cement (kg)	383
Fine aggregate	582
Coarse aggregate	1134
W/C	0.5
Water (lit)	192

2. MIX PROPORTIONS FOR 6 CUBES (15x15x15):

Table: 2 Mix proportions for 6 Cubes

MIX IDENTITIES	NOMINAL MIX
Cement (kg)	7.2
Fine aggregate	14.0
Coarse aggregate	28.0
W/C	0.5
Water (litre)	4.00

MIX PROPORTION (6cubes) BY USING GGBS &SP:

Table: 3 Mix proportion using GGBS & SP

Properties	Test results
Normal consistency	32%
Specific gravity	3.09
Setting time: • Initial setting time • Final setting time	30minutes 480minutes
Fineness of cement	99.5 %
Bulk density	1.44 gm/cc

Mix identities	Nominal mix	2.5 % GGBS	5% GGBS	10% GGBS	15% GGBS	20% GGBS
% of added cement	NIL	97.5	95	90.0	85.0	80.0
%of replacement of GGBS	NIL	2.5	5.0	10.0	15.0	20.0
Cement (kg)	7.1	7.1	6.925	6.561	6.196	6.00
GGBS (kg)	NIL	0.1	0.2	0.4	0.6	0.8
SP (ml)	NIL	71	69.2	65.61	61.96	60.0
Fine aggregate (kg)	14.0	14.0	14.0	14.0	14.0	14.0
Coarse aggregate (kg)	28.0	28.0	28.0	28.0	28.0	28.0
Water (lit)	4.0	4.0	4.0	4.0	4.0	4.0

EXPERIMENTAL WORK:

PREPARATION OF MATERIALS:

As per the calculations were done with respect to IS 10262:2009 collect the required amount of cement, GGBS, fine aggregates, coarse aggregates, super-plasticizers and water and mix the matter with appropriate measurements.

MIXING: Mixing of concrete is done by two methods they are,

1. Hand mixing.
2. Machine mixing.

TESTS ON FRESH CONCRETE: After mixing of all the concrete properties thoroughly the following workability tests to be taken to the results of the grade of the concrete. The experiments done on the concrete material are

1. Slump flow test
2. L-Box test
3. U-Box test
4. V-Funnel test

RESULTS & DISCUSSION:

CEMENT:

Table: 4 Physical properties of Portland cement

COMPRESSIVE STRENGTH OF CEMENT:

Table: 5 Compressive Strength of Cement

S.No	Compressive Strength of Cement	Values Obtained	Standard Values
1	3 days	24.42	27
2	7 days	35.11	37
3	28 days	50.23	53

FINE AGGREGATE:

Table: 6 Physical properties of fine aggregate

Properties	Test results
Specific gravity	2.39
Bulk density	1.7

COARSE AGGREGATE:

Table: 7 Physical properties of coarse aggregate

Properties	Test results
Specific gravity	2.62
Bulk density	1.52

FRESH CONCRETE TEST:

Table: 8 Fresh Concrete Test Values

S.No	Methods	Units	Property	Min	Max	Values Obtained
1	Slump Flow test	Mm	Filling ability	650	800	550
2	T50 cm Slump Flow	Sec	Filling ability	2	5	3
3	L-Box test	(h2/h1)	Passing ability	0.8	1	0.8
4	U-Funnel test	(h2-h1) mm	Passing ability	0	30	25
5	V-Funnel test	Sec	Filling ability	6	12	10
6	V-Funnel at T5 minutes	Sec	Segregation resistance	0	3	2

Table:9 Compressive Strength Test for different proportions of GGBS

MIX ID	3 days	7 days	14 days	28 days
Nominal mix	12.54	15.42	20.16	23.98
2.5% GGBS	20.33	22.43	28.60	35.57
5% GGBS	19.36	22.91	30.43	37.46
10% GGBS	18.30	23.65	32.03	39.11
15% GGBS	16.69	24.25	34.17	42.29
20% GGBS	15.24	26.38	37.49	45.86
25% GGBS	14.36	28.22	39.21	46.73
30% GGBS	13.18	25.45	36.84	43.52

COST COMPARISON

From the above results and graph plotted which will give the different proportions of GGBS.

COST ANALYSIS:

Table:10 Cost Analysis

ITEM	QUANTITY	RATE	TOTAL COST
Cement	1 bag	300	300
Fine aggregate	3 bags	200	600
Coarse aggregate	4 bags	100	400
GGBS	1 bag	500	500
Superplasticizer	1 can	900	900
		TOTAL	2700

Comparison of cost analysis of materials (1cum)

Table:11 Comparison of cost analysis of materials

Materials	Nominal mix	2.5% GGBS	5% GGBS	10% GGBS	15% GGBS	20% GGBS	25% GGBS	30% GGBS
Cement	2160	2103.7	2052	1944	1836	1781.76	1666.6	1555.5
Fine Aggregate	975.25	975.25	975.25	975.25	975.25	975.25-	975.25	975.25
Coarse Aggregate	3829.5	3829.5	3829.5	3829.5	3829.5	3829.5	3829.5	3829.5
GGBS	0	40	40	40	40	40	40	40
Super plasticizer	0	0.54	0.54	0.54	0.54/-	0.54	0.54	0.54
Total	6964/-	6948/-	6897/-	6789/-	6681/-	6627/-	6511/-	6400/-

Comparison of cost analysis of materials (1cum)

Table:11 Comparison of cost analysis of materials

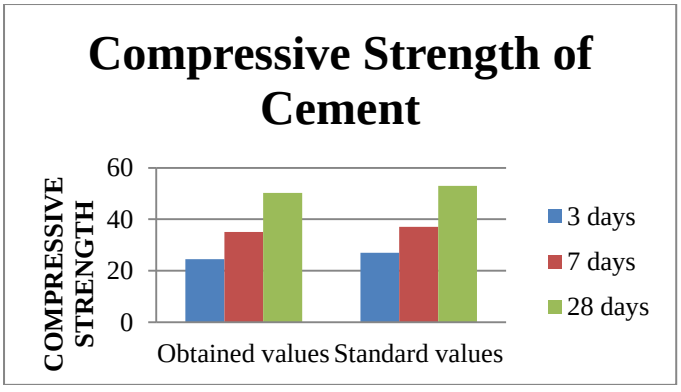

Fig.1: Compressive Strength of cement.

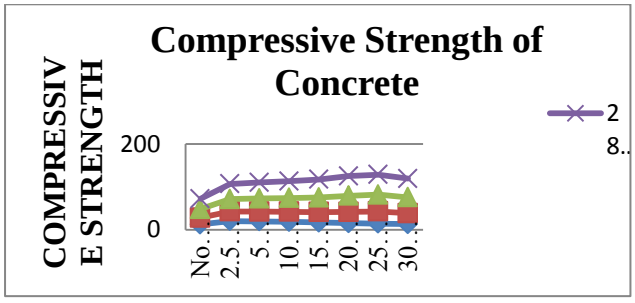

Fig.2: Compressive Strength of Concrete.

Fig. 2 shows the relation between the compressive strength of concrete with the addition of GGBS. As a percentage of GGBS is increased its showing good strength with 25% of GGBS on 3rd, 7th, 14th and 28th day.

CONCLUSION

The latest trend in concrete research is to use mineral admixtures in preparing the concrete mixes. In this work, SCC prepared using the GGBS are evaluated in terms of self-compact ability, compressive strength. From the experimental investigations, the following conclusions have been drawn:

Self Compacting Concrete (SCC) technology can save time, cost, enhance quality, durability and Moreover it is a green concept.

It was observed that as the GGBS proportion is increasing, initially there is a decrease in strength for 3 days, simultaneously there is an increase in strength for 7,14,28 days for all the proportions except for the 30% proportion as there is a decrease in the strength for this proportion.

Replacement up to 30% of cement with GGBS shows a decrease in strength when compared to replacement of cement with GGBS of 25%.

The results derived from compressive strength tests showed that GGBS cement is more effective than Normal concrete in terms of early strength gain beyond 28 days strength.

REFERENCES

1. Brain Paulson. EFNARC, Secretary-General, 'Specifications and Guidelines for Self-Compacting Concrete", February 2002.
2. Bureau of Indian Standards, IS 10262: 2009, Concrete Mix Proportioning-Guidelines.
3. Bureau of Indian Standards, IS 12269: 1987, "OPC-53 Grade Cement.
4. Bureau of Indian Standards, IS 4031: 1968, For Determining the properties of Cement.
5. CHAMPION, J. M. and JOST, P., 'Self-compacting concrete: Expanding the possibility of Concrete Design and Placement', Concrete International, Vol.22, No.4, pp. 159-178, June 1998.

6. EFNARC (www.efnarc.org) Indian Standard Codes for Concrete & Guidelines.
7. HENDERSON, N. "Self-compacting concrete at Millennium point", CONCRETE, vol.34, No. 4, April 2000, pp.26-27.
8. HEINE, HANS J. "Saving Dollars Through Sand Reclamation - Part 1," Foundry Management and Technology. (May 1983).
9. IS 456-2000, Code of practice for plain and reinforced concrete (3rd revision).
10. IS 516-1959, Method of test for strength of concrete.
11. IS 10262-2009," Recommended guidelines for Concrete mix design", Indian standards bureau, New Delhi, India.
12. IS 383-1970, "Specification for coarse and fine aggregates from natural sources for concrete.
13. Indian standard method of tests for strength of concrete, IS 516: 1959, Edition (1991-07), Bureau of Indian Standards, New Delhi.
14. Nan Su, K.C. Hsu, H.W. Chai. A Simple mix design method for self-compacting concrete, cement and concrete Research 2001.
15. Okamura H., Ozawa K., Mix Design for Self-Compacting Concrete, Concrete Library of Japanese Society of Civil Engineers, June 25, 1995, p. 107-120.
16. Okamura.H.'Self-Compacting High-Performance Concrete', Concrete International, Vol. 19, No.7, pp. 50-54, July 1997.
17. Prentice Hall, pp. 367-378, 1986. ICI Journal July-Sep 2002.
18. SK Singh "Self Compacting Concrete - A Paradigm Shift", *Journal of New Building*.
19. SUBRAMANIAN. S., CHATTOPADHYAY. D, "Experiments for mix proportioning of self-compacting concrete", The Indian Concrete Journal, Jan 2002. 7. The quality of GGBS is as per IS: 12089-1987.